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Gestion complexe d'une contamination des sols par du mercure au droit d'un site sensible

Complex remediation management of mercury soil contamination on a sensitive site

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Congrès-Exposition International sur les Sols, les Sédiments et l'Eau
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*Crédit photos :
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1. Context / sensitive site

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Old former company (*lights company*) – South of Paris

1985	End of activity
2010	Buildings demolition
2013	Earthwork excavation for Sensitive building (basement, foundation...)
May 2015	Volatile mercury concentration over ambient air quality criteria (up to 12 $\mu\text{g}/\text{m}^3$) in the future courtyard
May 2015 → March 2016	Site complementary studies, remediation solution evaluation





Site Contest



**Winter
2015**

Thermal desorption cinetic bench test with mercury speciation.
Other studies and analysis (SEM OFI)

**May
2016**

First **earthwork phase** with off site disposal for specific remediation.

**Nov.
2016**

Second earthwork phase

**June
2017**

Thermal Remediation mobilization (drillings, setup...)

**Nov.
2017**

Remediation ignition (successive area loaded)

**Summer
2018**

Previous end of thermal desorption – Final monitoring, Sampling and analysis : « Agence Régionale de Santé » advice





Project team



SADEV
MAÎTRE D'OUVRAGE

EGIS Structures et Environnement
AMO - OPC



SEMOFI
MOE Dépollution



OUTAREX
ENTREPRISE GÉNÉRALE



BIOGENIE
*ENTREPRISE SPÉCIALISÉE
DÉPOLLUTION*



**HAEMERS
TECHNOLOGIES**
*ENTREPRISE ST - TRAVAUX
DESORPTION THERMIQUE*



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2. Earthwork remediation phases with several off- sites disposals

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Earthwork phases :

- excavation, on site storage and sampling
- Loading and off site disposal

PHASE	SCHEDULE	QUANTITIES
PHASE 1	June-Oct 2016	6.500 t
PHASE 2	Nov 2016 – today	16.700 t

- 80 % Non Hazardous (ISDND)
- 10 % Hazardous (ISDD)
- 10 % Stabilization Hazardous (ISDD Stab.)

Free phase collect

- Mercury Drops and puddles → Difficulties for collect and segregation
- *About 2 liters of free phase (25kg)*
- *About 2 m³ of soil mixed with drops sent to valorization site*



Dense residential area



Under Building earthwork



Electricity concrete pipe protection
225.000 V

Sensitive excavation – low cadencies



Network electricity ... protection

Earthwork close to cheminey



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3. Thermal desorption – Essais pilotes / Pilot Trial

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ISTD and ESTD

Thermal Desorption On site

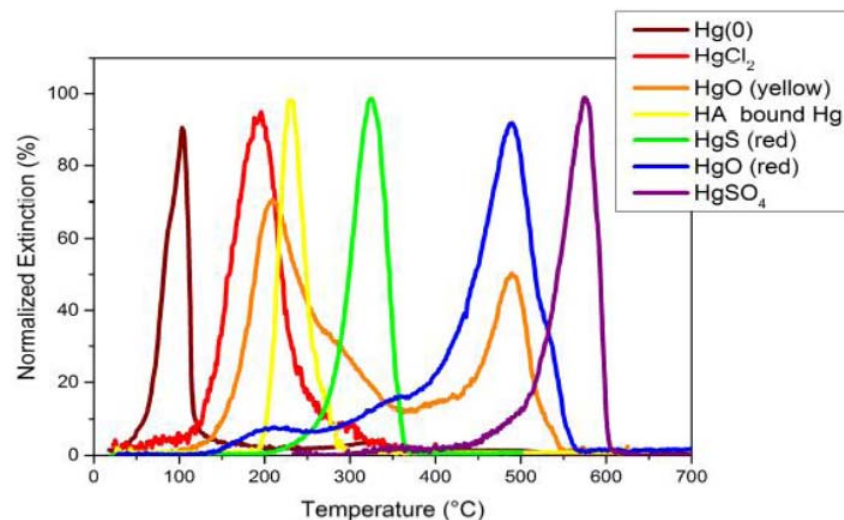


Definitions / goals

- ESTD / ISTD : volatilizing the polluting compounds by thermal and recovering of the pollutants volatilized with on-site treatment
- Thermal treatment known and proven for managing high concentrations (source zones) but need to be adapted to local restrictions :
 - Existing buildings, networks, etc.
 - Hg concentrations on residual crude although more volatile

Objectives:

To eliminate any risk of volatil Hg° and/or unstable HgCl₂ compounds



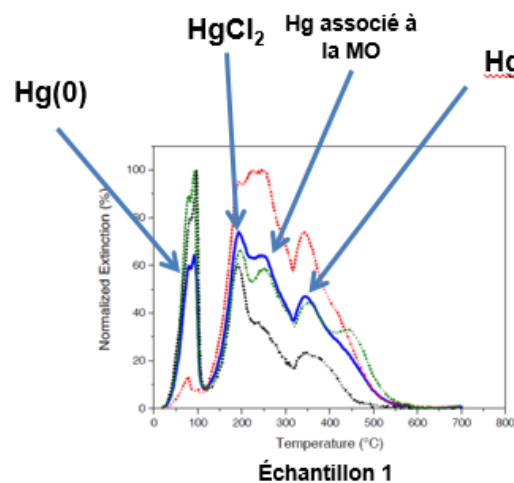


On-site/In situ thermal desorption

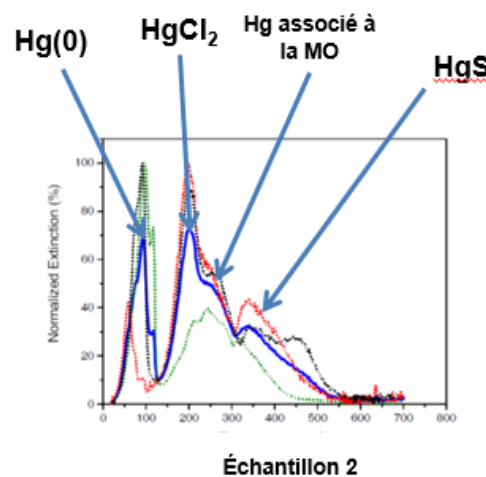


Feedback from experiences:

Thermal desorption kinetics tests with speciation analysis



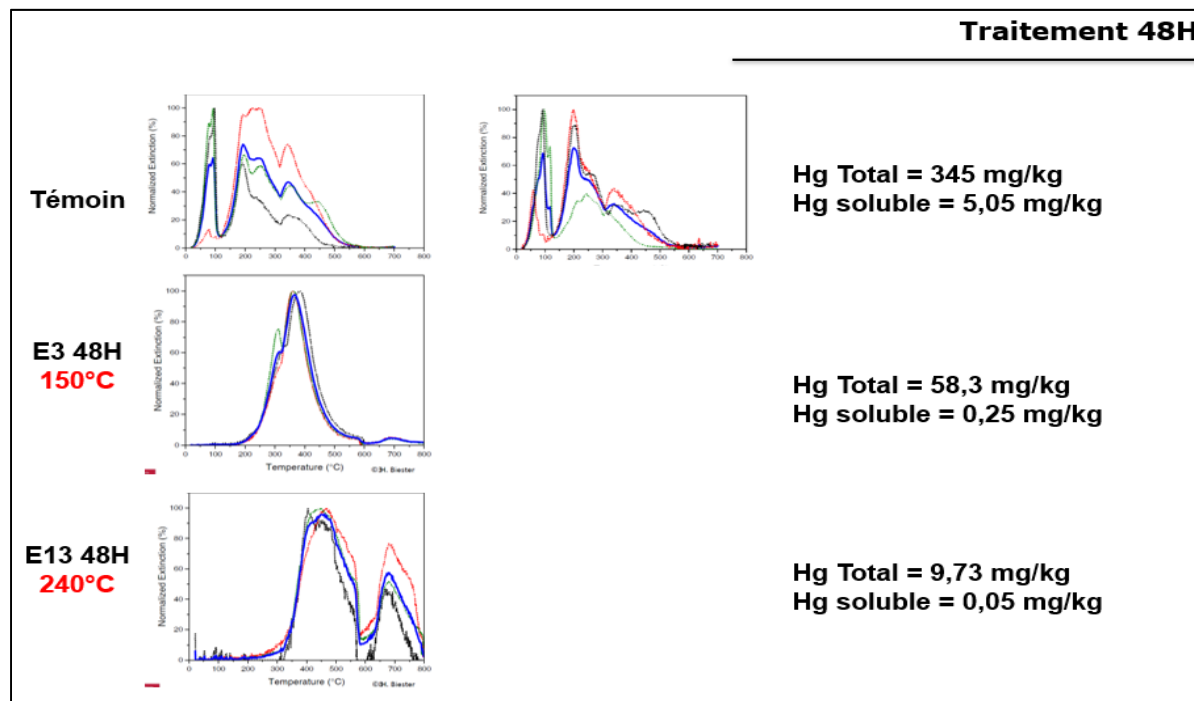
Témoin
Lot 1



T = 100 to 260°C over 12 to 168h



Results:



- Metal mercury disappears at 150°C;
- Most species disappear (HgCl₂ and Hg linked to organic matter) at 240°C;
- Residual form present in the samples: HgS (mercury sulphide)
 - ➔ Thermal desorption efficiency on tested samples
 - ➔ Allows to eliminate the mobile forms of Hg (Hg^0 , $HgCl_2$)



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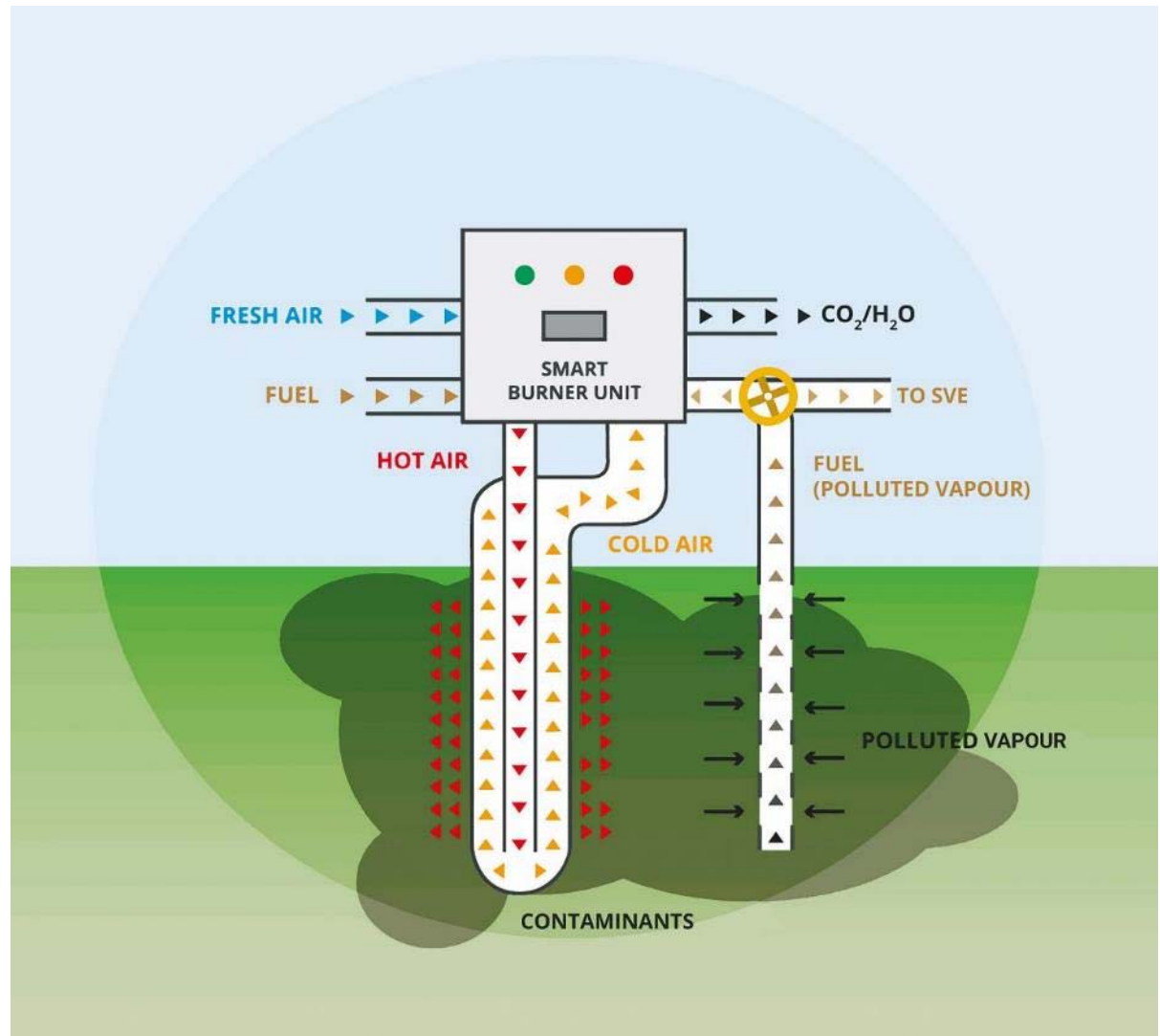
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4. ISTD / ESTD The project

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How do Smart Burners™ work?

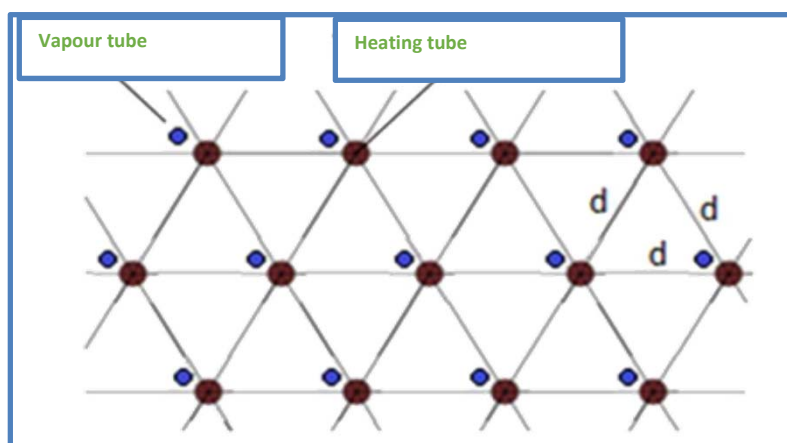
- Smart Burners and SVE wells are placed in the soil at approximately 1,5 to 2,5m apart.
- Smart Burners wells heat the soil resulting in the vaporization of water and Hg
- Water and Hg are removed from the soil by vacuum extraction wells for treatment by condensation



Heating the soil

The heating elements are placed in a triangular pattern.

- Provides a constant radius of action (homogeneity)
- Predictable treatment time for the whole area
- Adapted geometries for specific projects/site configurations
- Pipe length can be variable and adapted to the depth of the contamination

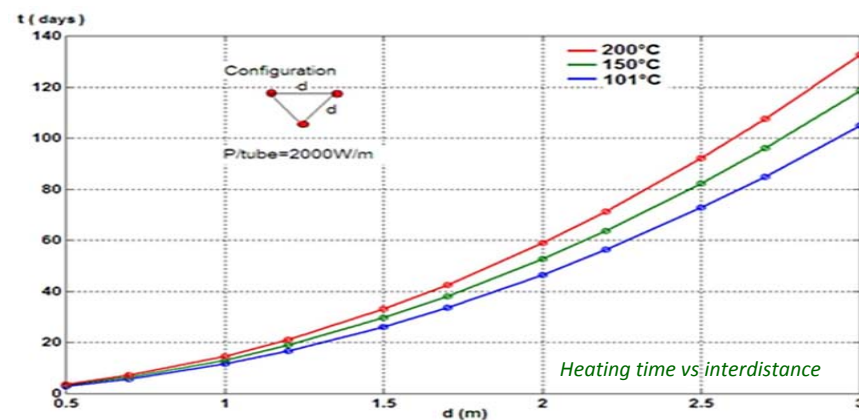


Heating mechanisms

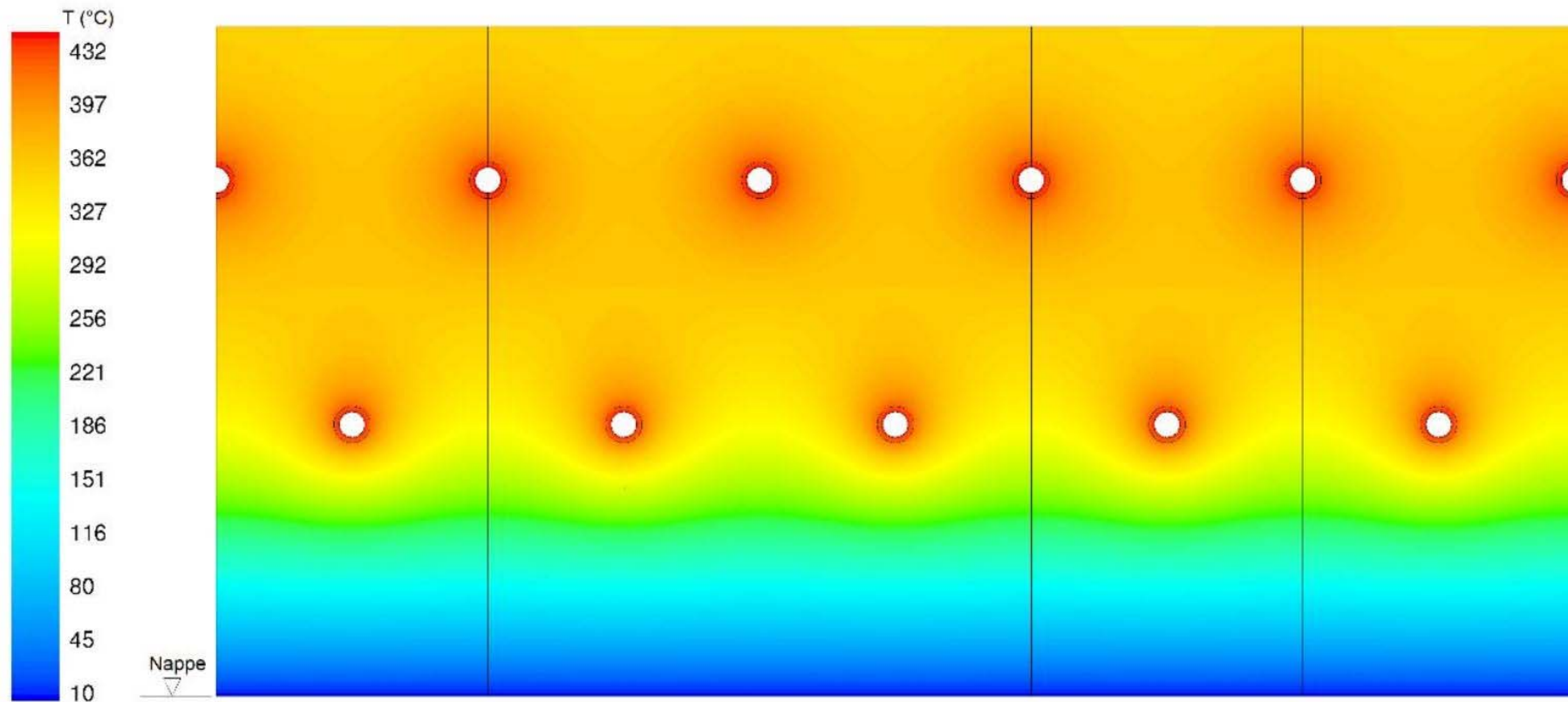
Heat transfer is based on conduction

Advantages of conduction:

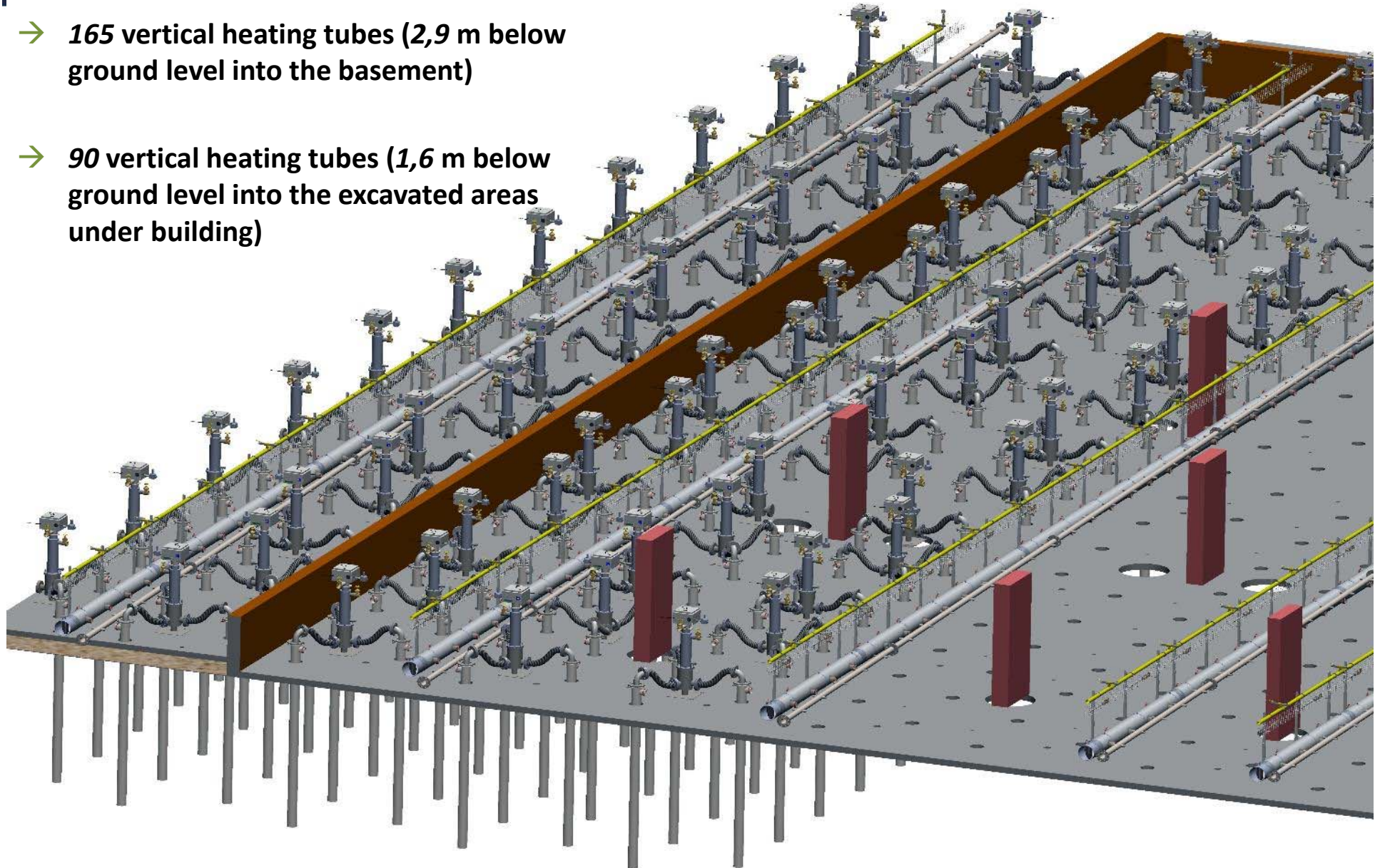
- Almost not influenced by soil heterogeneity
- Predictable heating/transfer time
- Whole mass is treated (no rebound)
- Can treat all types of soil



→ 41 horizontal drillings – 15 m long with 41 Smart Burners



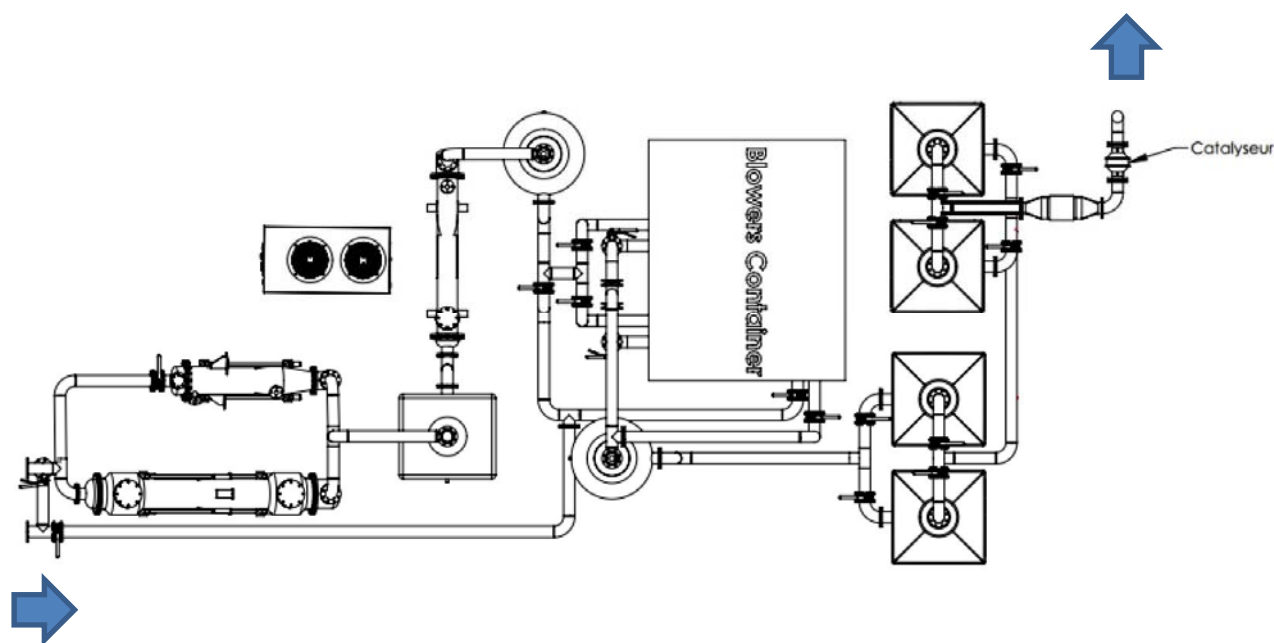
- **165 vertical heating tubes (2,9 m below ground level into the basement)**
- **90 vertical heating tubes (1,6 m below ground level into the excavated areas under building)**







Condensation / Activated Carbon adsorption



- Thermal desorption required low water moisture and no water table
- Project required dewatering (about 1 m dewatering)
- Dewatering system 265 m³/h with 14 boreholes (*Pumping*)
- Treatment plant with 8 activated carbon tower + 4 resin vessel tower
- Ponctual storage capacity for process water (from SVE DT plant) : 4 tanks of 70 m³



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5. Monitoring / Results

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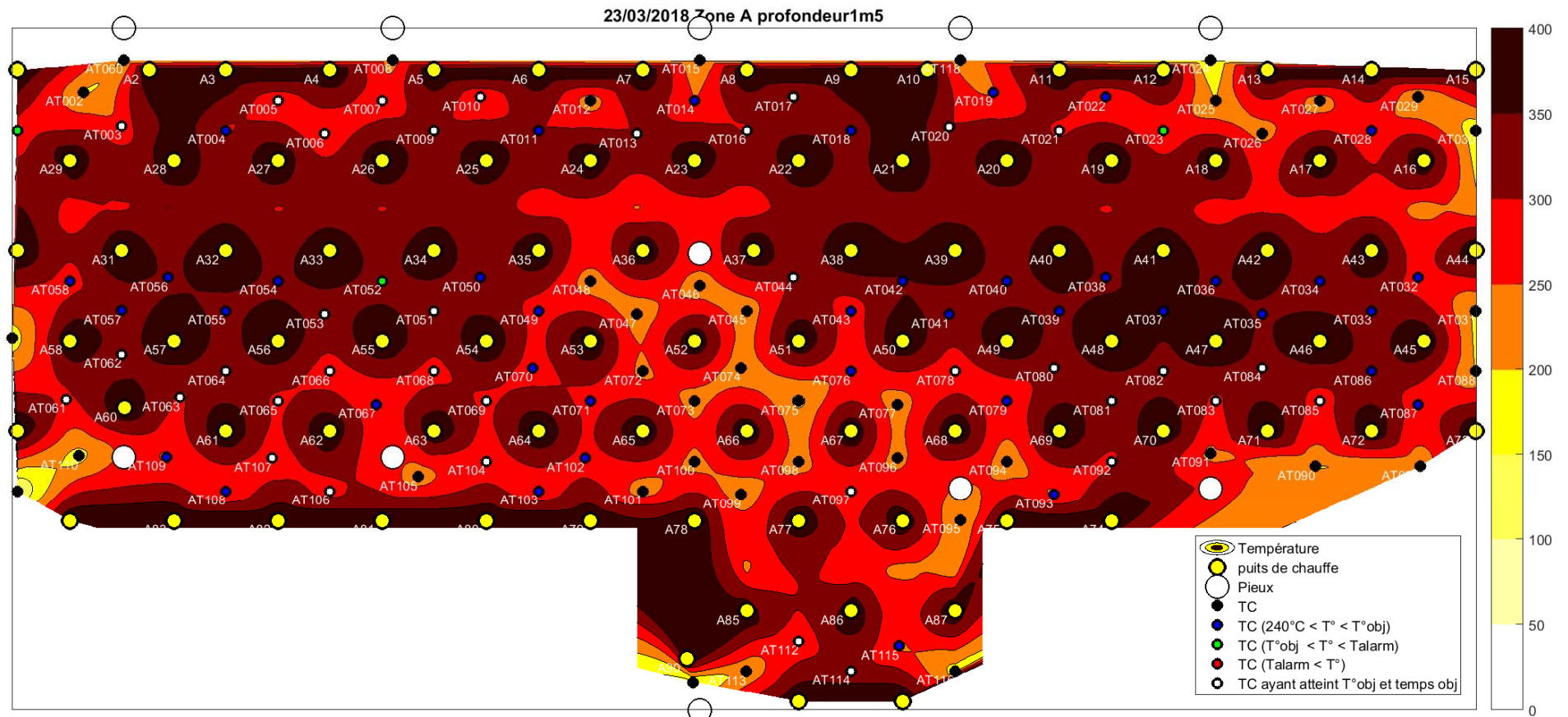
BIOGENIE HAEMERS Monitoring :

- Temperatures : 2700 thermocouples
- Control of pressure, flowrates...
- Combustion gas control (Nox, SO₂, CO...)
- Discharge effluent control of water and gaz :
direct mesuring with Jérôme and Lumex
- Gas Sampling on AC tubes (weekly)
- Water sampling water tank (one/tank)
- Dust control analysis on Owen Jauge (quaterly)
- Total mass recovery calculation

Initial quantification between 91 – 250 kg of Hg



Temperatures monitoring (*Thermographies*) – 3 Areas controlled



- 9 thermography/day (zone A) + 15 Th/day (zone B/C) + 9 Th/day (zone D)
- About 33 Thermography/day to follow T° evolution

- **Average Hg Total recovery / day
about 2 kg/d recovered**
- **More than 15 kg of total mercury
vaporized and collected sorbed on
activated carbon**
- **Expected free liquid phase condensed
in the piping and knockout : > 150 kg so
about 10 liters**



ON-SITE - Monitoring (*assumed by Maître d'Œuvre – Consultant SEMOFI*)

- Continual LUMEX measurement
- Water discharge control (daily)
- Air sampling with hopkalite tube and passive badge

OUTSIDE – Air quality Monitoring (SEMOFI)

- Daily monitoring with LUMEX

Employees Monitoring

- Medical exposure monitoring due to high toxicity



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6. Conclusions

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Complex management of mercury on-site implies :

- Specific approach and multi technologies of earthwork
- Specific waste management
- Thermal desorption in process : free phase collected
- High monitoring required

15.000 m³
excavated

2.500 m³
treated by ISTD

Free Phase
recovery

270 m³ ESTD

2.700
Thermocouples

265 m³/h water
discharge

Pour aller plus loin : snowmannetwork.com (ImaHg) ; rapports BRGM ; INERIS...

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