

Colloque final

Pollutions diffuses de la terre à la mer

1^{er} juin 2021



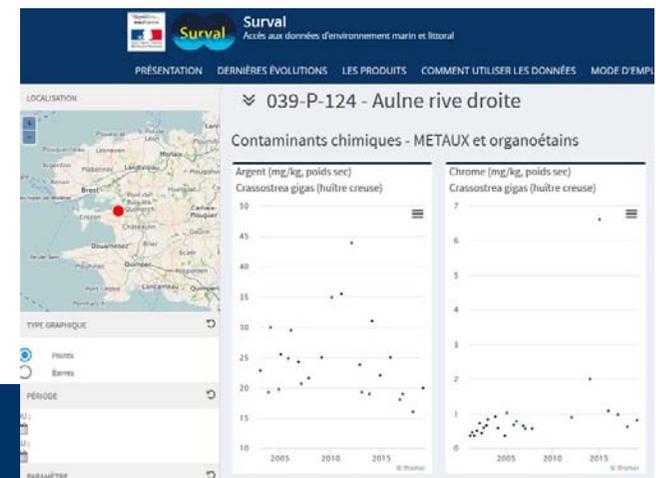
Réseau de surveillance et isotopes: détection de *hotspots* et traçage de sources

Daniel Ferreira Araújo (Ifremer)



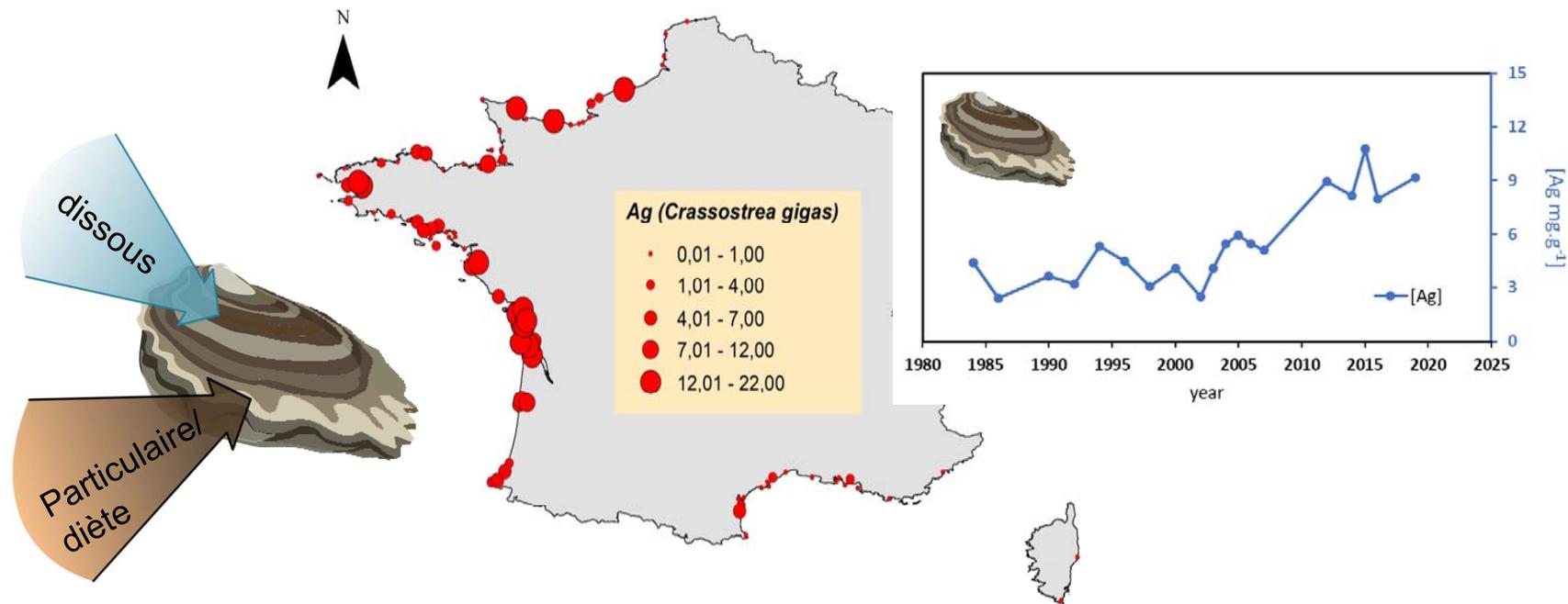
ROCCH- Réseau d'Observation de la Contamination Chimique

- Objectif: évaluer la contamination chimique du milieu marin littoral
- En opération depuis 1974
- Contaminants :
 - Métaux (Cd, Pb, Hg, Cu, Zn, Cr, Ni, Ag, V)
 - les hydrocarbures polycycliques aromatiques (HAP) les PCB, et DDT
- Matrices:
 - Sédiments (tous les six ans)
 - Mollusques bivalves (deux fois dans l'année)/Des espèces commerciales
 - Banque des échantillons
 - Base des données (SURVAL)



Mollusques bivalves

- (1) Fournir des informations sur les tendances de la biodisponibilité des métaux
- (2) Meilleure résolution temporelle que les profils de carottes sédimentaires
- (3) Préparation et analyses d'échantillons relativement simple



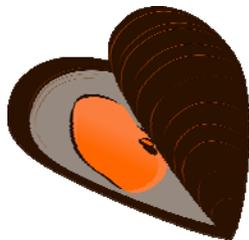
ROCCH- Réseau d'Observation de la Contamination Chimique

Mollusques bivalves:

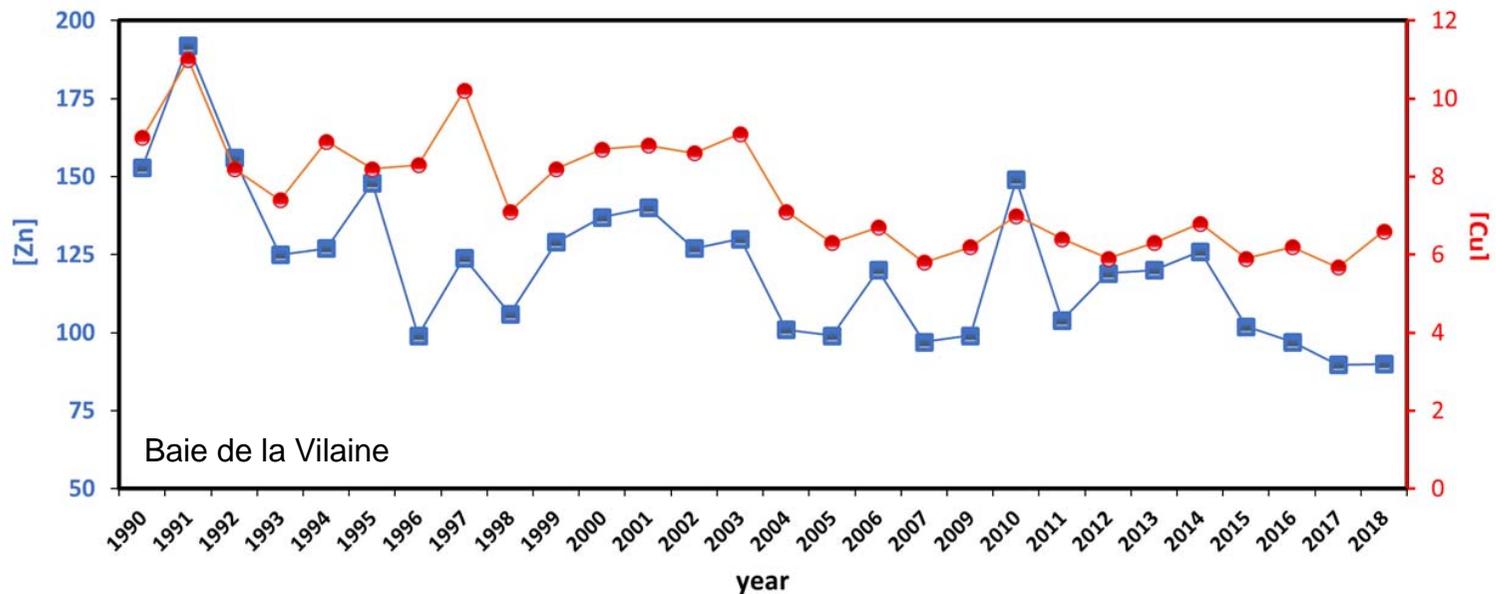
- **Limitations:**

(1) Distinguer les apports anthropiques des apports naturels.

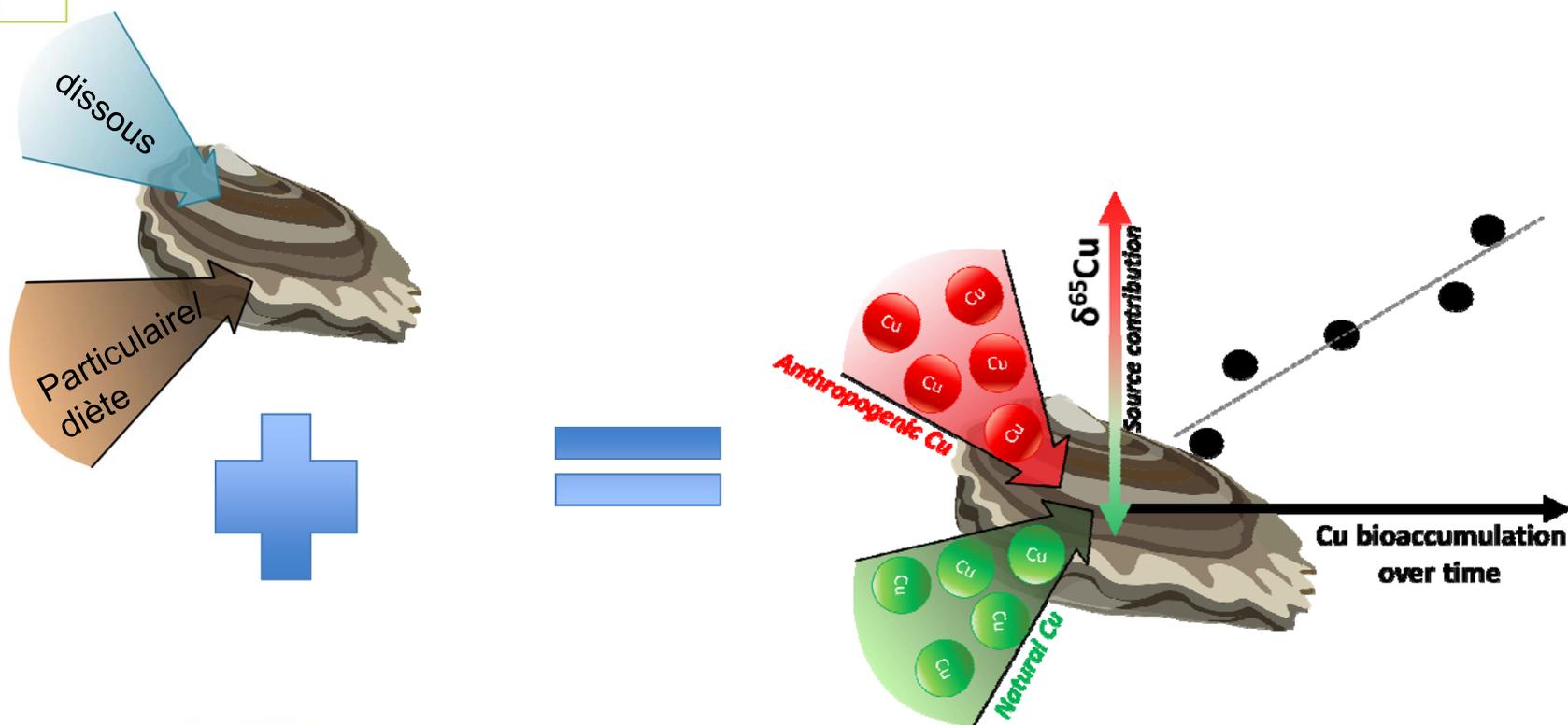
(2) Dépendance avec des facteurs biologiques (taille corporelle, âge, homéostasie) et environnementaux (Eh, pH, salinité, etc.).



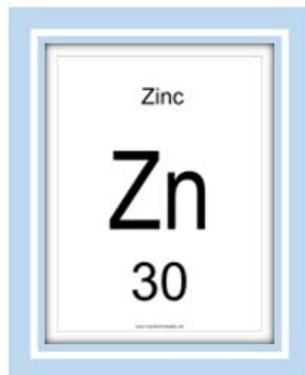
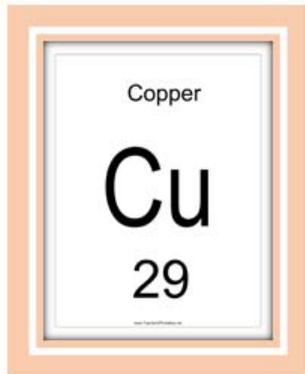
Mytilus edulis



Application des isotopes



Qu'est-ce que ce sont les isotopes ?



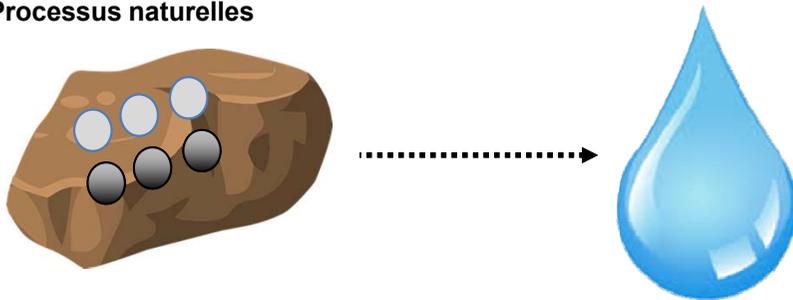
Isotopes	Protons	neutros	Abundances
⁶³ Cu	29	34	69,2 %
⁶⁵ Cu	29	36	30,9 %
⁶⁴ Zn	30	34	48,3 %
⁶⁶ Zn	30	36	28,0 %
⁶⁷ Zn	30	37	4,10 %
⁶⁸ Zn	30	39	19,0 %
⁷⁰ Zn	30	41	0,63 %



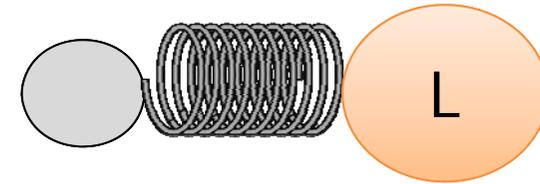
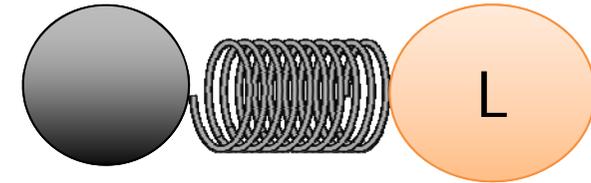
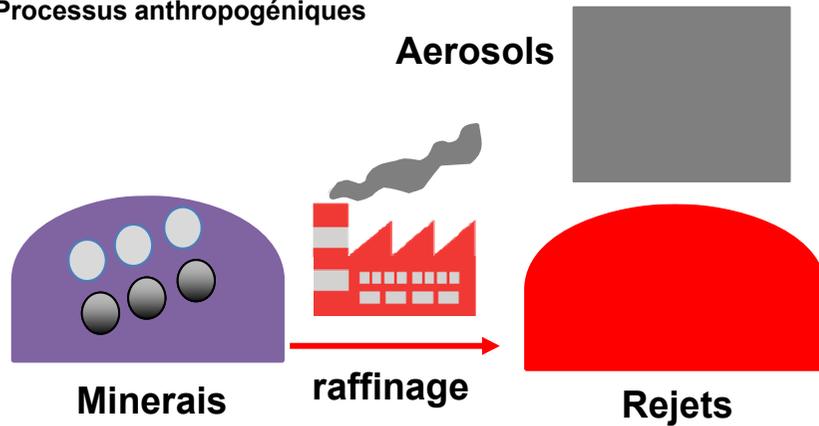
Isotopes stables de Cu et Zn

-  Isotope léger
-  Isotope lourd

Processus naturelles



Processus anthropogéniques



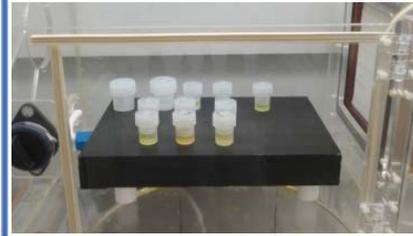
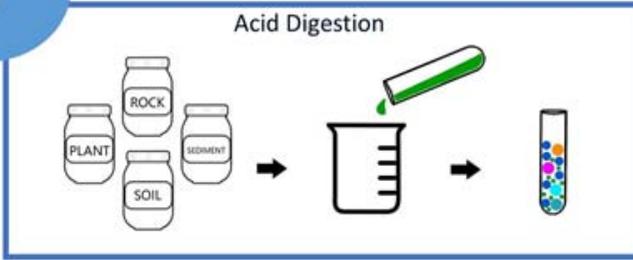
$$E_{\text{vibraciona } l} = \frac{1}{2} h \nu$$

a kinetic isotope effect:
 Light isotopes exhibit faster reaction rates

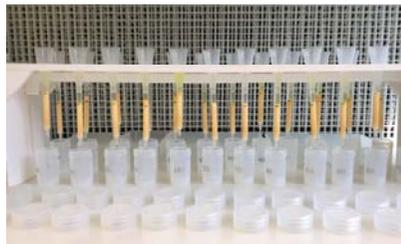
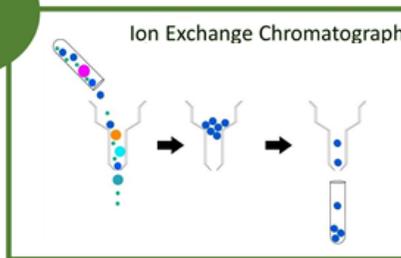
$$E_{\text{kin}} = \frac{1}{2} m v^2 \quad v_{\text{light}} / v_{\text{heavy}} = \sqrt{m_{\text{heavy}} / m_{\text{light}}}$$

b equilibrium isotope effect:
 Heavy isotopes are enriched in compounds with "stiffer" bonds
 (e.g., higher redox state, lower coordination number)

1

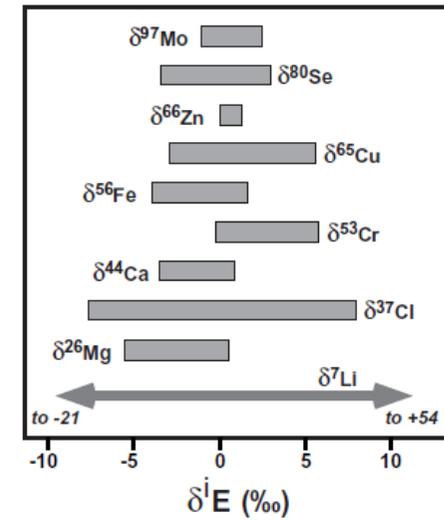
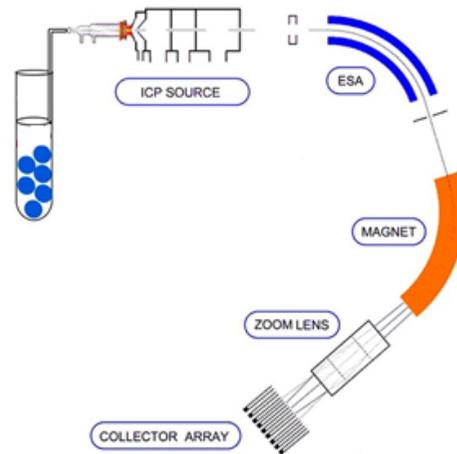


2



3

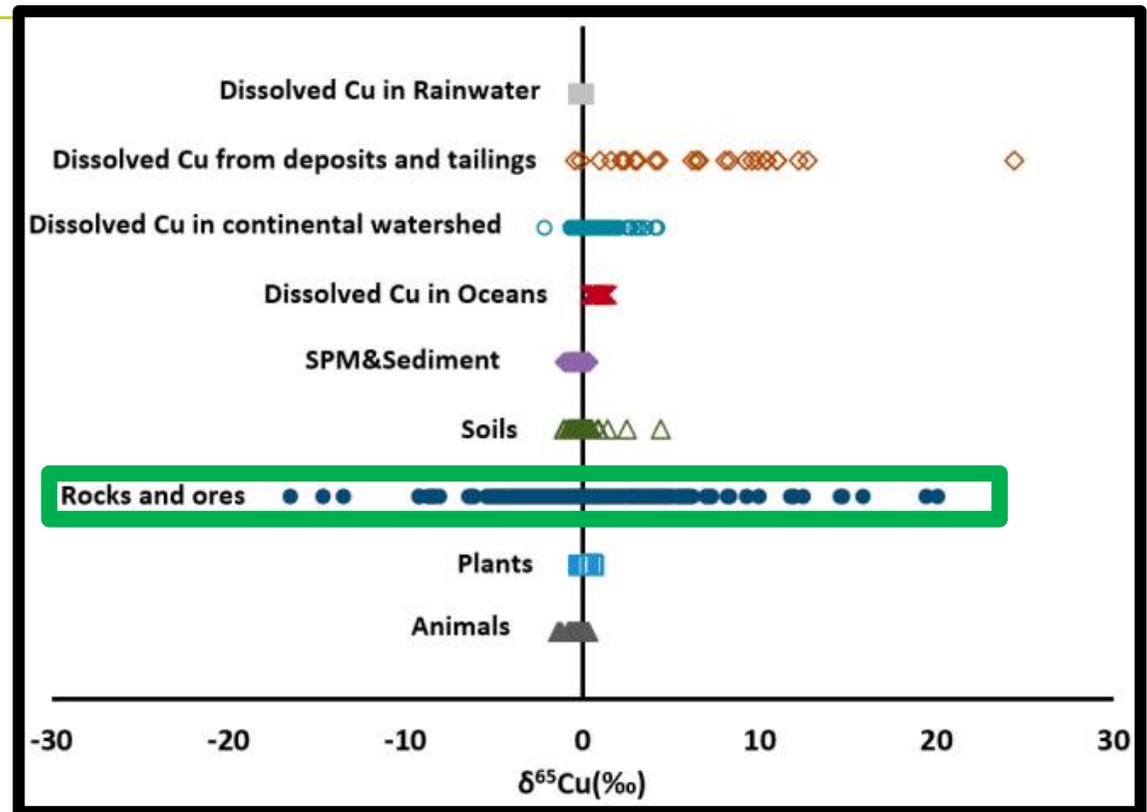
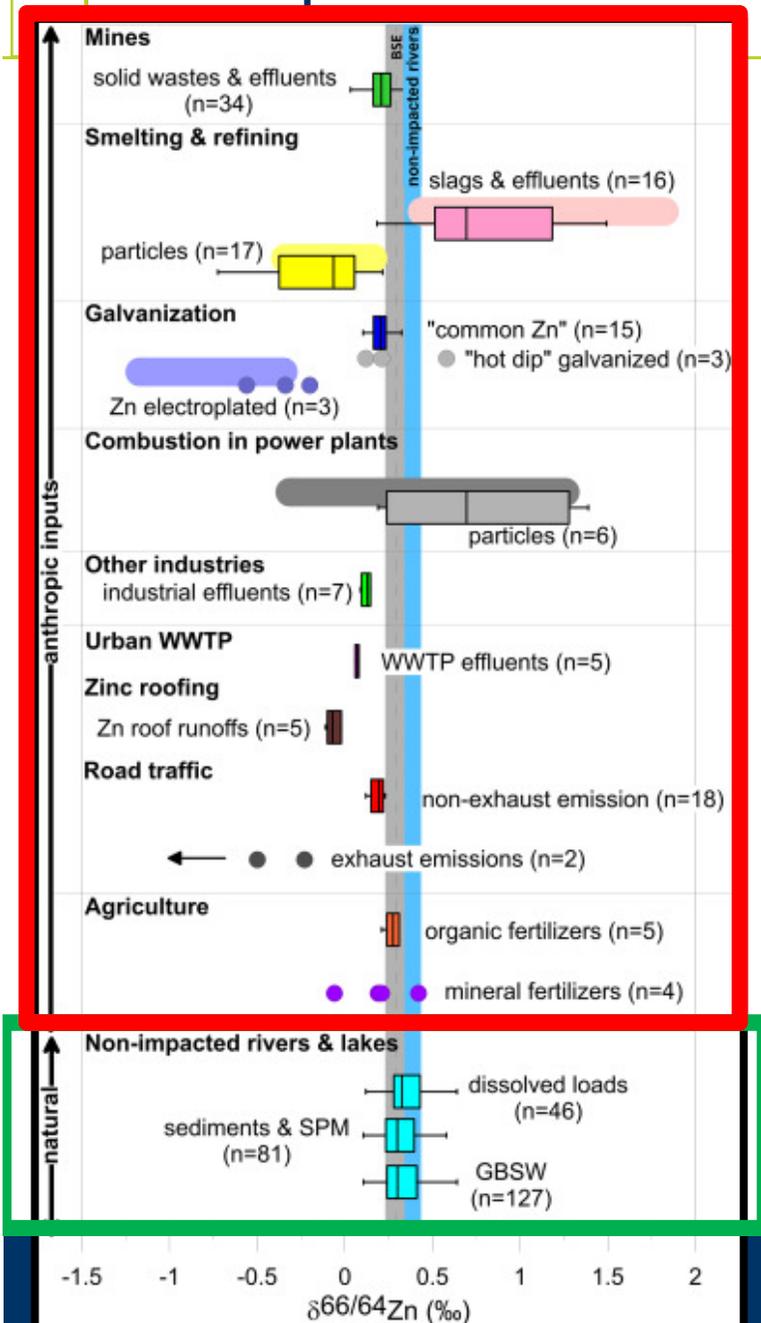
isotope Ratio Measurements by MC-ICP-MS



$$\delta X (\text{‰}) = \left(\frac{R_{\text{sample}}}{R_{\text{standard}}} - 1 \right) \times 1000$$



Isotopes stables de Cu et Zn



Isotopes stables de Cu et Zn



L'application multi-isotopique de Cu, Zn (et Pb)



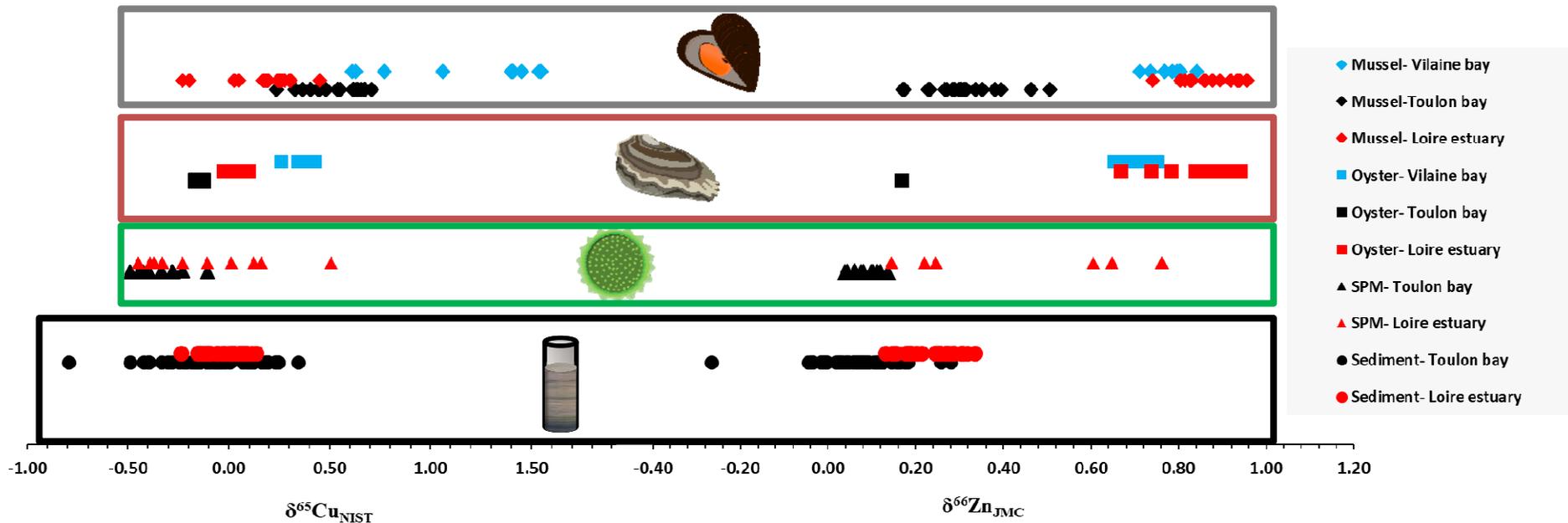
Estuaire de la Loire



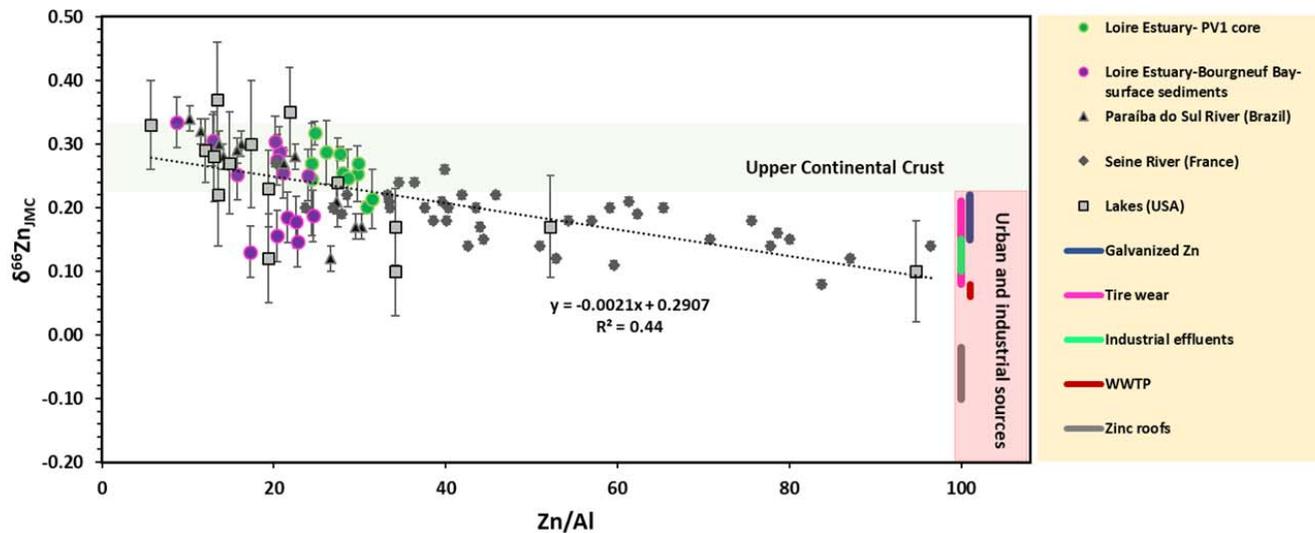
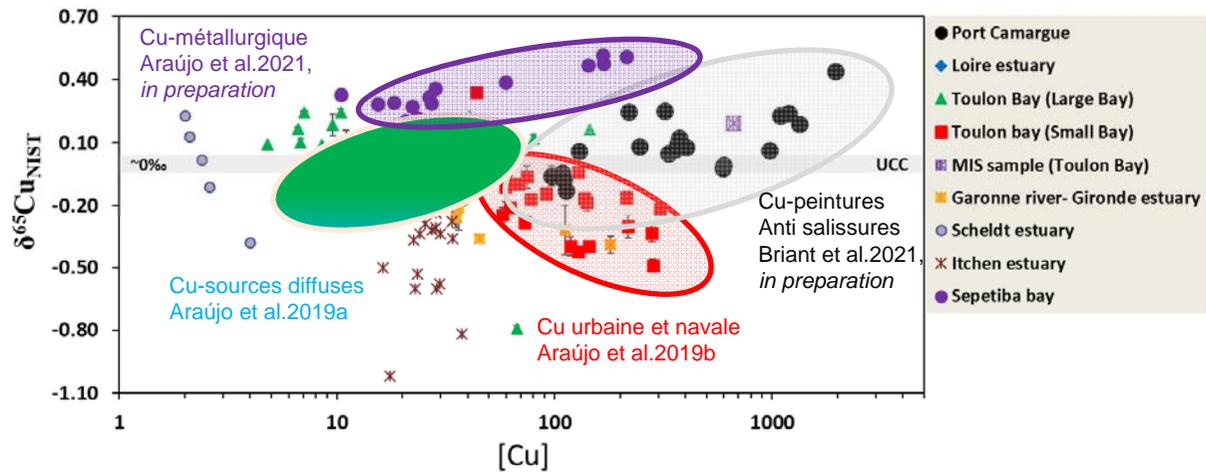
La Rade de Toulon



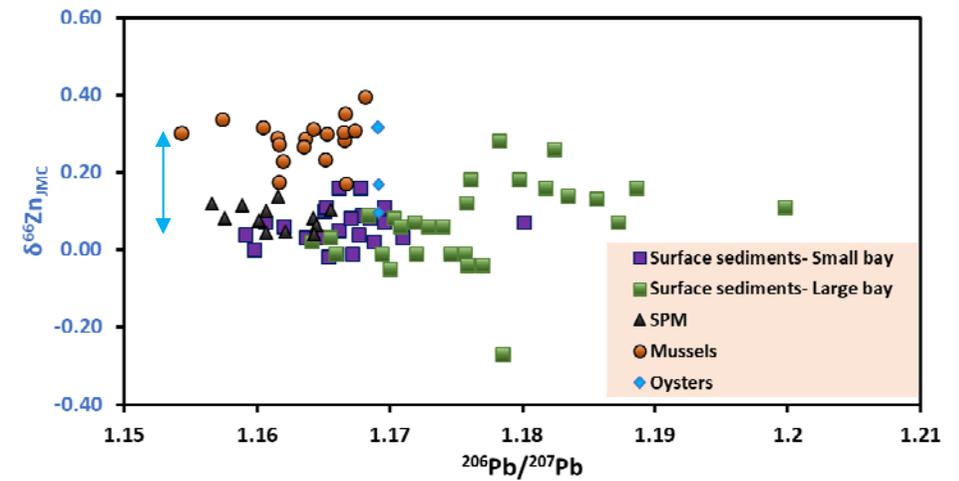
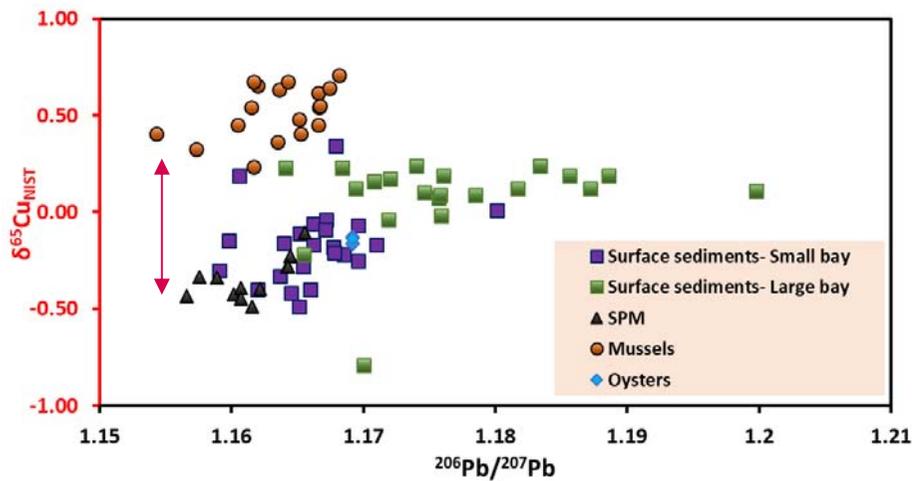
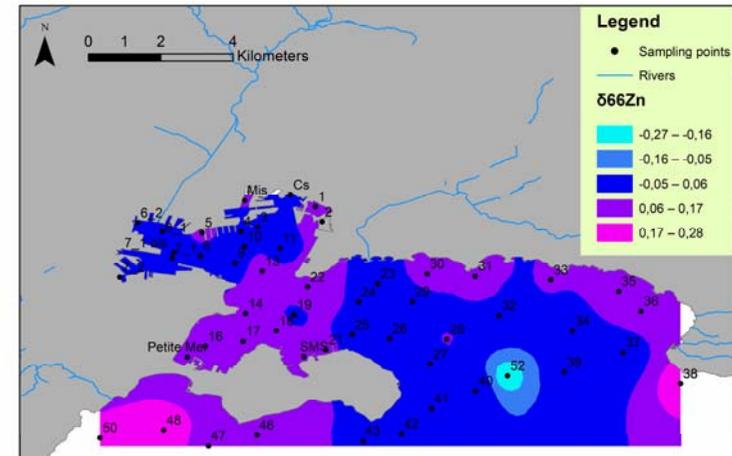
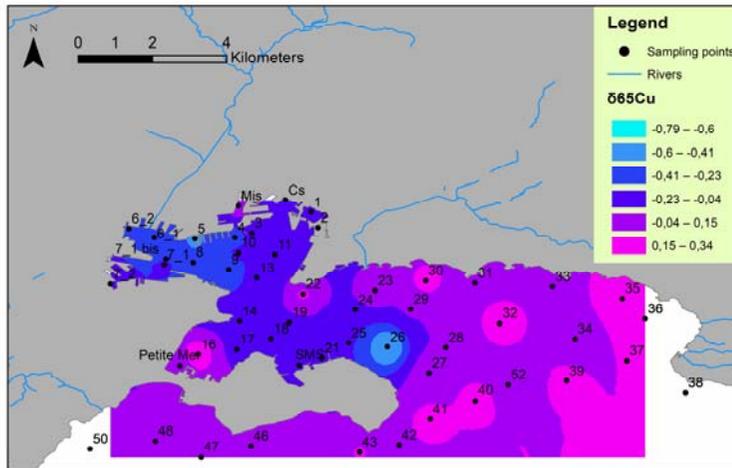
La Baie de la vilaine

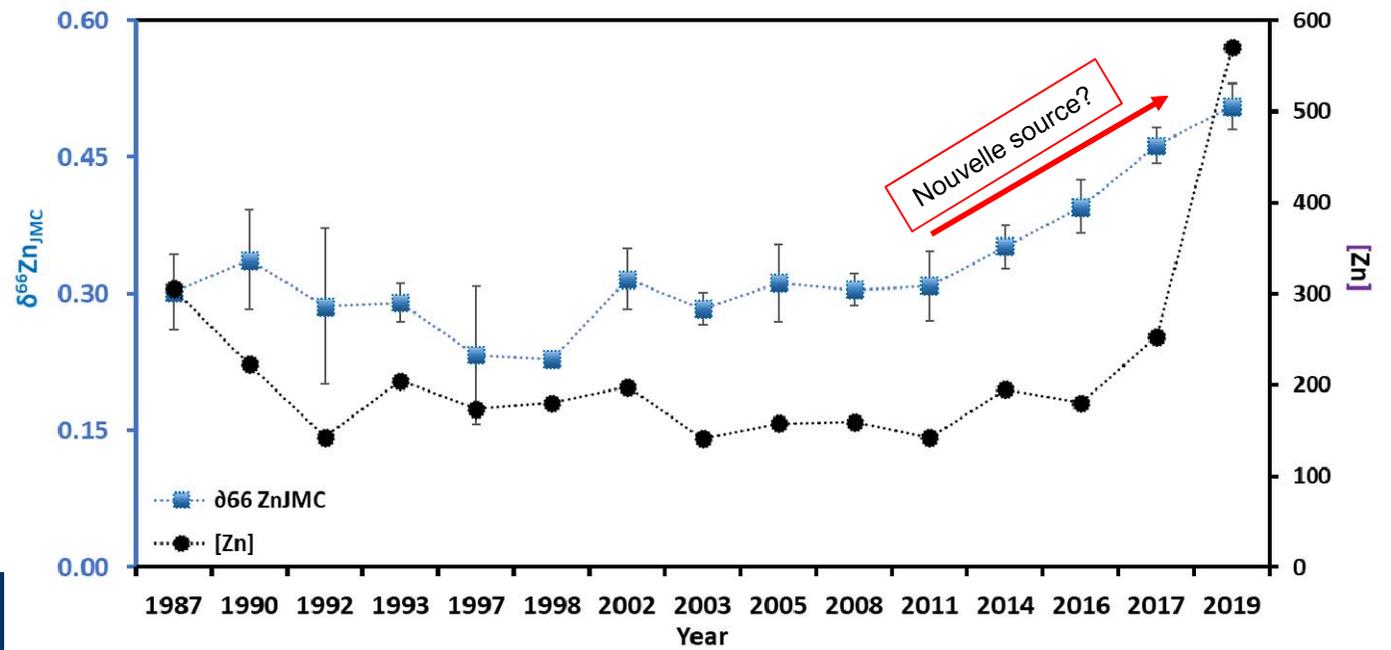
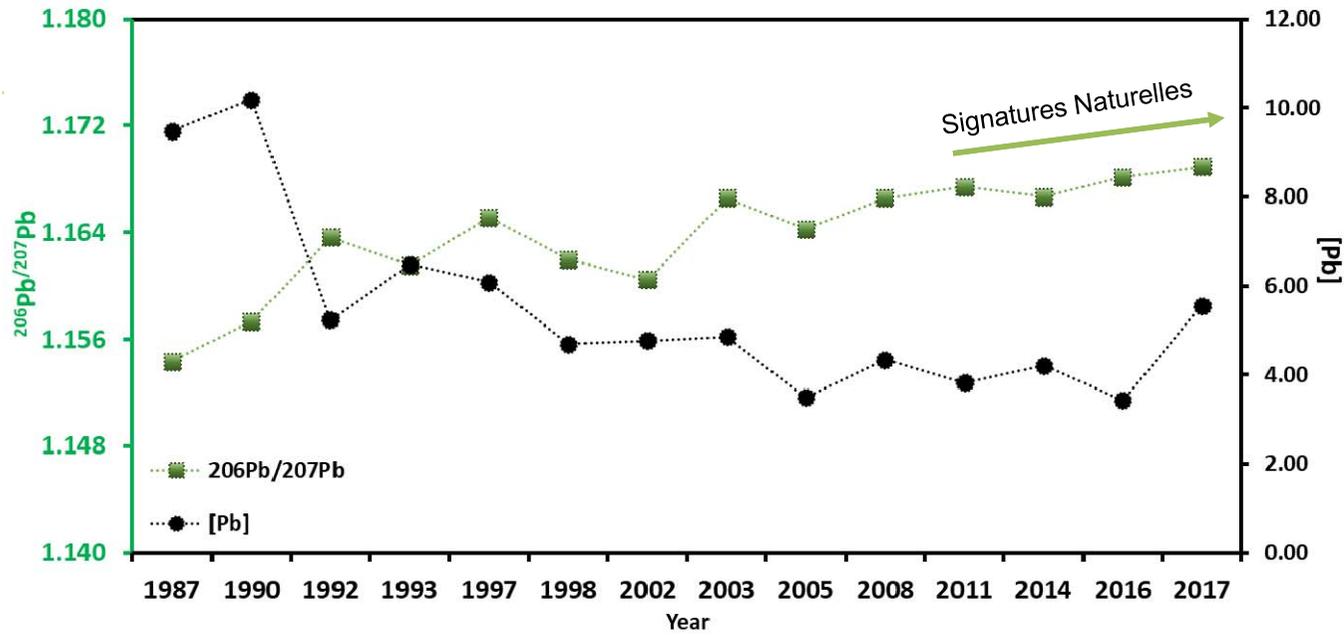


L'application des isotopes stables Cu et Zn en systèmes marins et côtiers sous différents contextes de pollution:



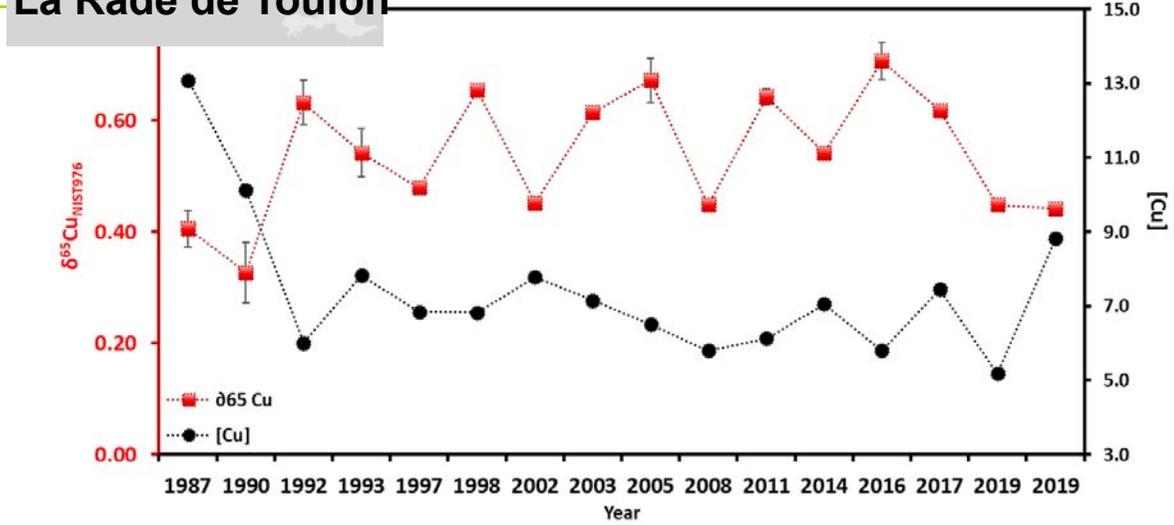
La rade de Toulon



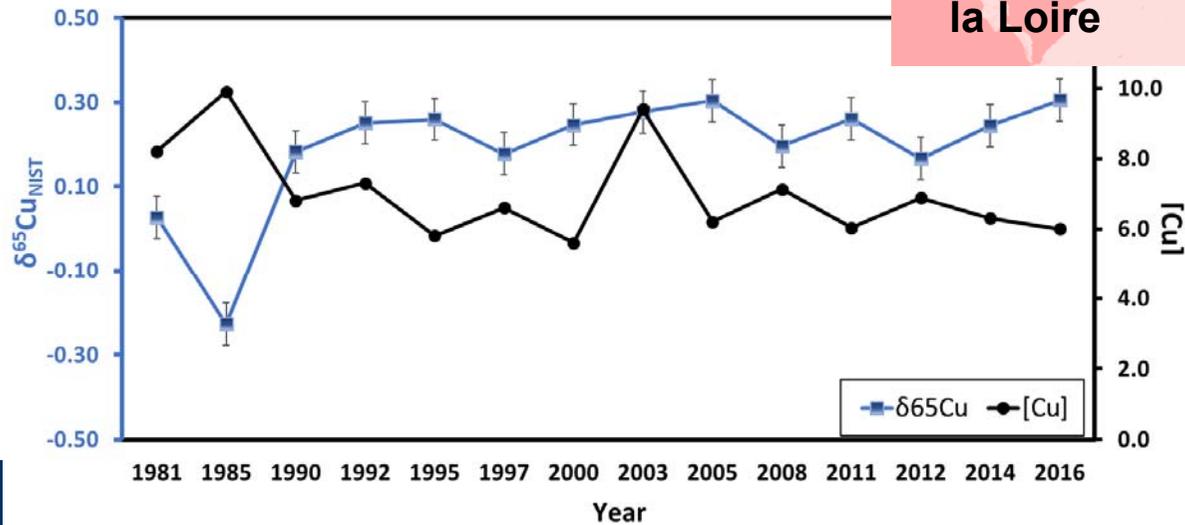


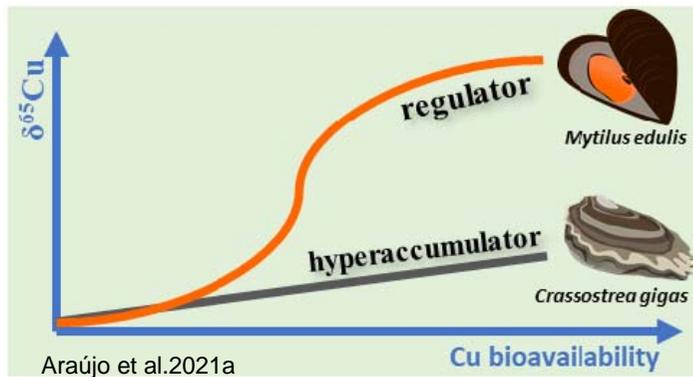
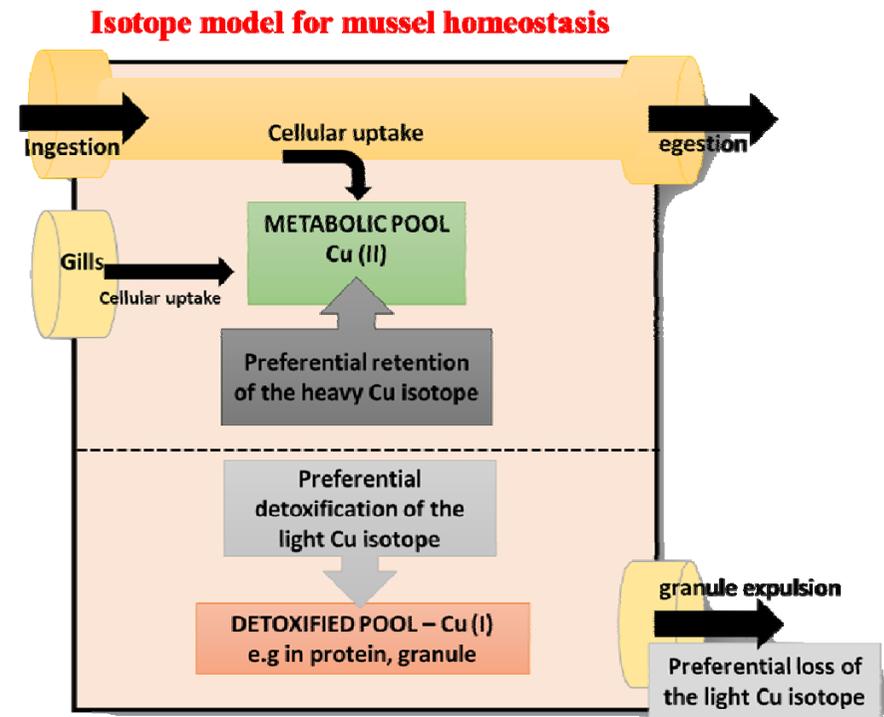
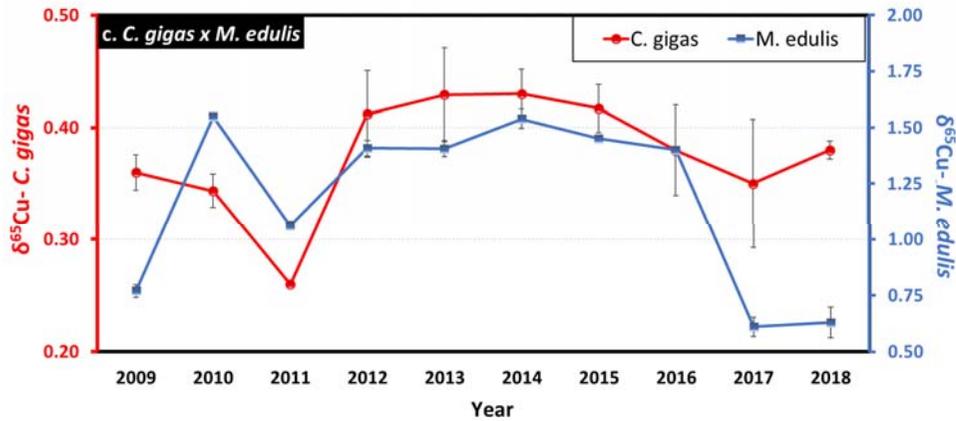
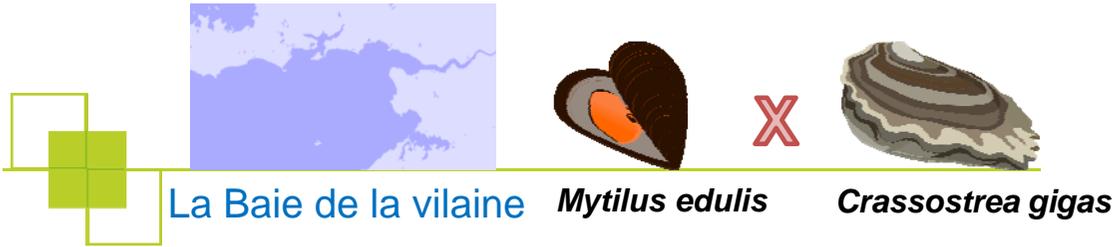


La Rade de Toulon



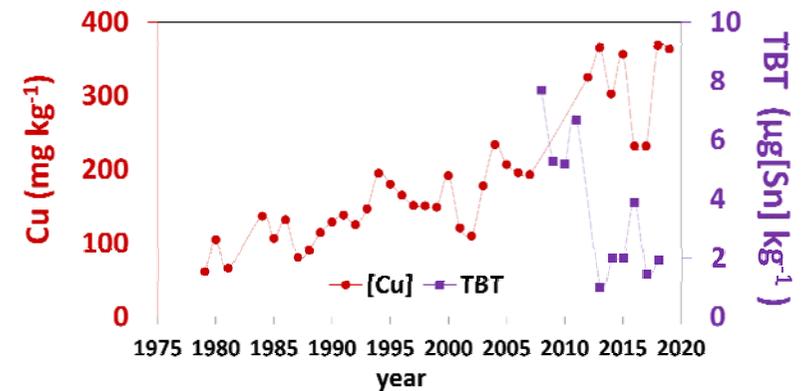
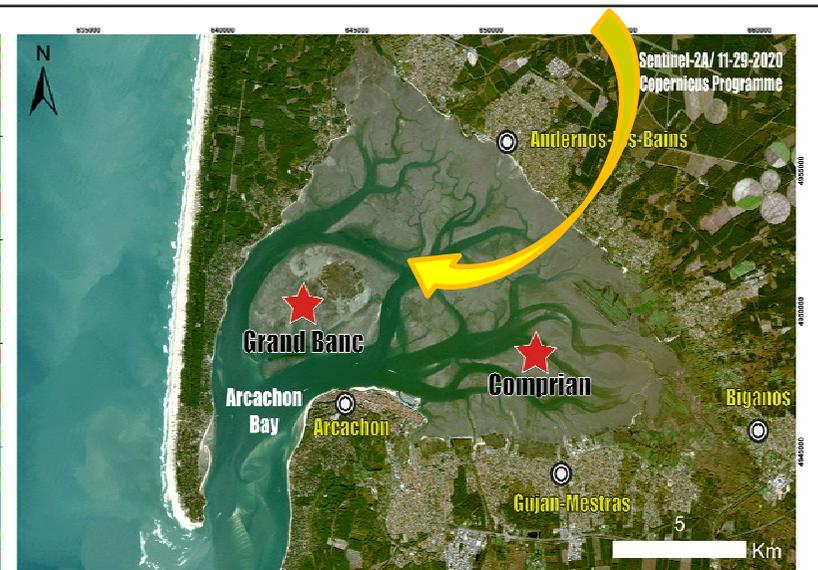
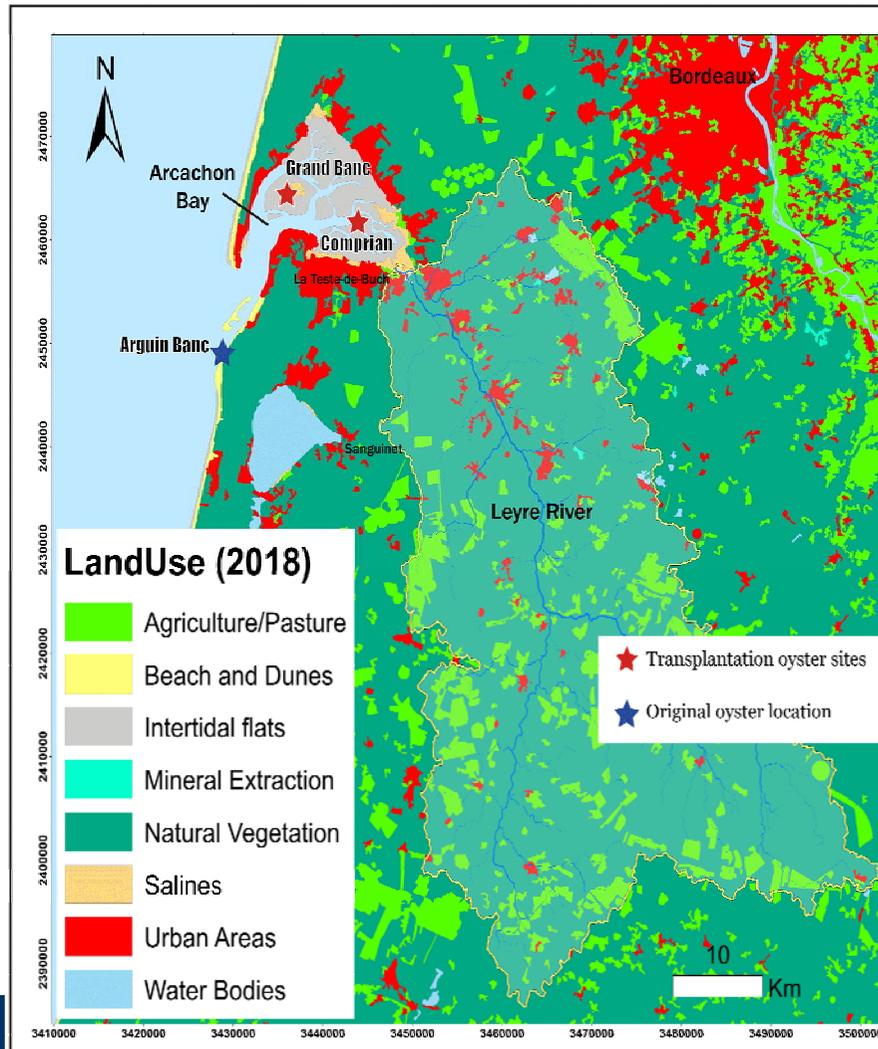
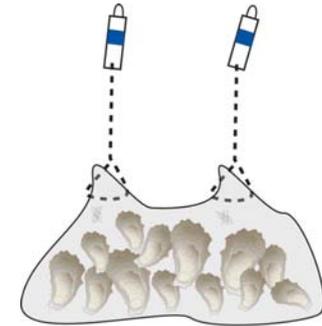
Estuaire de la Loire





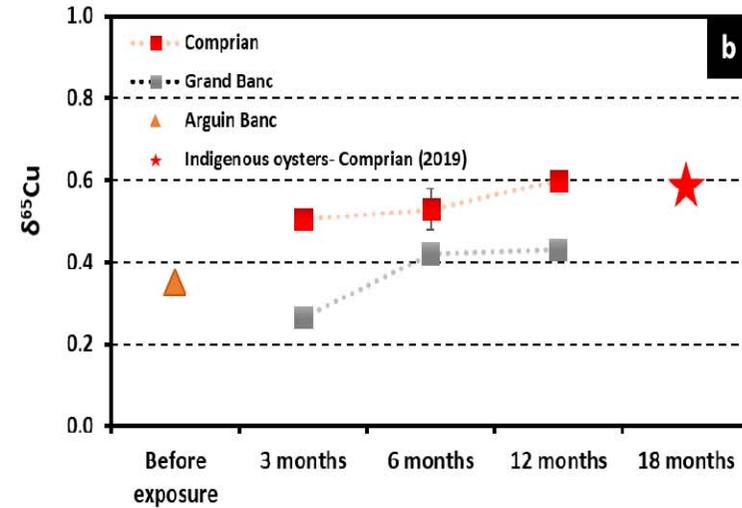
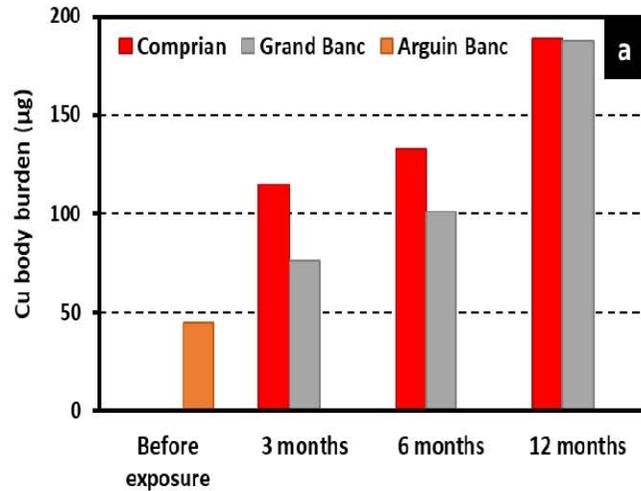
La baie d'Arcachon

Transplantation des huîtres

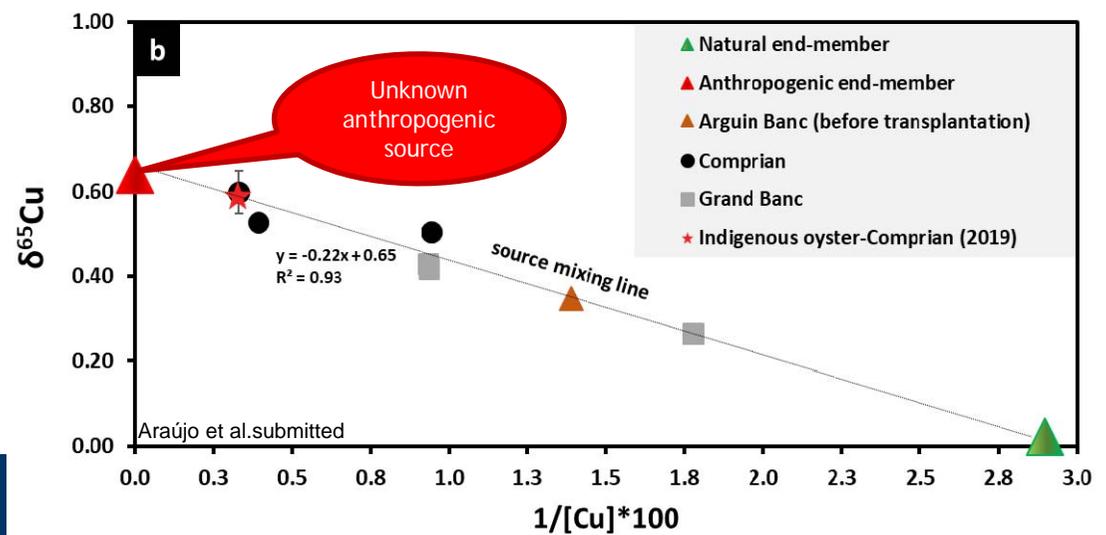


La baie d'Arcachon

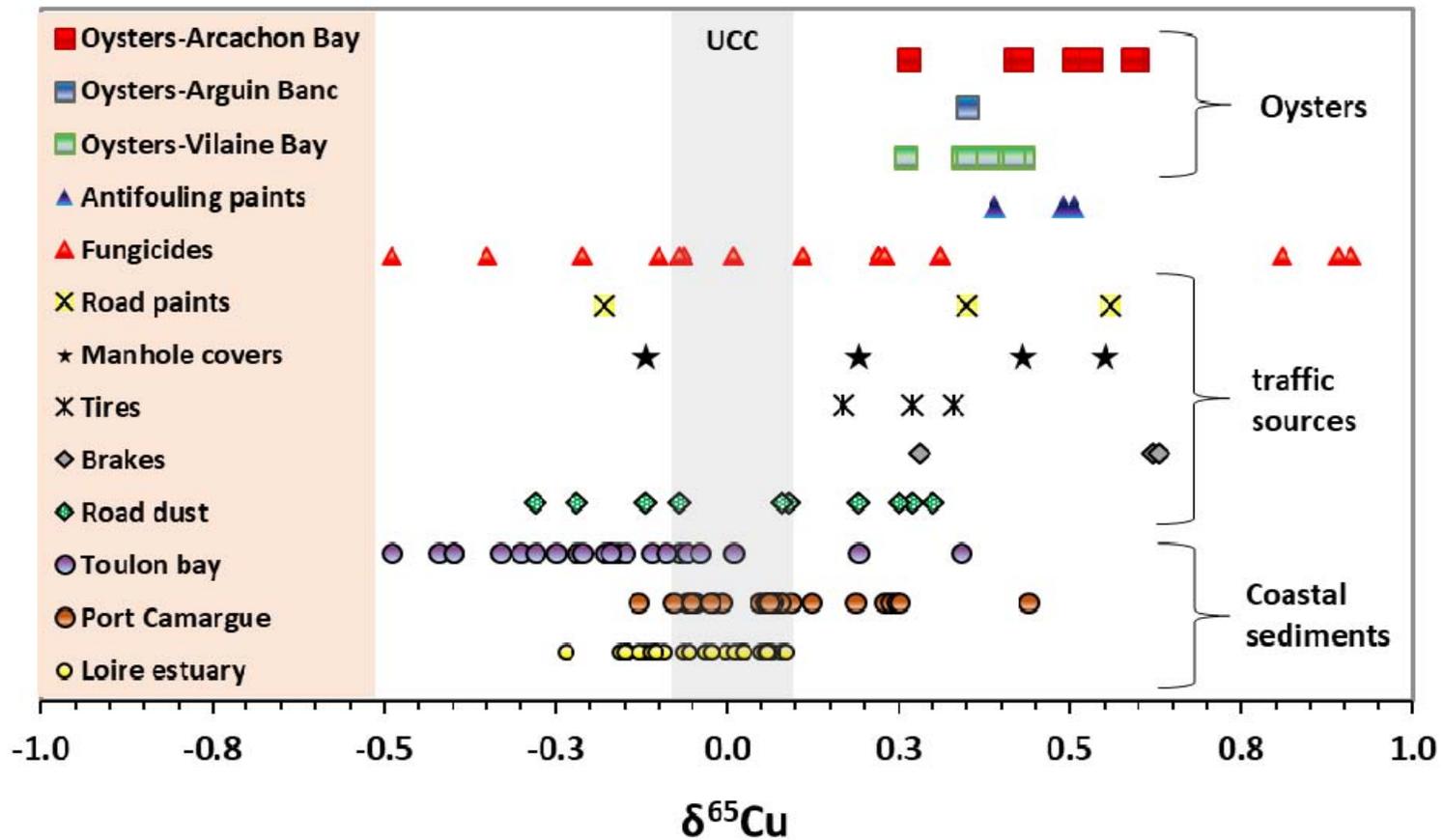
Projet TOUCAN



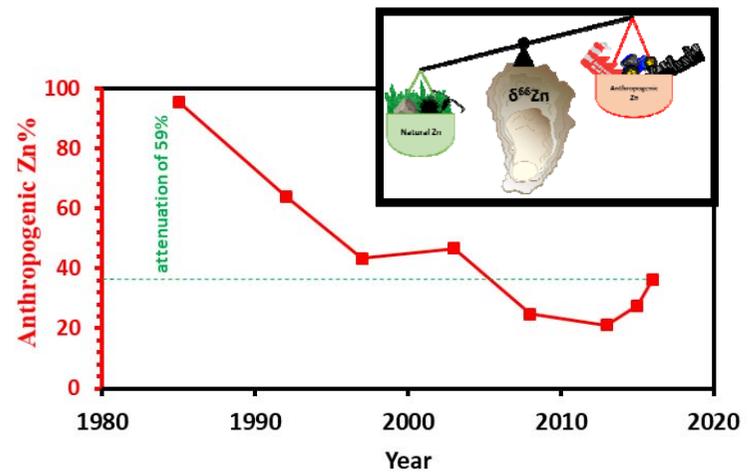
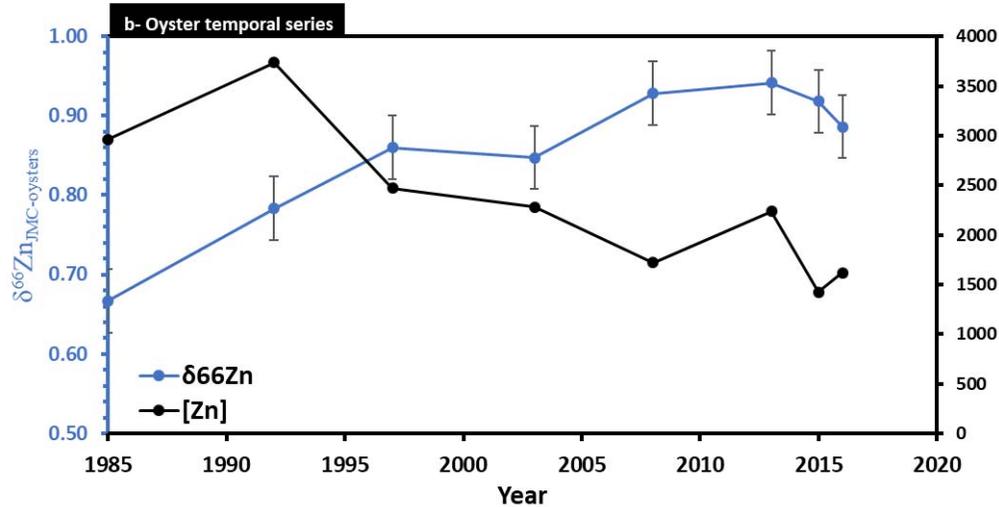
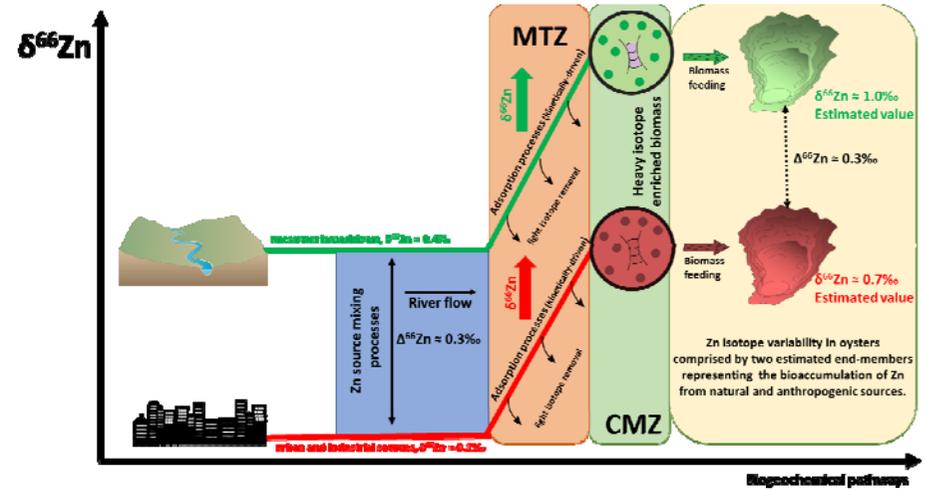
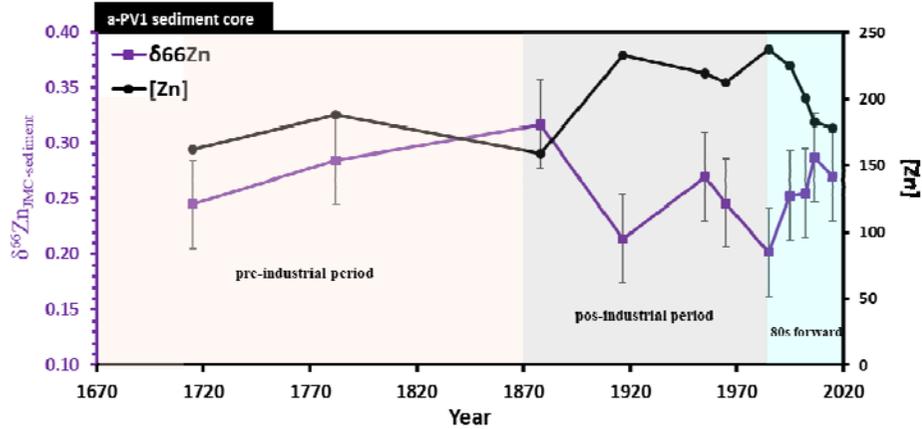
$\delta^{65}\text{Cu}$ (‰)	Anthropogenic Cu (%)
0.35	52
0.50	77
0.53	81
0.60	92
0.26	39
0.42	63
0.43	65
0.59	90



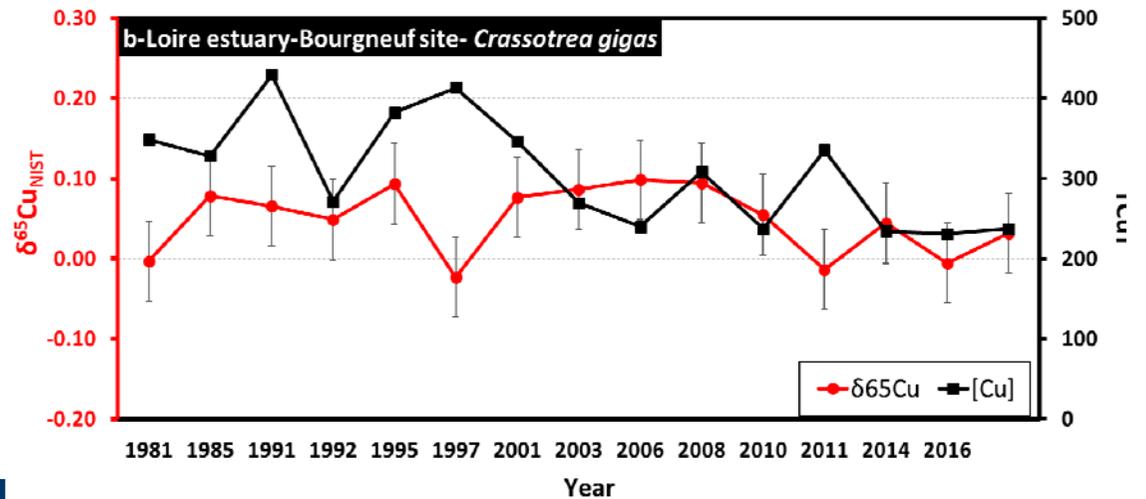
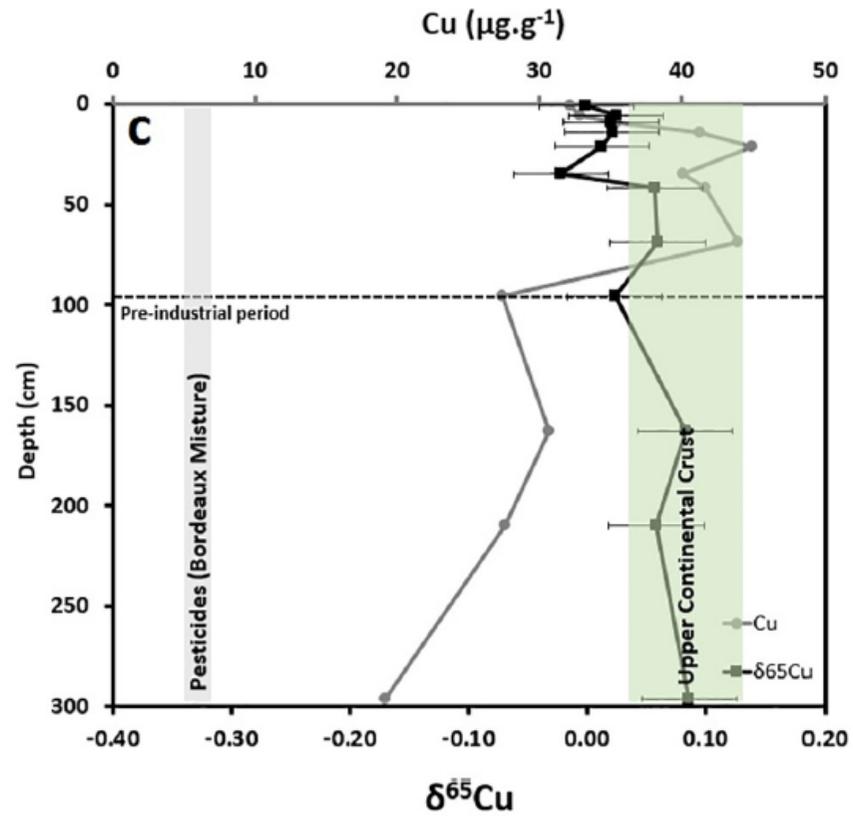
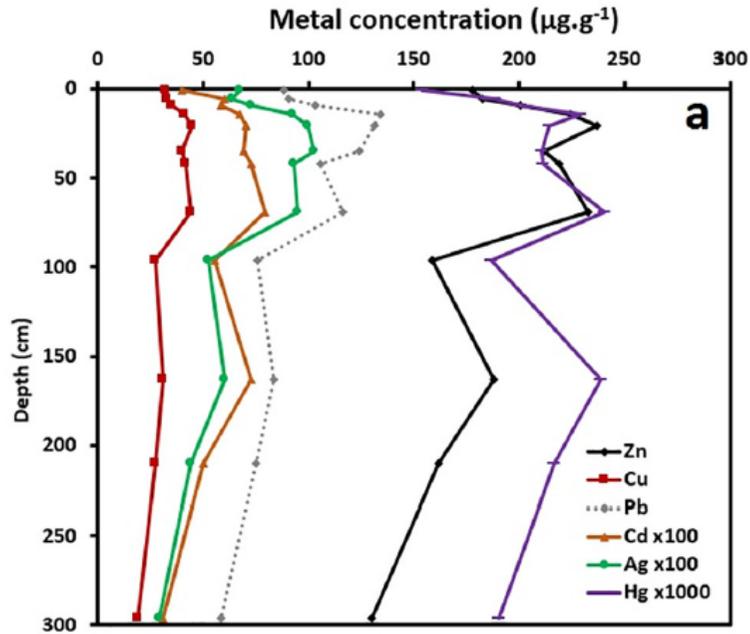
La baie d'Arcachon

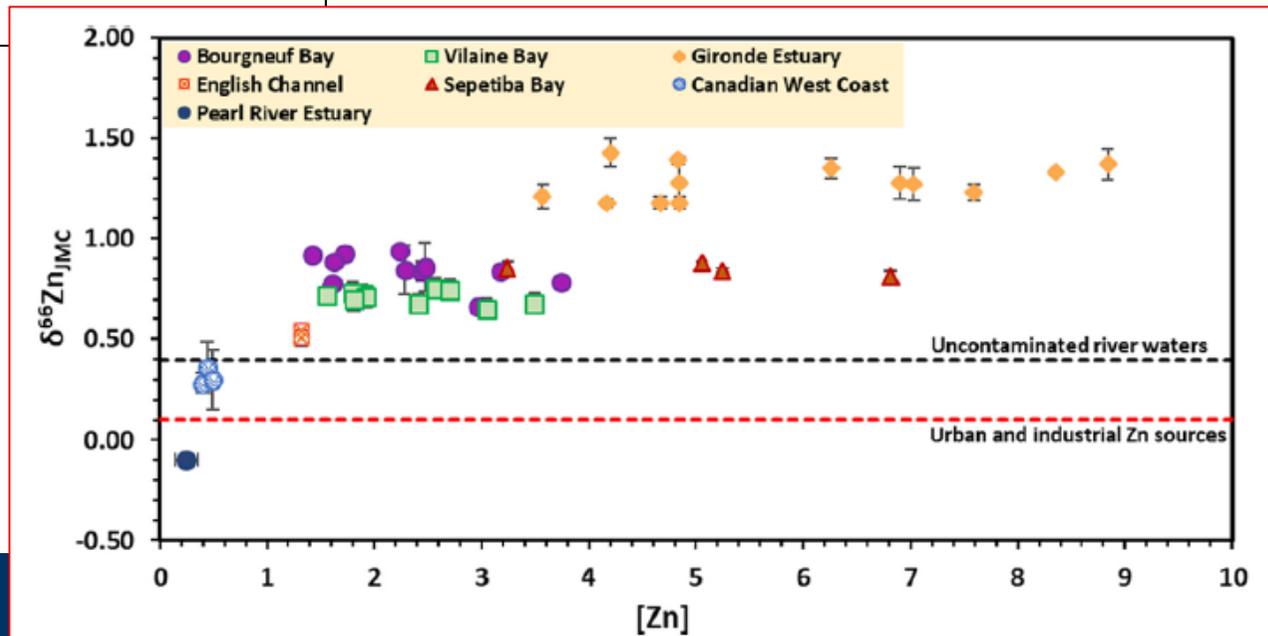
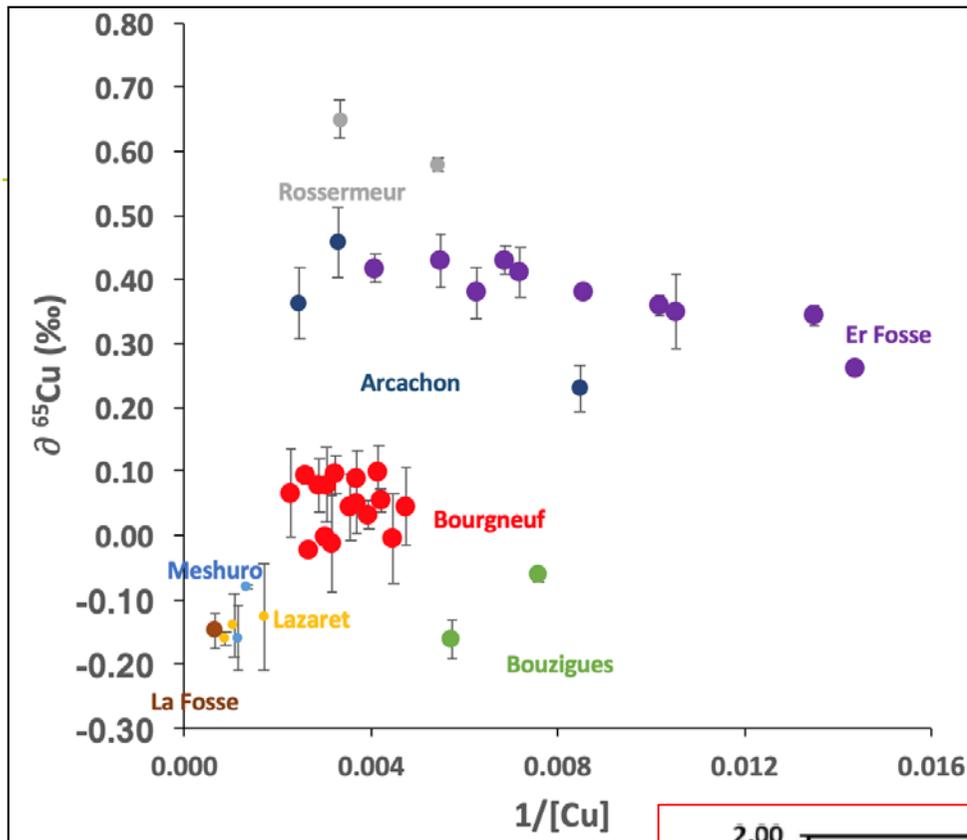


L'estuaire de la Loire



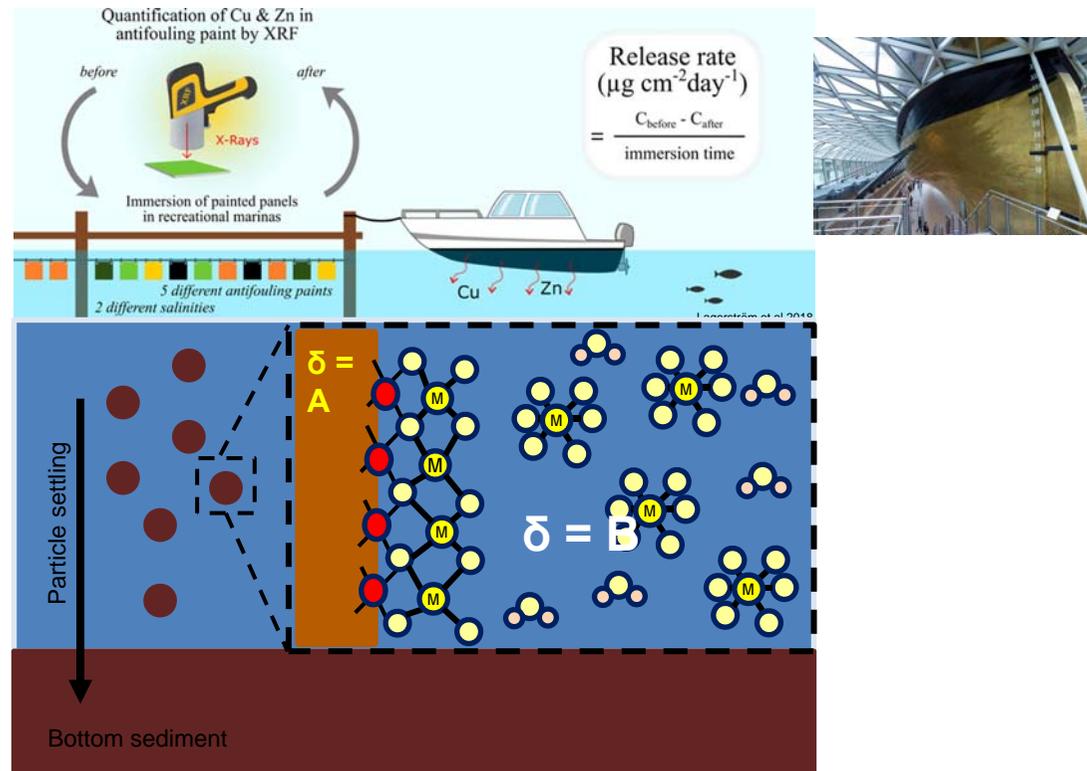
L'estuaire de la Loire





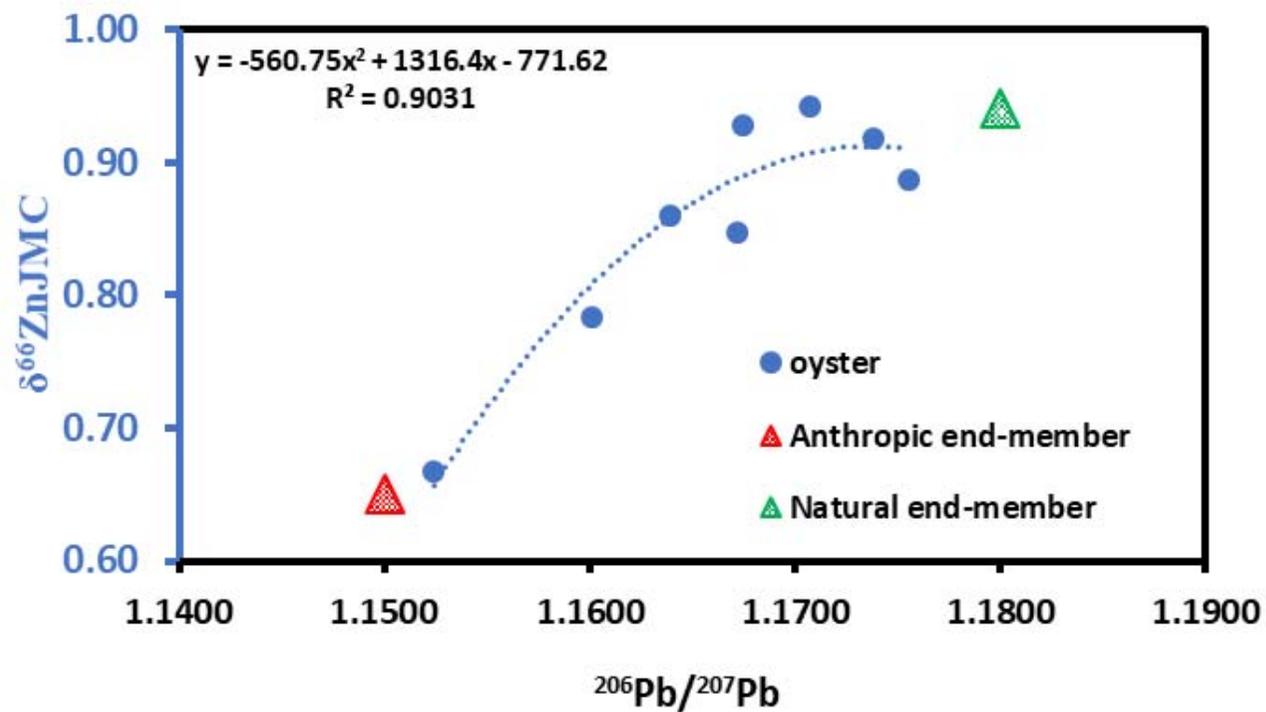
Conclusions et perspectives

- ✓ Comprendre les mécanismes de fractionnement isotopique des contaminants anthropogéniques dans les compartiments naturels (ex: peintures antisalissures)

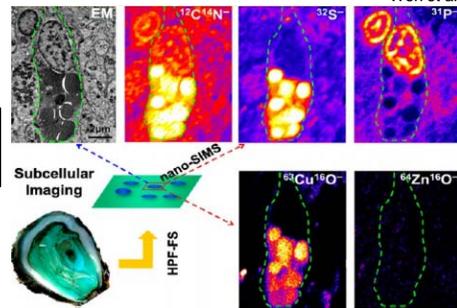
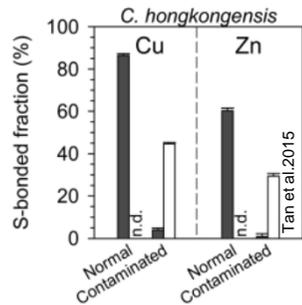


Conclusions et perspectives

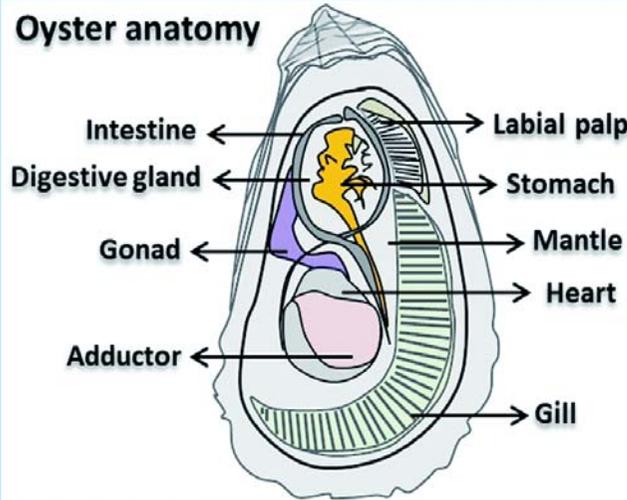
- ✓ Combiner deux ou plus systèmes isotopiques.
- ✓ Nouveaux développements analytiques pour les contaminants émergents (Li, Sb, Ag, etc.)



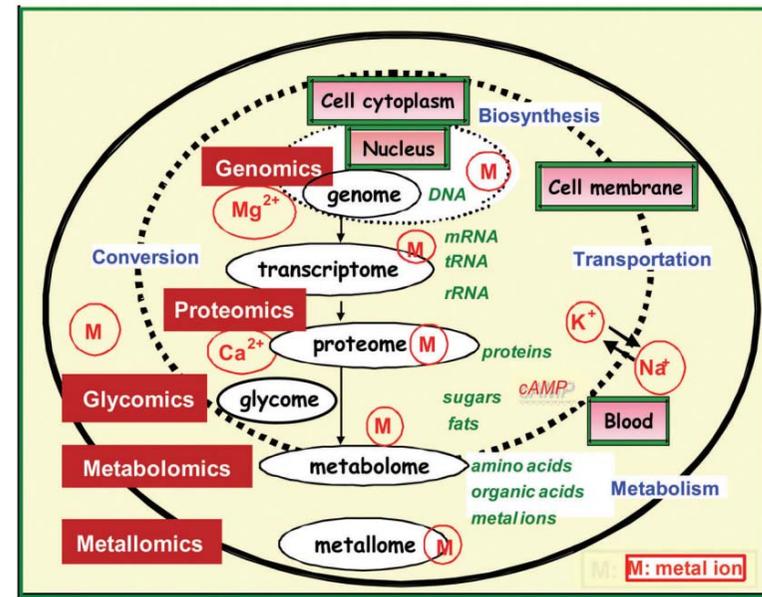
- ✓ Comprendre le fractionnement isotopique biologique à niveau tissulaire et cellulaire.
- ✓ Obtenir des informations sur les conditions physiologiques en conditions de stress environnementale.



Élucider mécanismes de détoxification



Allocation proportion	
Cu, Zn, Cr, Ni, Cd, Ag, Pb, As	
M > G > V > gd > add	
M+G+V > 80%	gd < 10%
Accumulation level	
Cu, Zn, Ni: G > M > V > gd	
Cr, Ag: G > V > M = gd	
Cd, Pb: V = gd > G = M	





Merci!

