

June 22, 2022

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# Progress in the management and securing of mercury-polluted sites



SARPI REMEDIATION

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BURGEAP



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Union des Professionnels  
de la Dépollution des Sites.

Redonner vie aux sites et sols pollués

  
Congrès-Exposition International sur les Sols, les Sédiments et l'Eau  
International Conference-Exhibition on Soils, Sediments and Water



# ABSTRACT

**1** | Context

**3** | Short term  
securing

**5** | Site  
implematisation

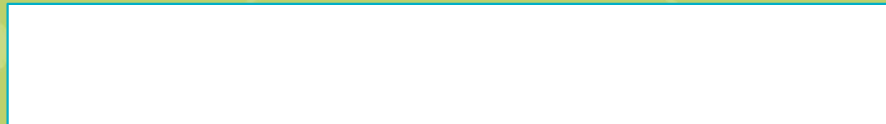
**2** | Soil Mercury  
contamination  
management

**4** | Long term  
securing

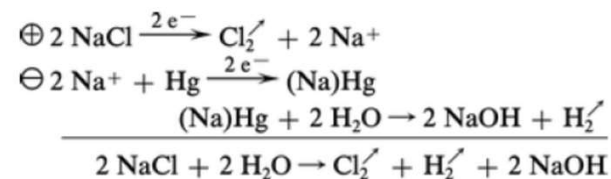
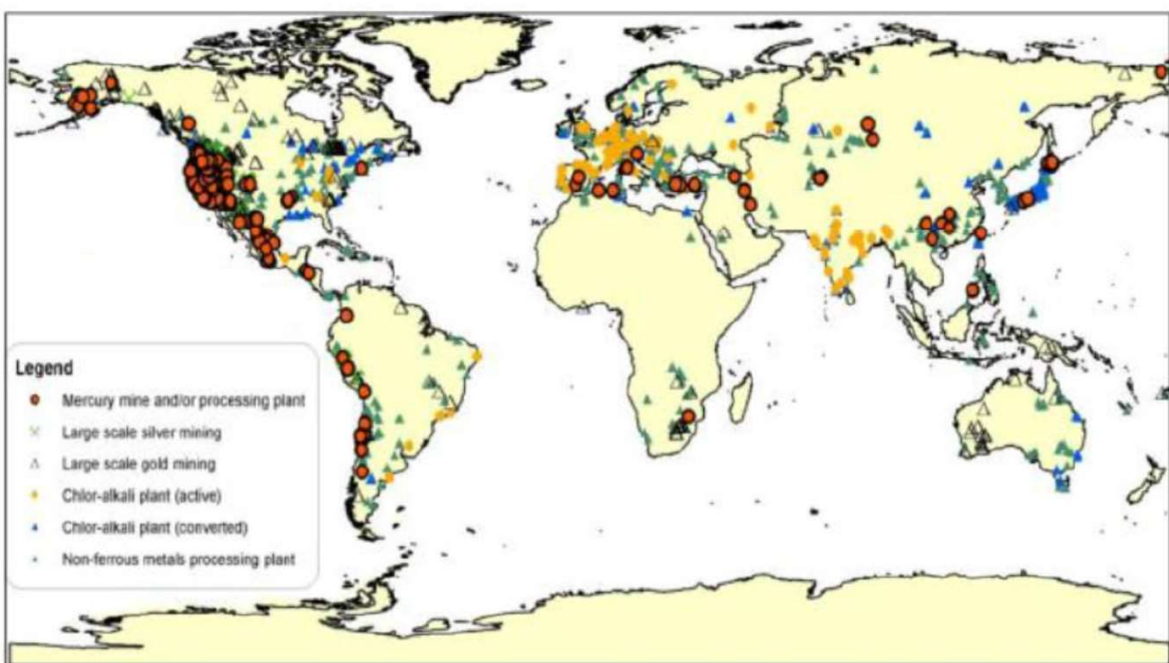
**6** | Vapor  
intrusion  
controls



# 1. Off site Mercury impacted soils management in France



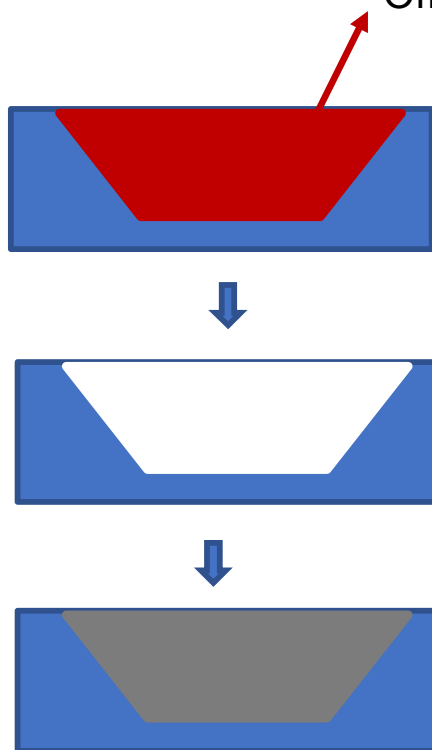
# Context



Chlorine chemistry (salt hydrolysis)  
 Very costly to remediation in total – waiting for action

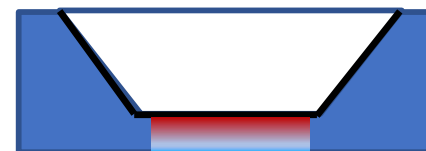
# Soil Management

## Total Hg polluted soil removal Off site



INTERSOL 2022

## Partial Hg polluted soil removal



Short term protection  
reactive barrier



Long term protection  
reactive capping



On site stabilization  
and containment (as needed)

22/06/2022

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# Off Site soil management

Visible pure mercury droplets	Hg total on crude Specific for France - FNADE convention (mg/kg)	Hg on leachate (L/S = 10) European Council Decision of 19 December 2002 (mg/kg)	Soil management & treatment possibilities
Yes			Droplets vacuum suction + Thermal Recovery or Treatment
No	< 1	< 0,01	Inert Landfill
	< 7	< 0,2	NHW Landfill
	<100	<2	Direct HW landfilling
	< 2000	< 10	Special stabilization* into storage cells HW Landfill (Sarpi Drambon / Bellegarde)
	<10 000	< 10	Pre-stabilization* on site (transport securing) + solidification into HW Landfill storage cells (Sarpi Drambon / Bellegarde)
	>10 000	No limit	Drum conditioning + deep salt mining storage

\* : works done by Sarpi Remediation



# Site securing : why ?

## ⇒ TECHNICAL LIMIT

- End of excavation of huge quantities
- Close to water table
- Pudding rock compacity / layers of sand : risk of droplets migration.
- Vapor securing necessity

## ⇒ SOLUTIONS ?

- ISTD : need drilling and implement thermal equipment
  - Injection in sandy layers to stop migration : drillings again...
  - ISS : drillings again..
- ➔ Discussion with administration / Ginger to stop excavation and site securing



# Site securing

Securing TIME

- ⇒ **SURFACE PASSIVATION SHORT TERM (<1 YEAR) : “REACTIVE COATING” : 0,5 – 1 CM THICKNESS**
  - Enhanced soil cleaning for mercury removing Ineris « Le mercure - prévention contre l'hydrargyrisme » – ED 546, 2003: application of a suspension sulfur – slaked lime 1:1, washing after application
  - Modification of the application : post spraying of Dustreat® chemical fixator → avoid dust (harsh and windy conditions); prevent rainwater leaching of the coating.
- ⇒ **SURFACE PASSIVATION LONG TERM (>>1 YEAR) : REACTIVE CAPPING (20 – 50 CM THICKNESS)**
  - Capping made of Sand/clay/Sulfur mix
  - Permeability < 10<sup>-9</sup> m/s after compaction. Special formulation non sensitive to dehydration – rehydration cycles (long term stability, no hydric cracking)
- ⇒ **SOIL Hg° STABILIZATION FOR RESIDUAL / DIFFUSE IMPACTS : SOIL-MIXING**
  - Polluted soil mixed with special clays and sulfur base reagent → Hg° → HgS cinnabar





## SITE N°1 : coating



- Active coating applicated in 2 tests :
- TEST 1 : Small thickness. 100 kg/m<sup>3</sup> suspension of lime sulfur. post fixation with Dustreat® 5% in spray. Quite immediate red color of Cinnabar HgS
- TEST 2 : slurry concentration at 500 kg/m<sup>3</sup> (Sulfur/lime) + post fixation with Dustreat 5%. higher thickness. Impacted Surface turns red, then black.

→ Cinnabar formation (red) ?





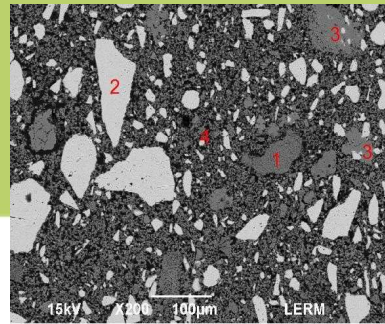
## SITE N°1 : coating



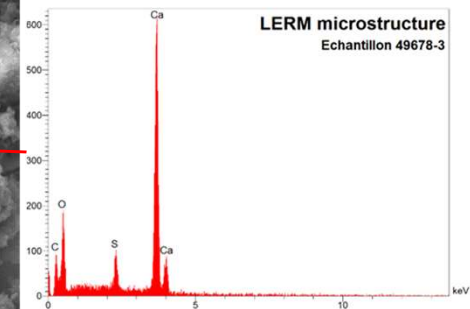
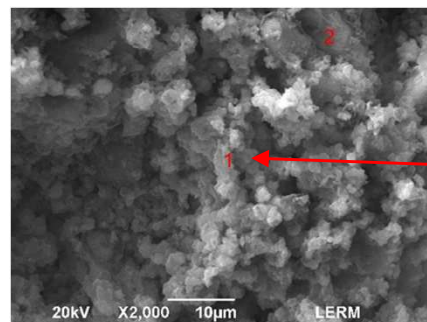
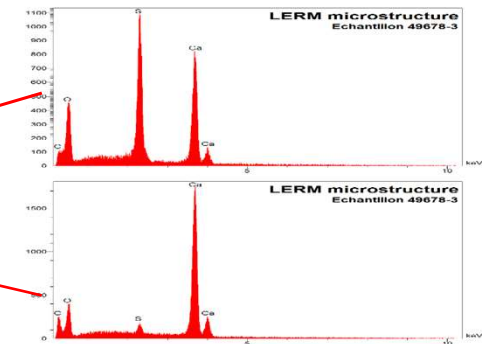
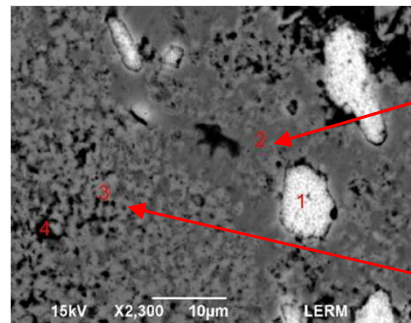
# SITE N°1 : coating



Electronic Microscopy. microporous microstructure on fracture  
1: grain rich in sulfur, 2: calcite matrix

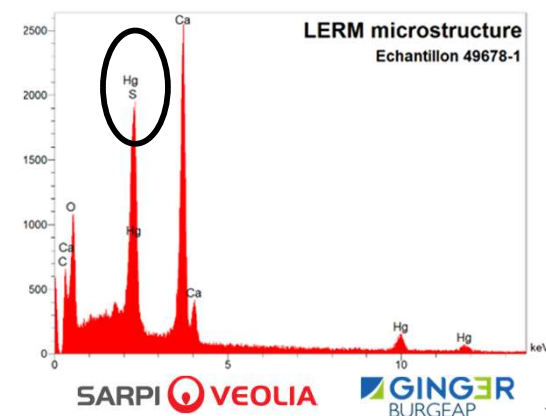
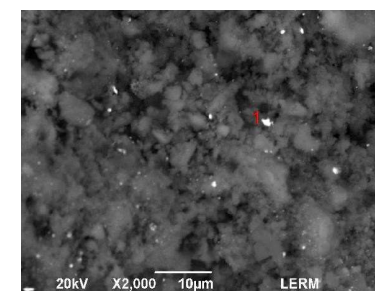
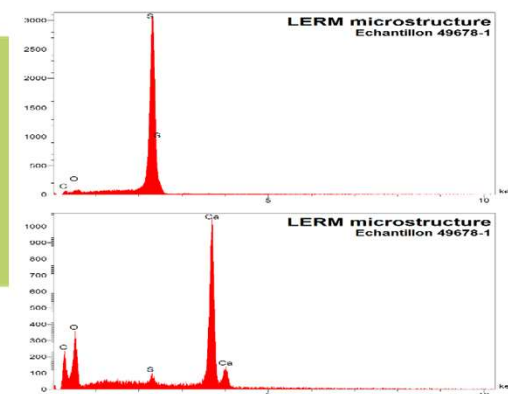
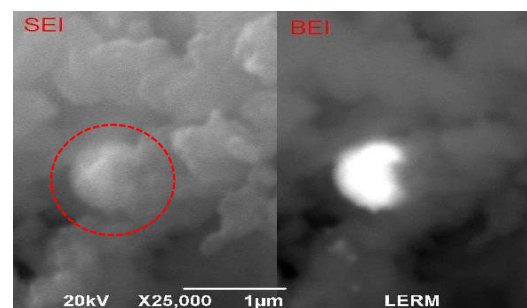
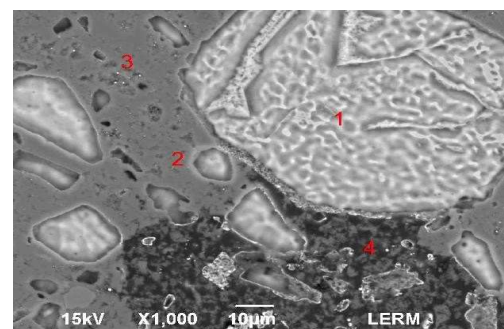
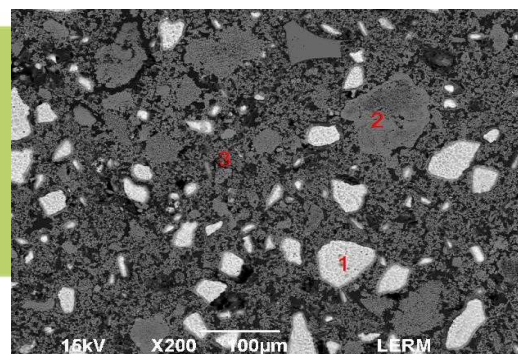
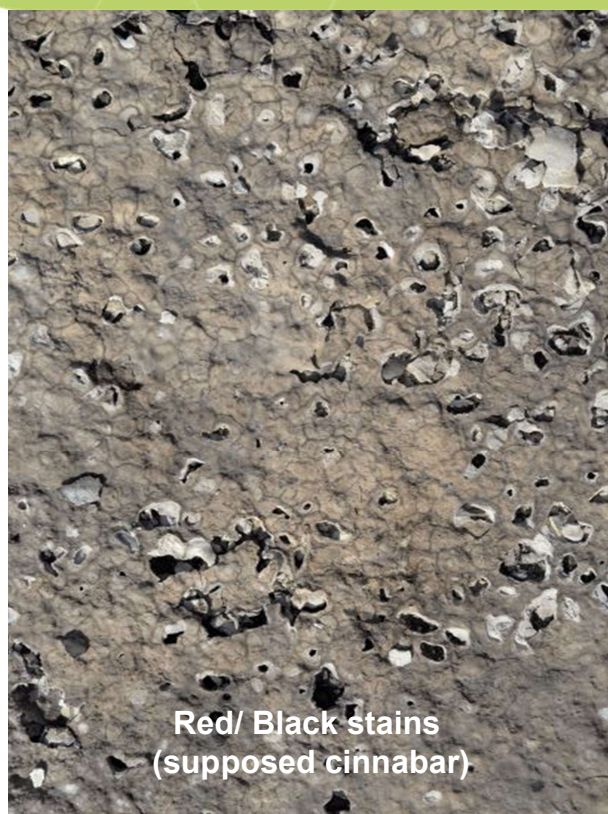


- 1: calcite grain,
- 2: sulfur grain,
- 3: dense zone calcium sulphates,
- 4: matrix





# SITE N°1 : coating

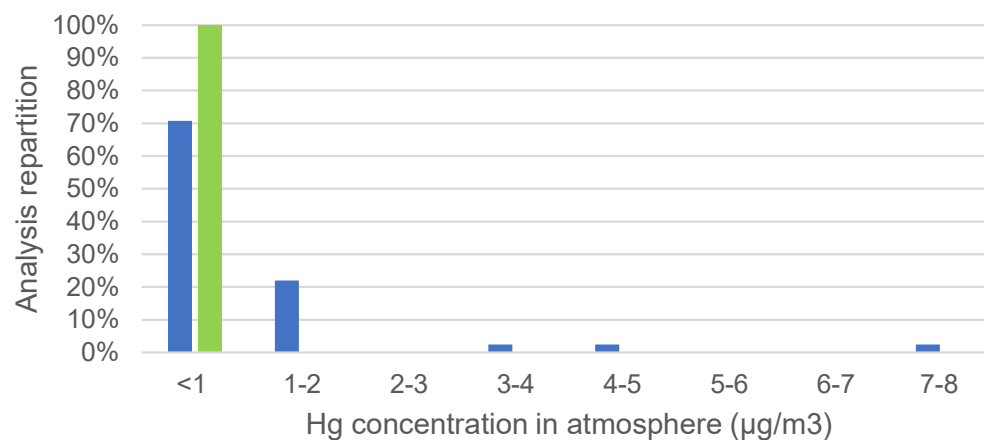


# SITE N°1 : coating

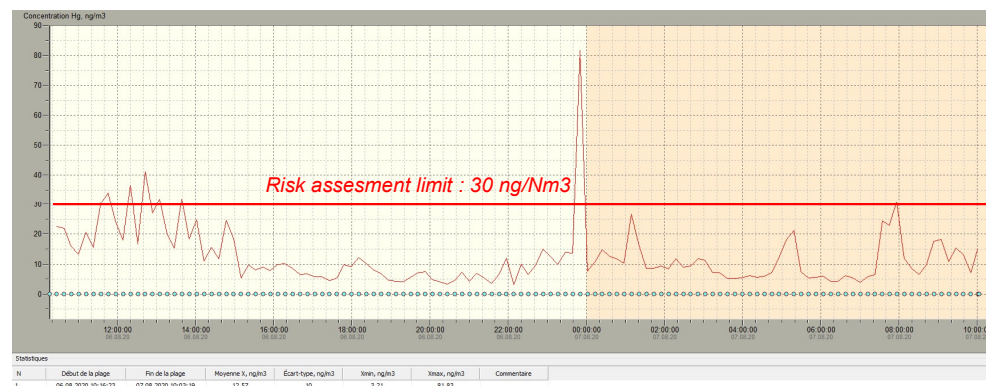
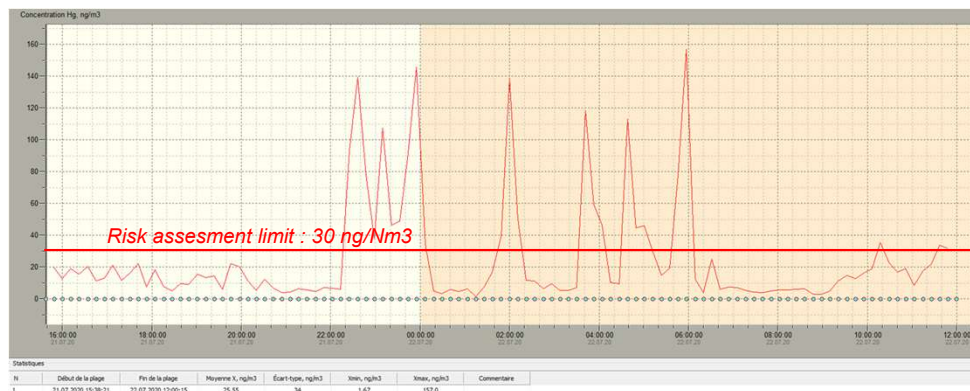
## Atmosphere analysis

- with JEROME analyzer (No value > 1 µg/m<sup>3</sup> after treatment)
- With LUMEX analyzer : Lower peaks, average < 20 ng/m<sup>3</sup> of mercury after treatment

## Hg vapor (JEROME)



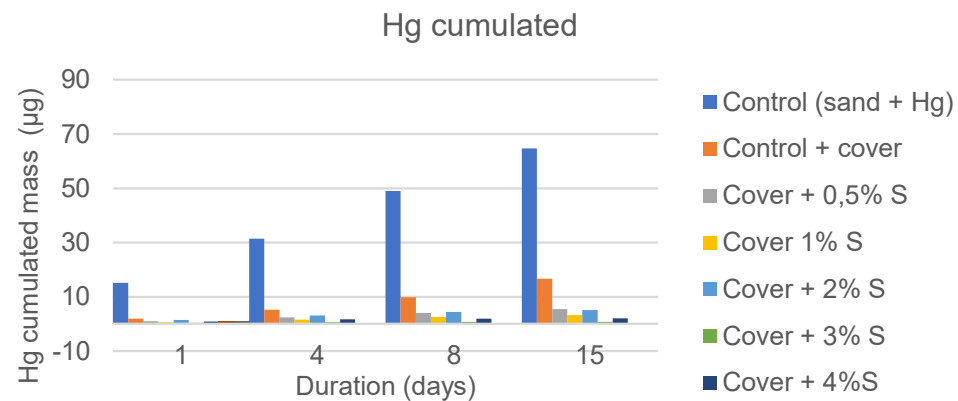
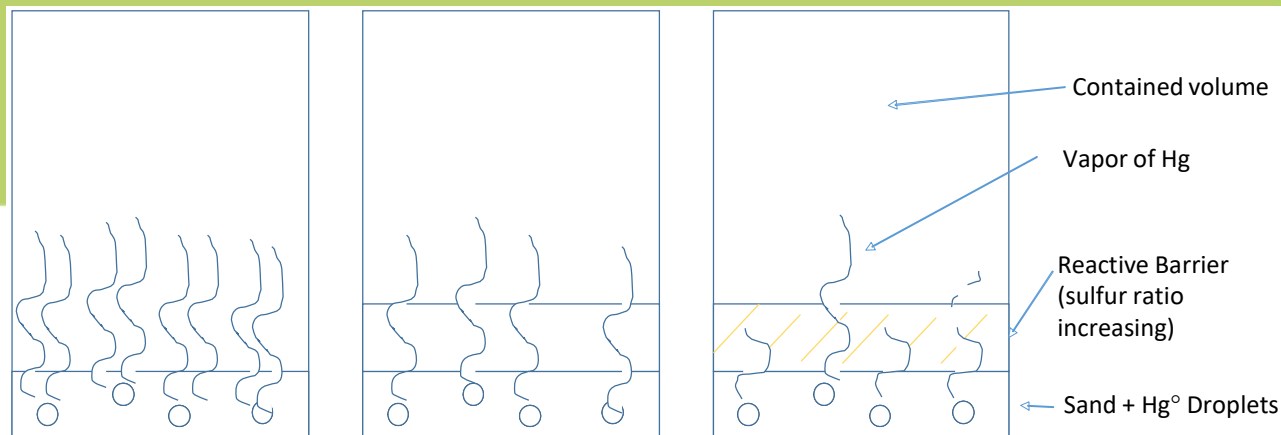
■ Before spraying ■ After spraying



# Reactive passive capping

## Lab tests

1. Hg vapor transit throw special mis Clayed sand and Sulfur.



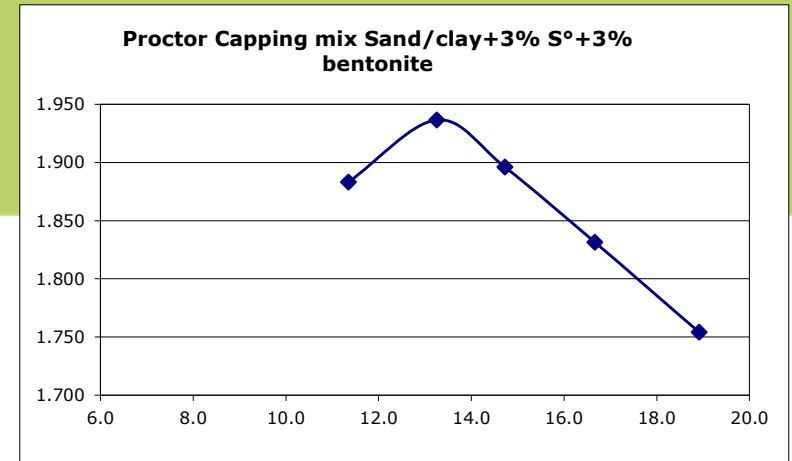


# Reactive passive capping

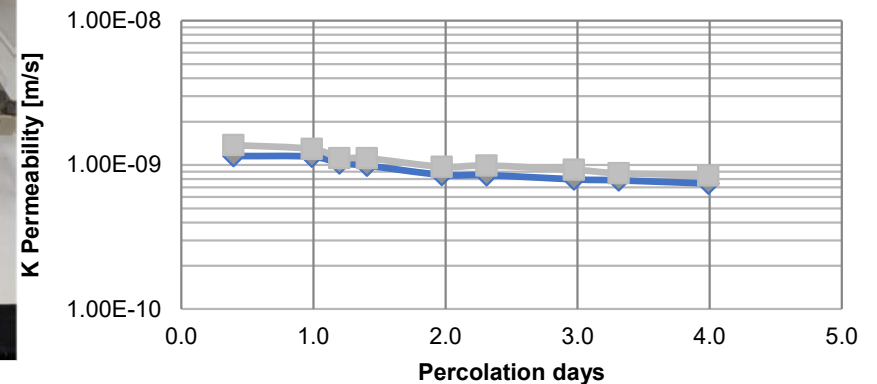
## Lab tests

### 2. Permeation (before/after dehydration)

Issue : material formula to be non sensitive to saturation / dehydration cycles (hydric shrinkage)



## Capping permeation tests



—◆— Saturated      —■— Dehydrated and resaturated

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# Reactive passive capping

## Site application



### Mixing :

- 80% silty sand
- 20% silty clays
- Water adjust to  $W_{OPN}$
- Reagents : Sulfur based reagent + special bentonite : total 4%





# Reactive passive capping

## Site application (Controls)



*Chambres à flux*  
CF1 :  $30 \mu\text{g}/\text{m}^2/\text{j}$   
CF2 :  $< 3 \mu\text{g}/\text{m}^2/\text{j}$   
CF3 :  $< 3 \mu\text{g}/\text{m}^2/\text{j}$   
CF4 :  $< 3 \mu\text{g}/\text{m}^2/\text{j}$

Conform  
objectives

# Reactive passive capping : atmospheric monitoring

Dates de prélèvement	Concentrations en mercure gazeux en $\mu\text{g}/\text{m}^3$			
	Prélèvement 1	Prélèvement 6	Prélèvement 3	Prélèvement 4
du 05/08 au 11/08/2021	<0.03	<0.03	<0.03	nm
du 12/08 au 18/08/2021	<0.03	<0.03	<0.03	nm
du 16/09 au 22/09/2021	<0.03	<0.03	<0.03	<0.03
du 13/10 au 19/10/2021	<0.03	<0.03	<0.03	<0.03

nm : non mesuré

Hydrar (Anasorb C300) tube sampling

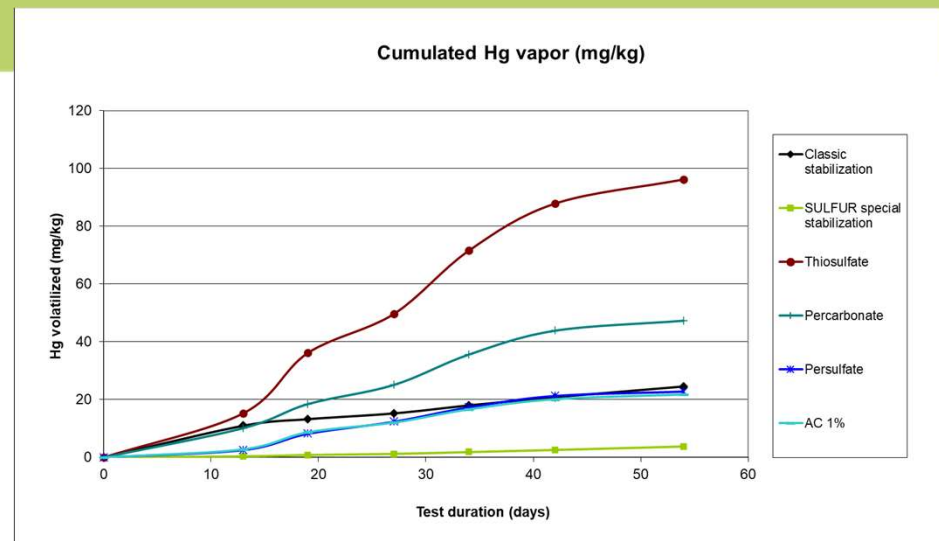
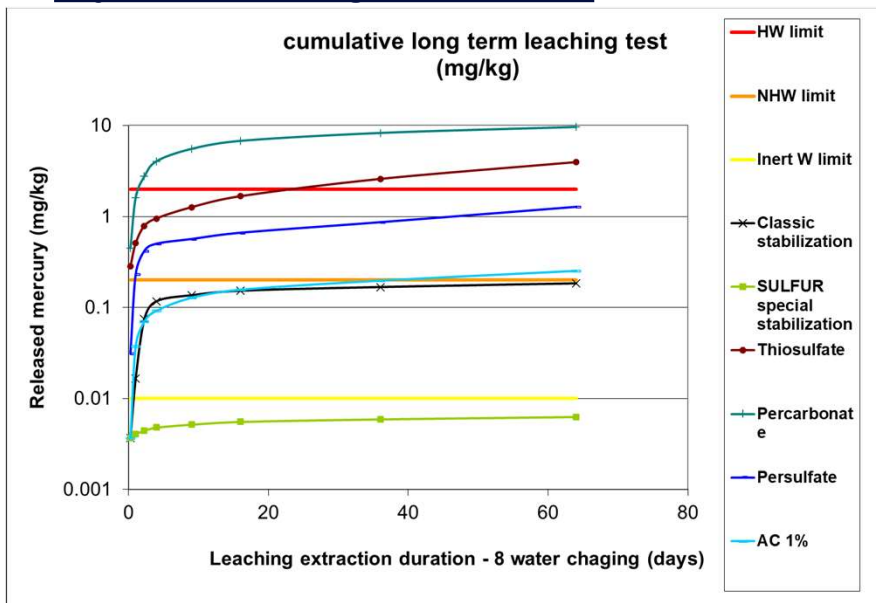
➔ Summer conditions

➔ Conformity with objective  $\text{Hg} < 30 \mu\text{g}/\text{Nm}^3$

# Other possibilities : on site stabilization for diffuse impacts

## R&D formulation for dry way stabilization

- ➔ Classic stabilization (cement) = control
- ➔ Test of reagents (reducing / Oxidizing...)
- ➔ Objective : Create HgS metacinnabar



## Results :

- ➔ Low efficiency of reducers thiosulfate or oxidizer coupled with cement
- ➔ Very good efficiency of the sulfur base reagent
- ➔ Key point : Vapor more complex than leachate stabilization



## Other possibilities : on site stabilization for diffuse impacts

### Site application



HSE : Attention to explosive working conditions using pure sulfur (soil mixing) !



# Conclusion

## **SOIL MANAGEMENT :**

- ⇒ **POSSIBLE LANDFILLING FOR HIGH HG IMPACTED SOIL MANAGEMENT**
- ⇒ **VAPOR BARRIER (EMERGENCY WORKS / LONG TERM)**
- ⇒ **STABILIZATION ON SITE FOR DIFFUSE TO MEDIUM IMPACT**



# Contacts

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