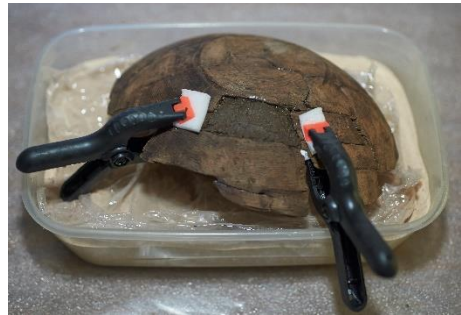
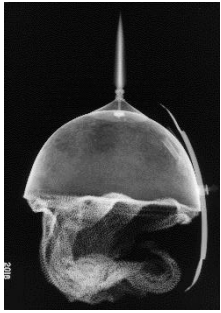


Apport de la microscopie dans la restauration des objets archéologiques

CHARLÈNE PELÉ-MEZIANI, ÉLODIE GUILMINOT ET NICOLAS STEPHANT



Le Laboratoire Arc'Antique

Recherche et Restauration-Conservation



Le Laboratoire Arc'Antique

Recherche et Restauration-Conservation

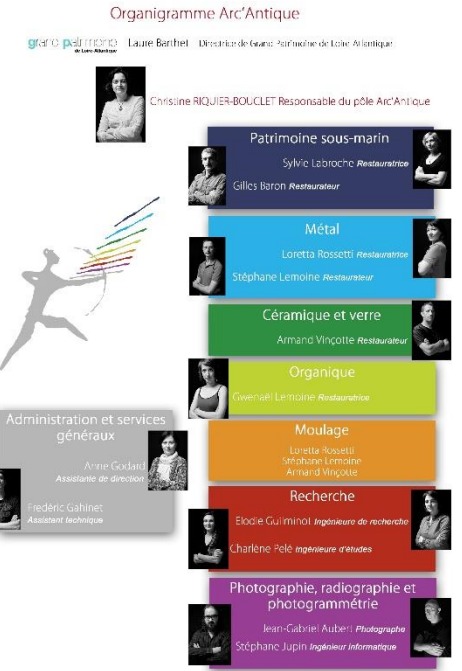


Services
Transversaux

Secteurs
Conservation
Restauration



Secteur
Recherche et
Analyses

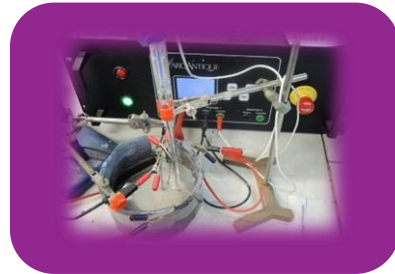
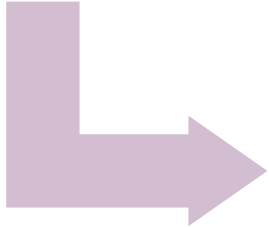


Identification d'un matériau

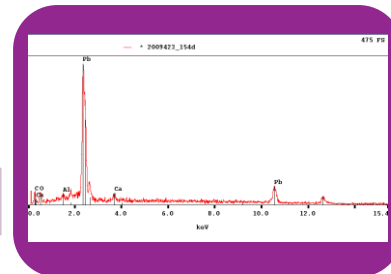
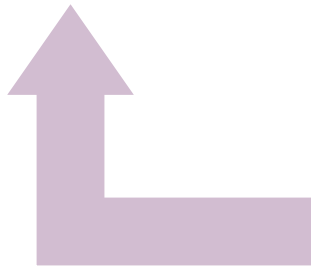
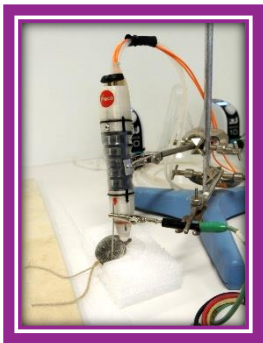
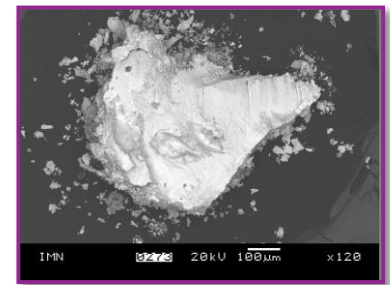
Aide au choix du traitement



- Altération des Objets en Pb



- Traitement par électrolyse



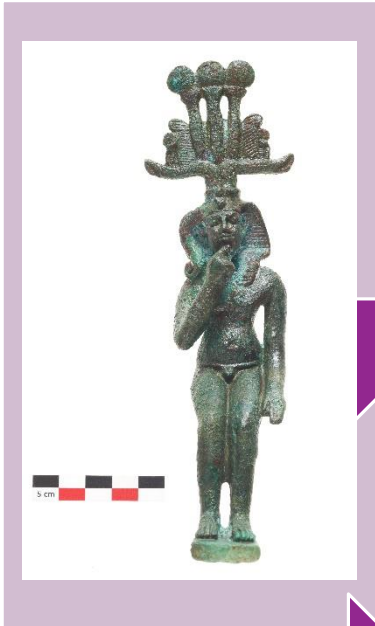
- Analyse MEB-EDS avant traitement

Identification d'un matériau

Aide au choix du traitement



Corrosion active due aux Cl



Analyses MEB-EDS:
Pas de Chlorure
Présence abondante de Sodium
↓
Chalconatronite ($\text{Na}_2\text{Cu}(\text{CO}_3)_2$)

Les Alliages Cuivreux

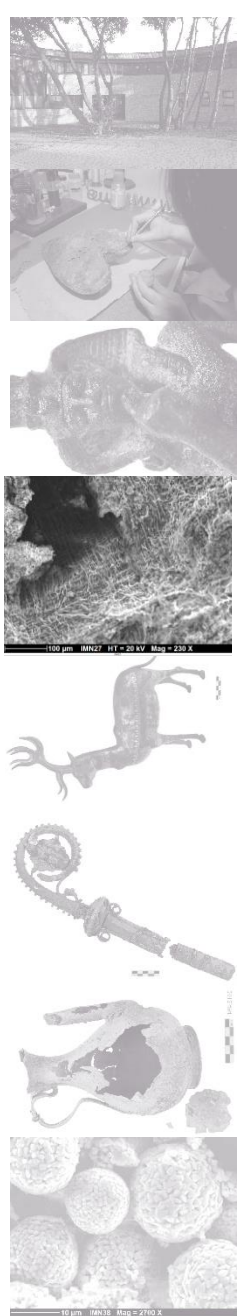


Identification d'un objet

Détermination du matériau organique

Manches de couteau (Musée de Bretagne de Rennes)

Question : OS ou BOIS ?

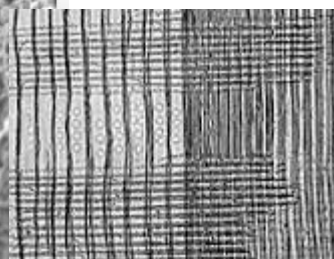
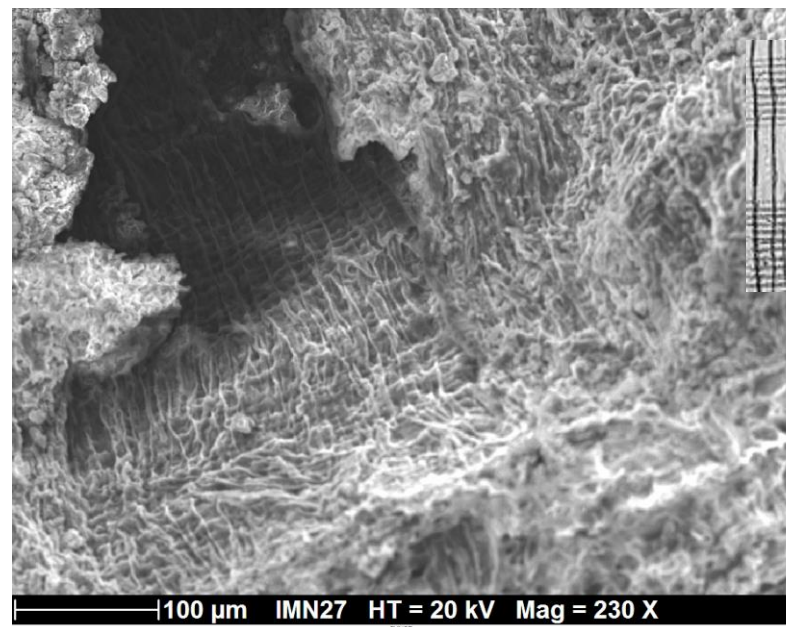
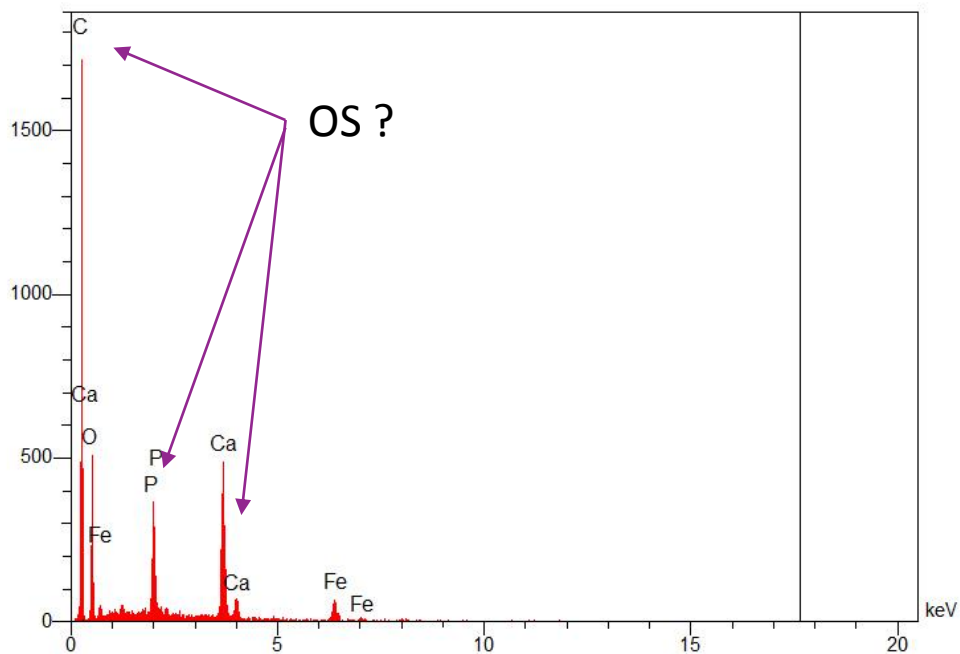


Identification d'un objet

Détermination du matériau organique



Manches de couteau (Musée de Bretagne de Rennes)
Question : OS ou BOIS ?



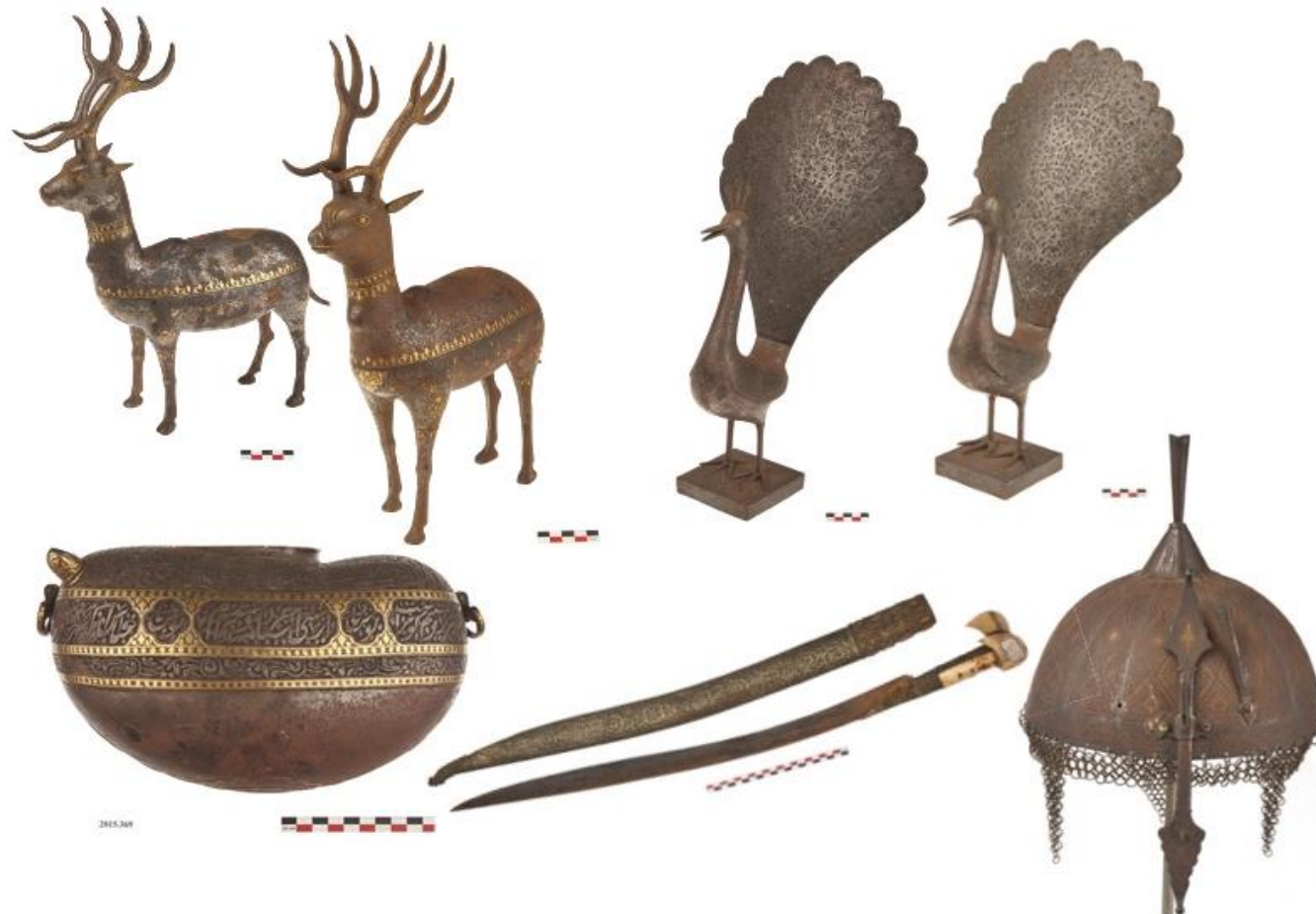
source : site web inra.fr

Analyses IR
BOIS

Compréhension d'un objet

Fabrication et Décoration

Corpus

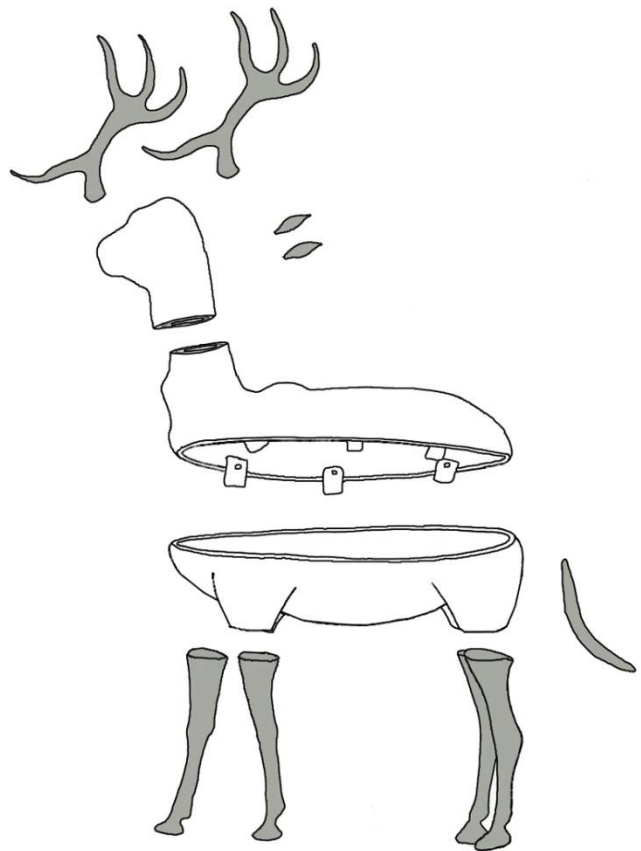


Compréhension d'un objet

Fabrication et Décoration



Questions



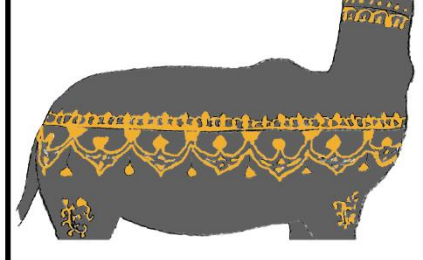
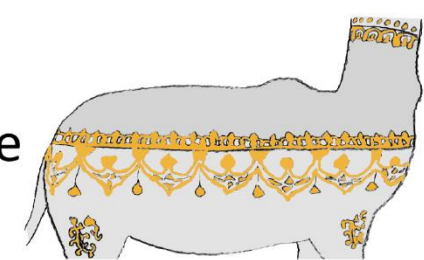
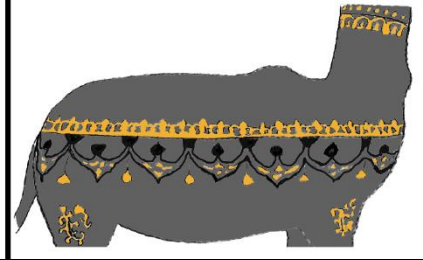
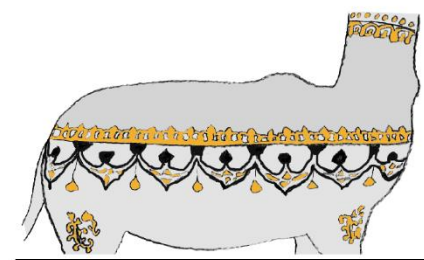
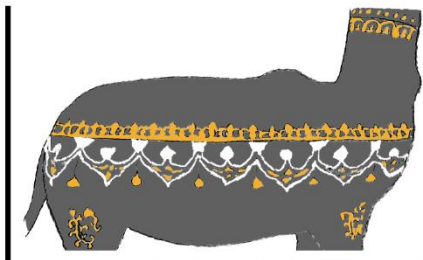
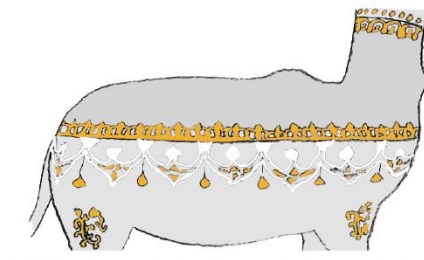
Argent brut

Argent sulfuré

Argent sous-couche adhésive

Fer brut

Fer modifié
(patination, cire, etc.)



Compréhension d'un objet

Fabrication et Décoration

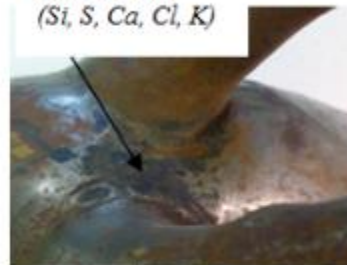
Analyses pour y répondre

154 analyses MEB-EDS
28/46 objets

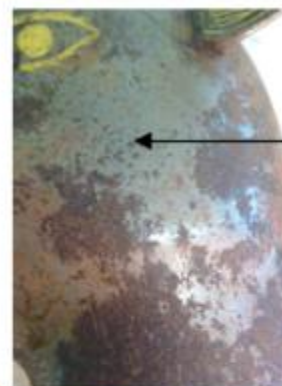
31 : Fe



32 :
C, Fe, Zn
(Si, S, Ca, Cl, K)



33 : Fe



34 :
Au, Ag, Fe
(Cu, Cl)



36 :
Au (Ag, Cu)
Ag, S (Au, Cl)

37 :
Ag, S, Fe
(Cl, Cu, Si)



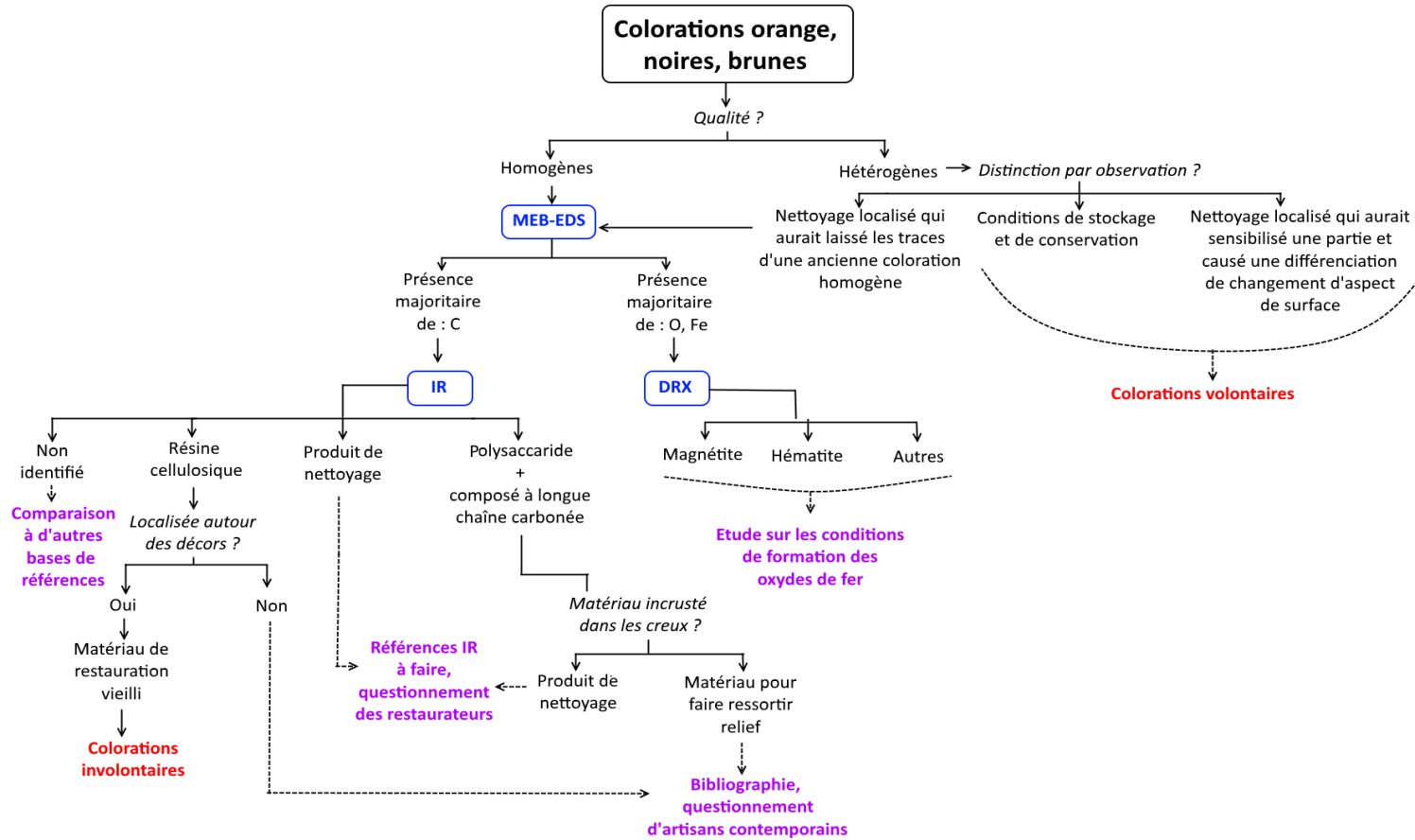
35 :
Ag, S, Fe
(Au, Cu, Al, Si)



Compréhension d'un objet

Fabrication et Décoration

Intérêts MEB-EDS



Compréhension d'un objet

Corrosion

Crosse d'Abbé (11^e siècle) (SRA Poitou Charente)

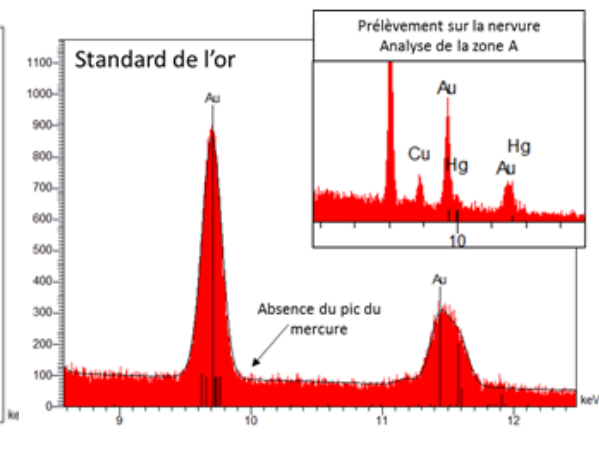
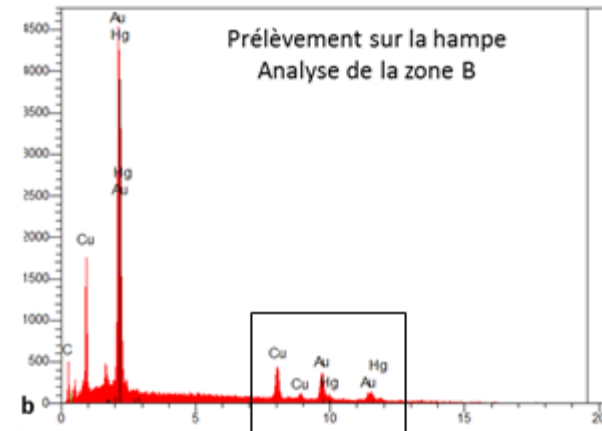
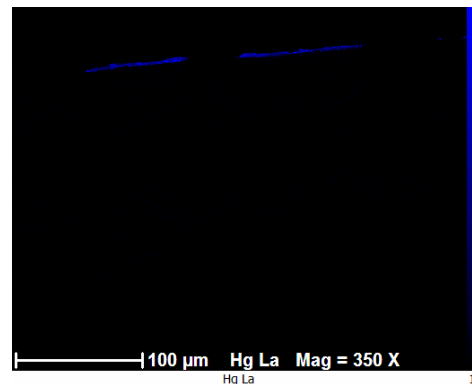
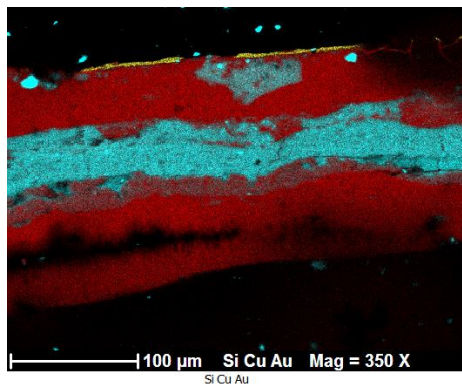
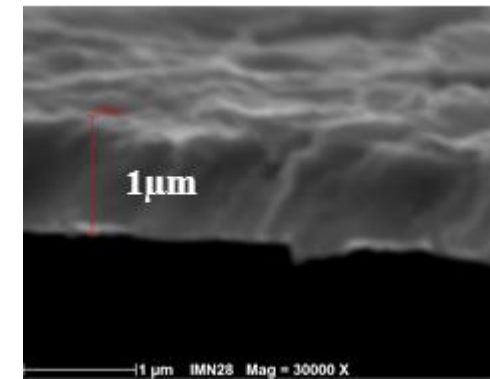
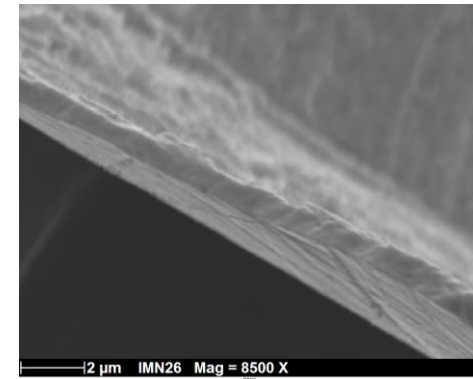
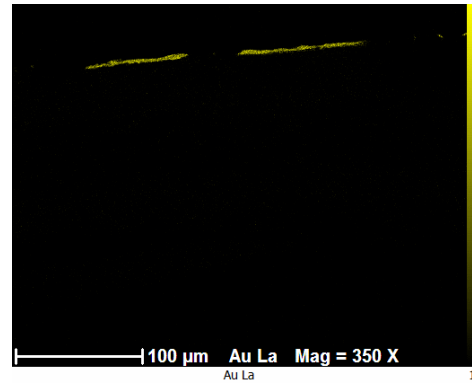
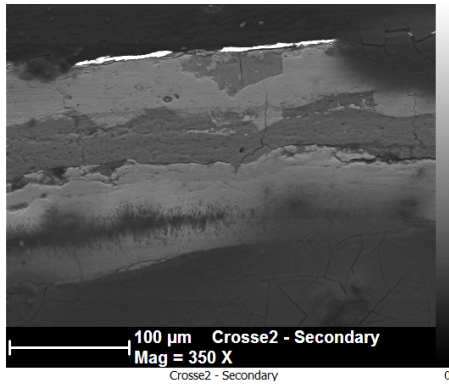
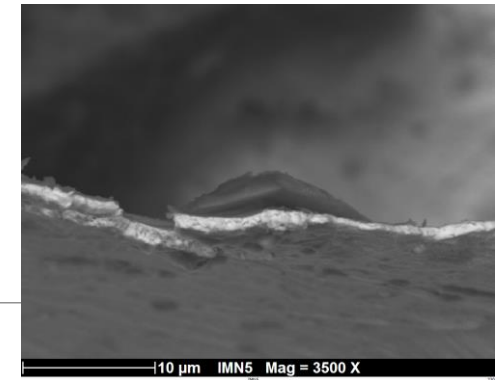


Compréhension d'un objet

Corrosion

Crosse d'Abbé (11^e siècle)

1. Dorure : épaisseur et composition

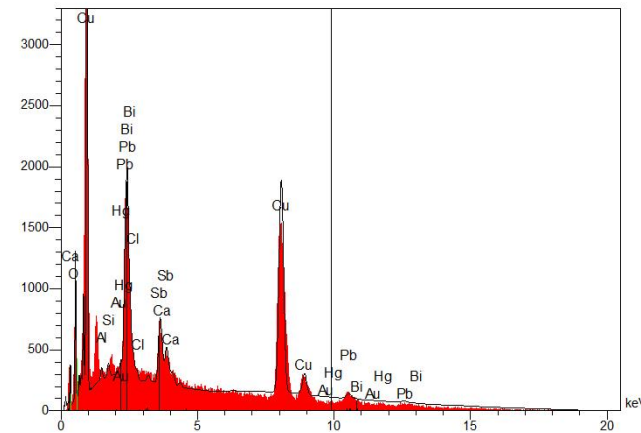
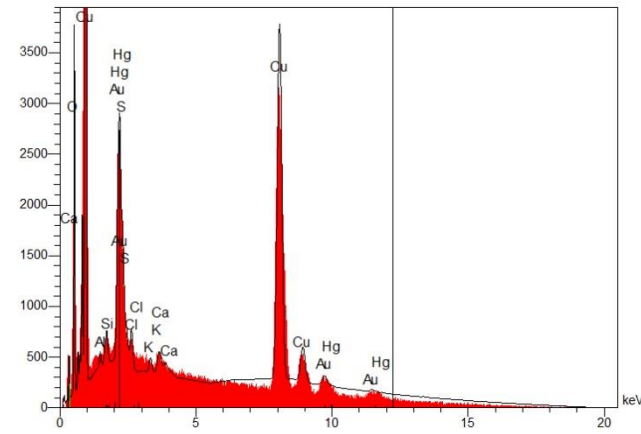
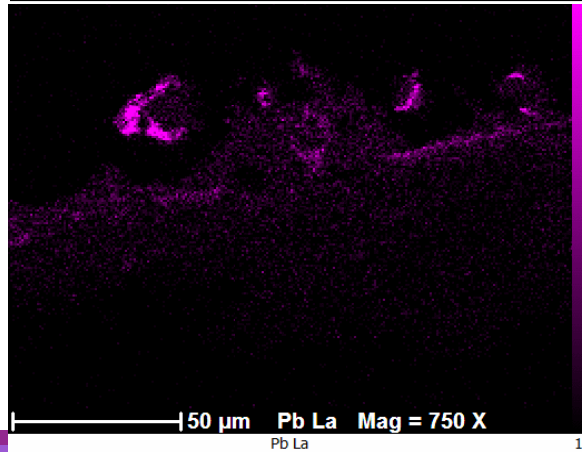
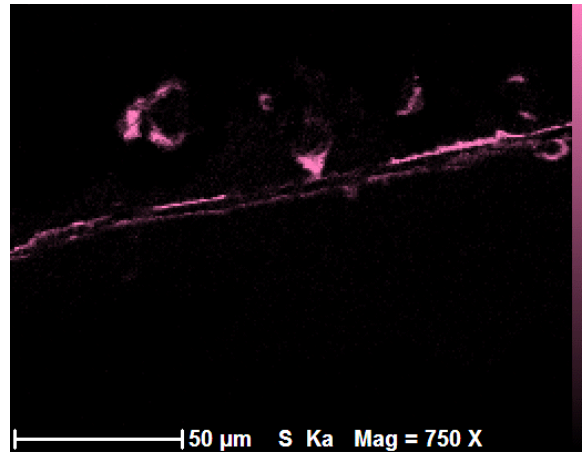
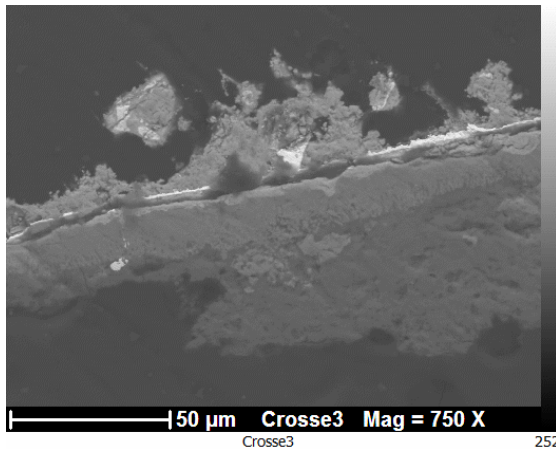


Compréhension d'un objet

Corrosion

Crosse d'Abbé (11^e siècle)

2. Constitution de la surface

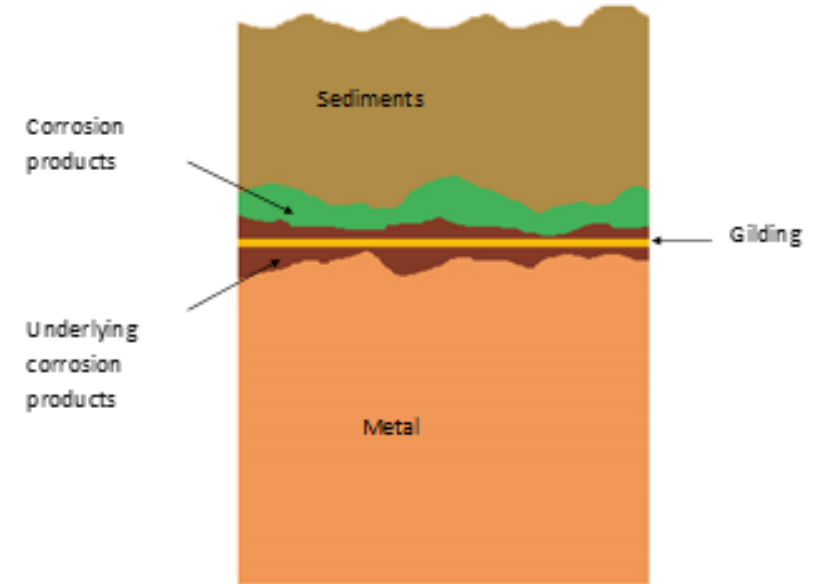
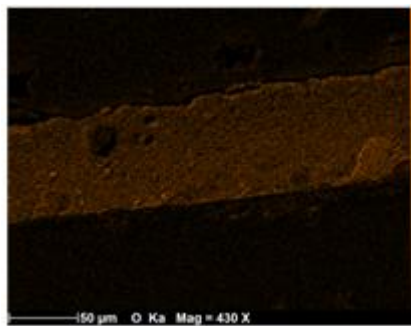
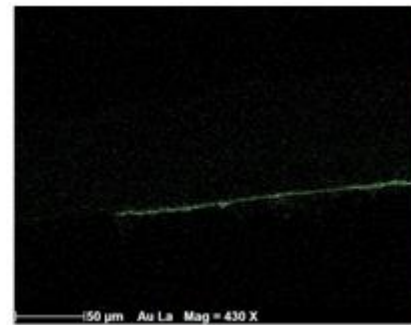
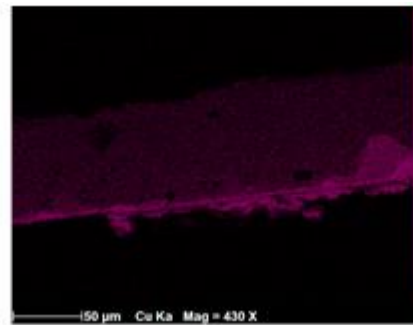
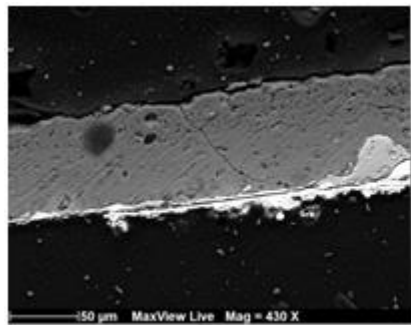


Compréhension d'un objet

Corrosion

Crosse d'Abbé (11^e siècle)

2. Constitution de la surface



L'Argent Corné

Localisation de la surface d'origine

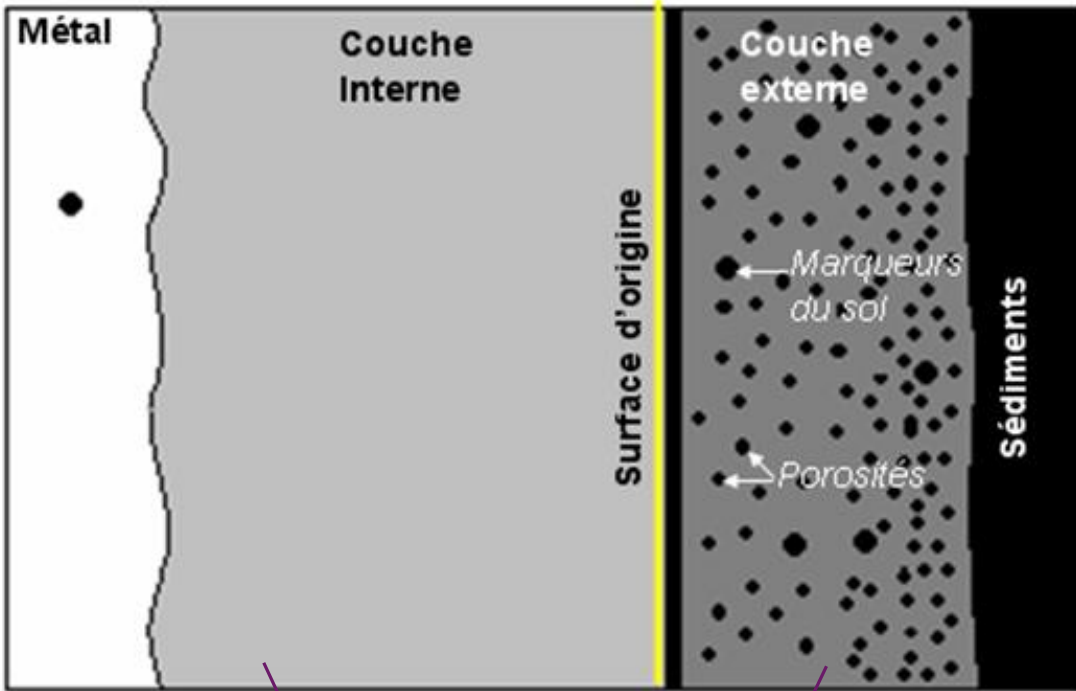


The diagram shows a cross-section of a coin with a central white star-shaped core labeled "Noyau métallique". This core is surrounded by a yellow ring labeled "Surface d'origine". The entire coin is encased in a grey, irregular layer labeled "Couche externe". A red arrow points from the "Couche externe" label to the SEM image. The SEM image shows a detailed view of the surface layers, with a red arrow pointing to the "Couche interne" (inner layer) and another pointing to the "Surface d'origine". A scale bar at the bottom of the SEM image indicates "200µm" and "x65".



L'Argent Corné

Localisation de la surface d'origine



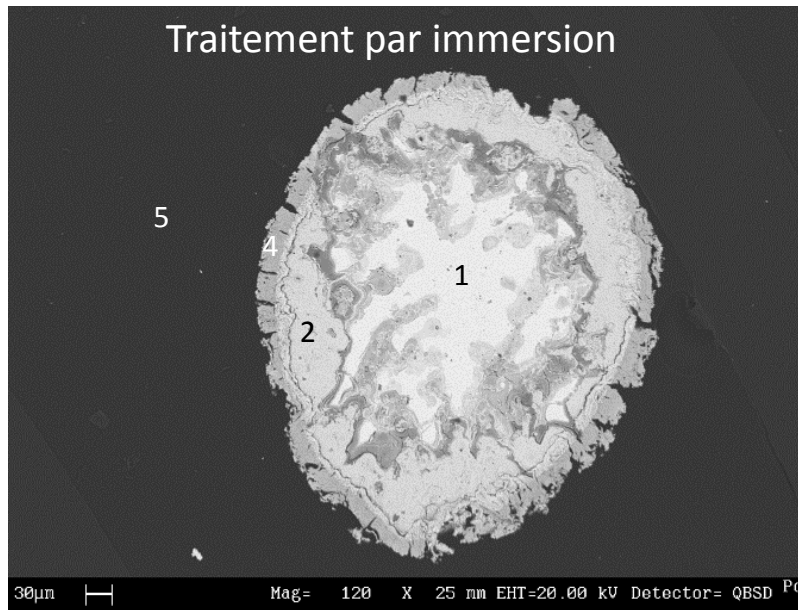
AgCl



L'Argent Corné

Mise au point d'un traitement de restauration

➔ **Thiosulfate d'ammonium**



Sample S3

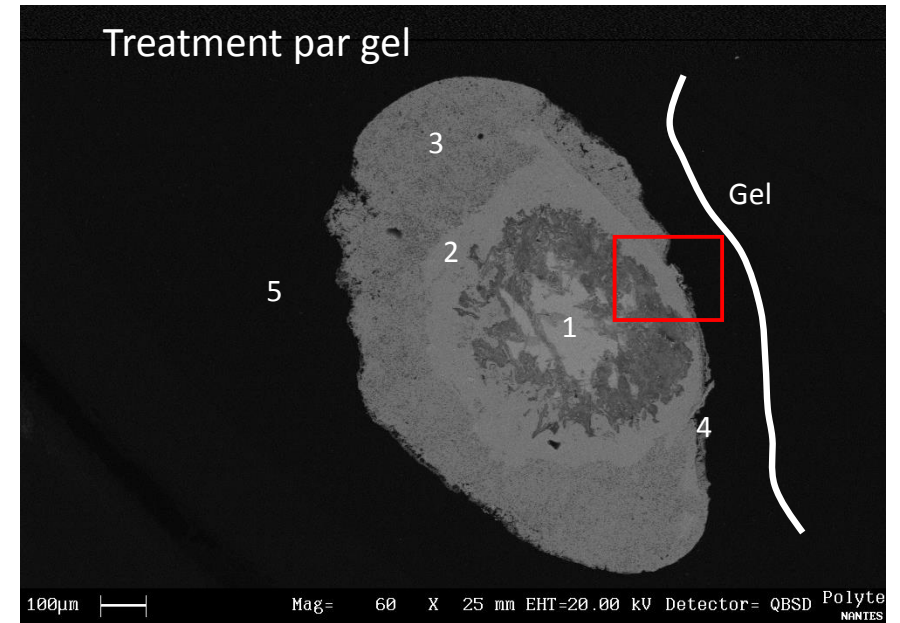
1: Métal

2: couche interne

3: couche externe

4: couche noire

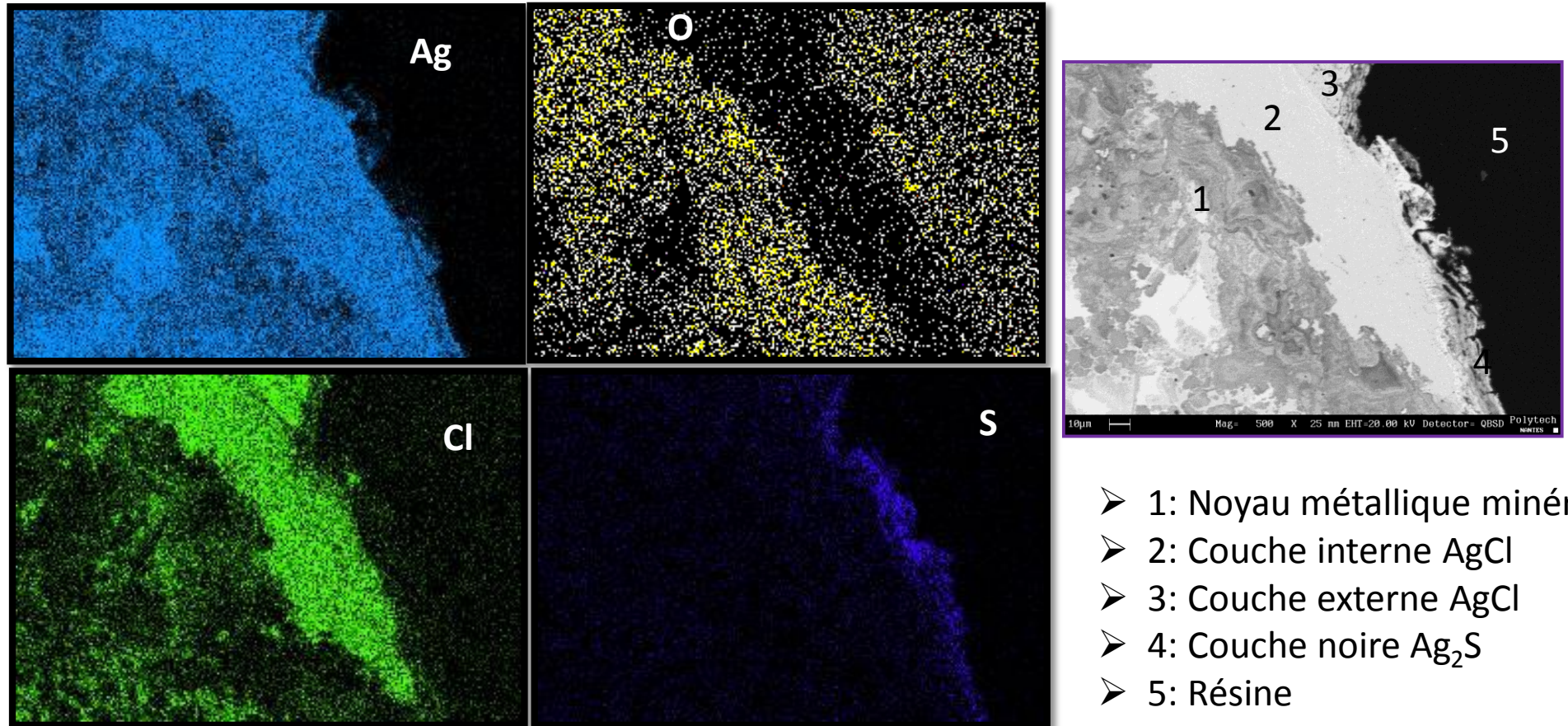
5: Résine



L'Argent Corné

Mise au point d'un traitement de restauration

➔ Thiosulfate d'ammonium par gel



- 1: Noyau métallique minéralisé
- 2: Couche interne AgCl
- 3: Couche externe AgCl
- 4: Couche noire Ag₂S
- 5: Résine

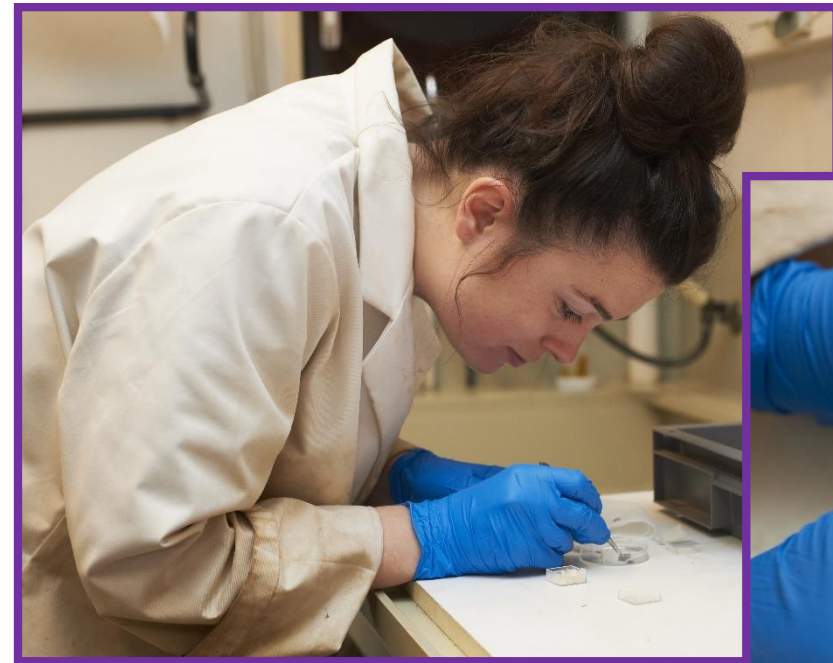
L'Argent Corné

Mise au point d'un traitement de restauration

Application



Thiourée par gel



Localisation de composés

Cas de la pyrite dans les bois archéologiques



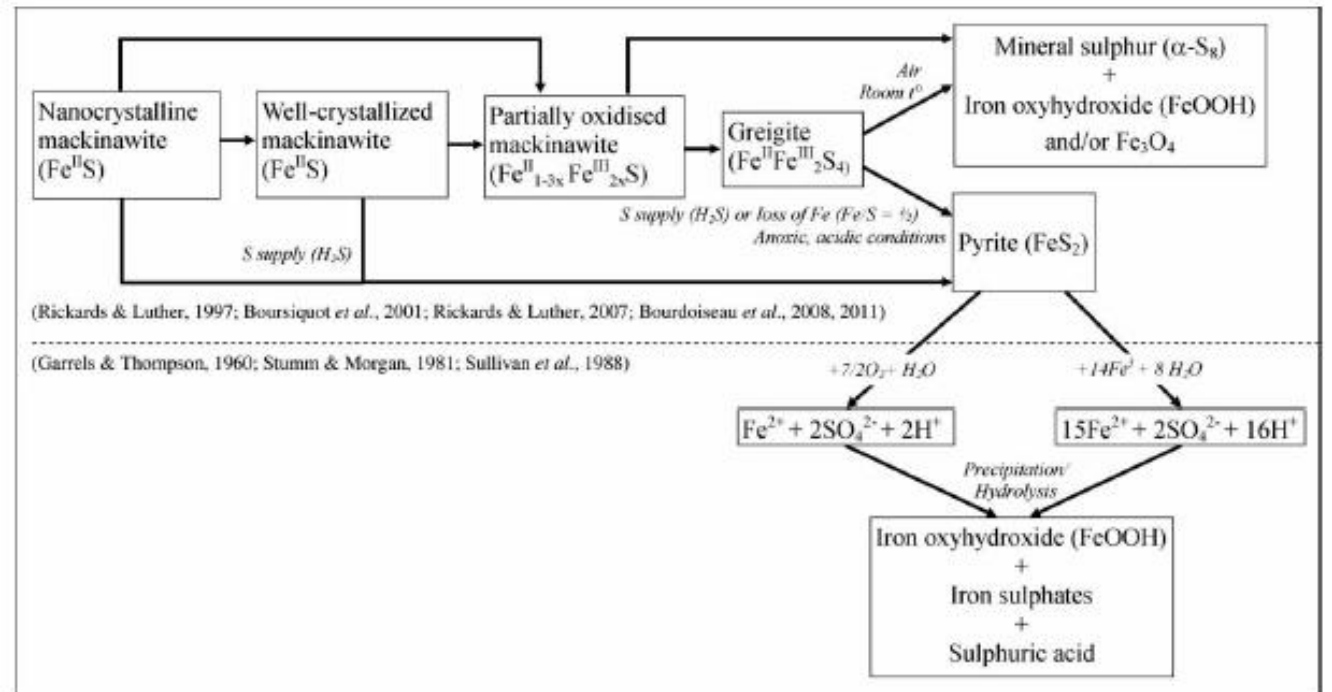
Bactéries



Corrosion du fer



Condition ambiante



Rémazeilles C., *et al.* (2013) SIC

Localisation de composés

Cas de la pyrite dans les bois archéologiques



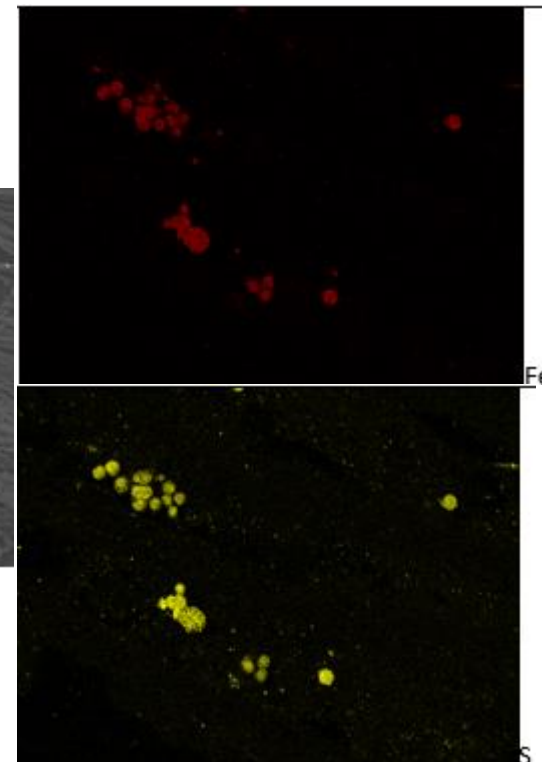
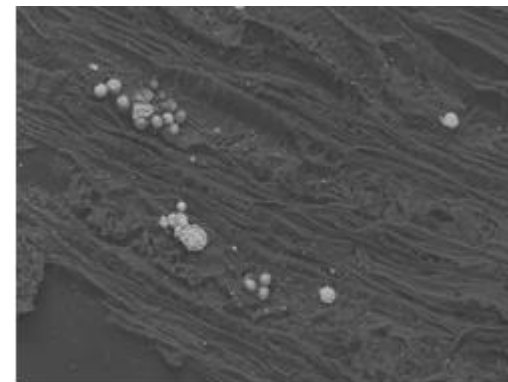
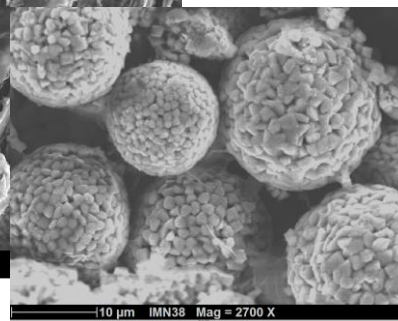
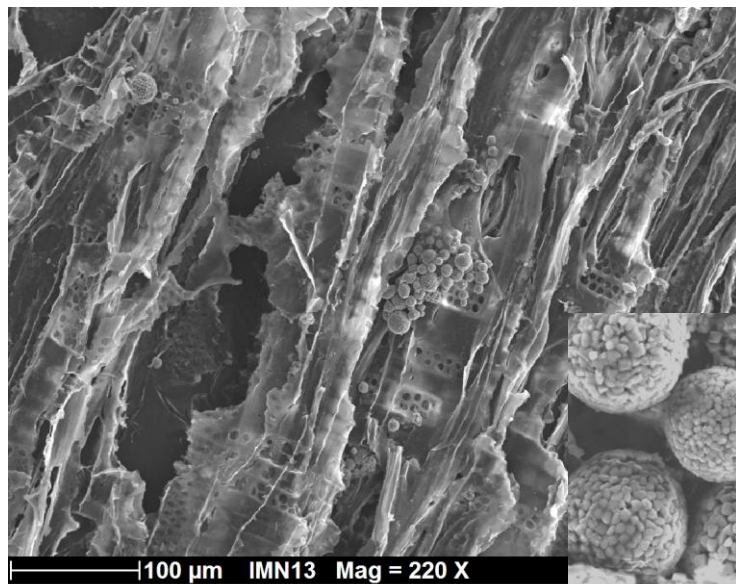
Vasa, 17^{ème} siècle
<http://mondesetmerveilles.cent-erblog.net/243-le-navire-le-vasa?ii=1>



- ⇒ Acidité
- ⇒ Emanation Acide sulfurique
- ⇒ Précipitation Sulfate de fer
- ⇒ Blocage des pores pour imprégnation

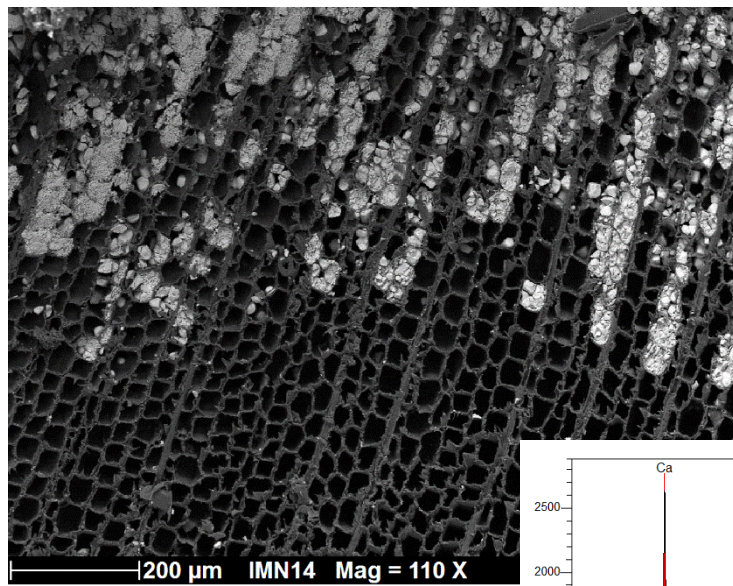
Localisation de composés

Cas de la pyrite dans les bois archéologiques

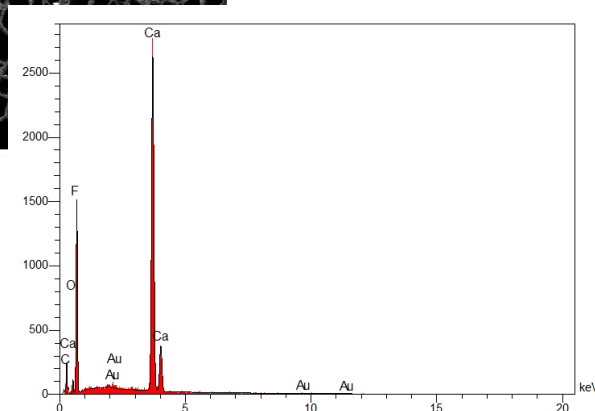


Localisation de composés

Cas de la pyrite dans les bois archéologiques



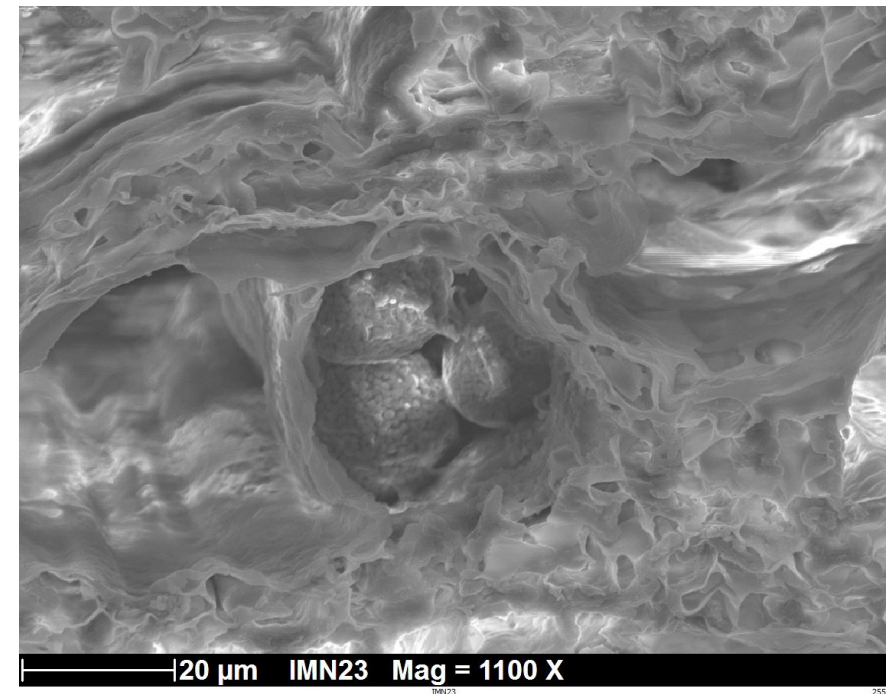
Fluorure de Calcium
Site : Pompéi
Traces d'éruption



Blocage des pores

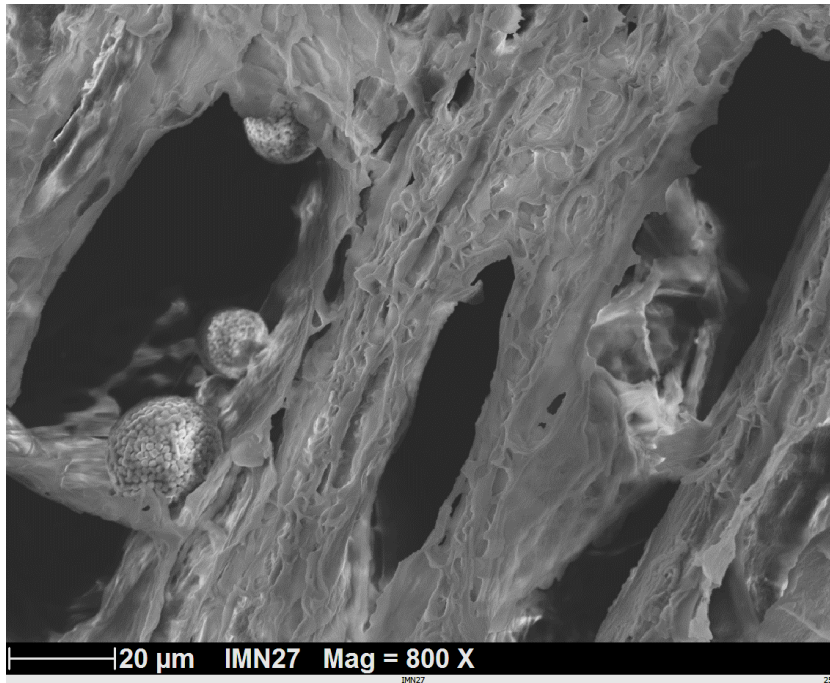


Traitement de consolidation inefficace



Localisation de composés

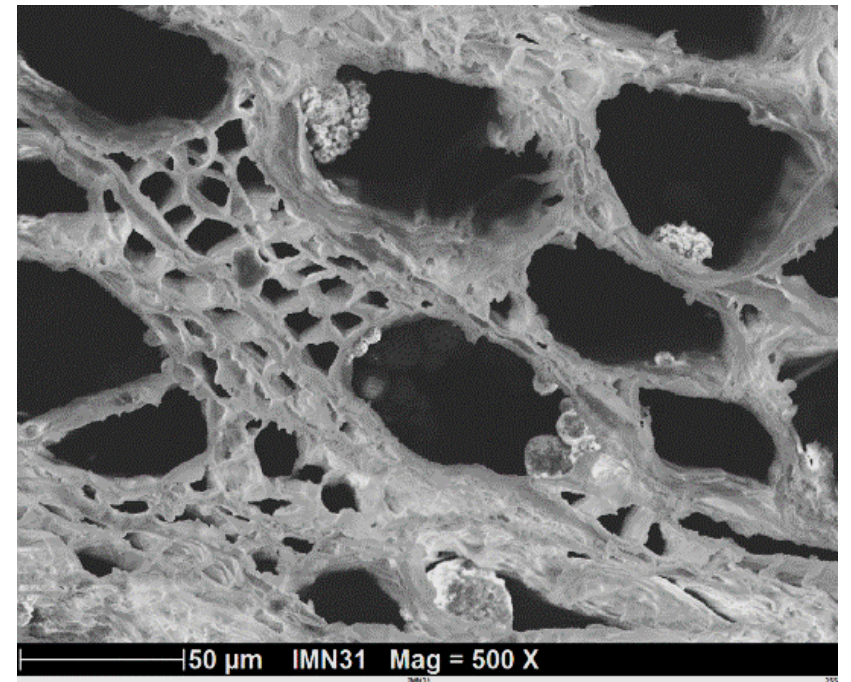
Cas de la pyrite dans les bois archéologiques



Tapissage des parois



Soutien mécanique



Evaluation de la structure anatomique

Cas des pommes de Landevennec (7ème siècle ap.)



1- Pomme fraîche	2- Pomme 8 sans traitement
3- Pomme 8 sans traitement : oxydes de fer ?	4- Pomme 8 pulpe + peau, séchage lent contrôlé
5- Pomme 8 pulpe + peau, séchage solvant	6- Pomme 7 endocarpe, séchage solvant

⇒ Diamètre cellule :
20-100 µm

⇒ Supérieur à celles du bois
(10-20µm)

⇒ Consolidants choisis
PEG 400 (2 nm)
PEG 1000 (4,5 nm)
PEG 4000 (18 nm)

Bilan

- ⇒ Accessible
- ⇒ Réponse rapide
- ⇒ Pertinent / questions
- ⇒ Taille des prélèvements

- ⇒ Représentativité limitée
- ⇒ Prélèvement destructif
- ⇒ Quantification limitée



Merci pour votre attention

