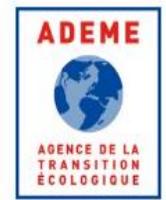




SoilVer Webinair “Engineered soils for territorial resilience: advancing Technosols/ Neosols in sustainable land management”

Creating fertile soils from backfill materials

Philippe Bataillard, Jean-Louis Lambeaux, Valérie Guérin (BRGM); Hugo Maurer, Margot Sahaghian (Néo-Eco); Catherine Keller (Université Aix-Marseille); Brice Chandon (Euroméditerranée); Jean-François Nau (EODD); Cécile Grand (Ademe) 13/02/2026



**POLLUTION PARTIELLE
DES SOUS-SOLS DÛE AU PASSÉ INDUSTRIEL**

#01

GENERAL CONTEXT

**TRAVERSES DE CHEMIN DE FER
TRAITÉES À LA CRÉOSOTE**

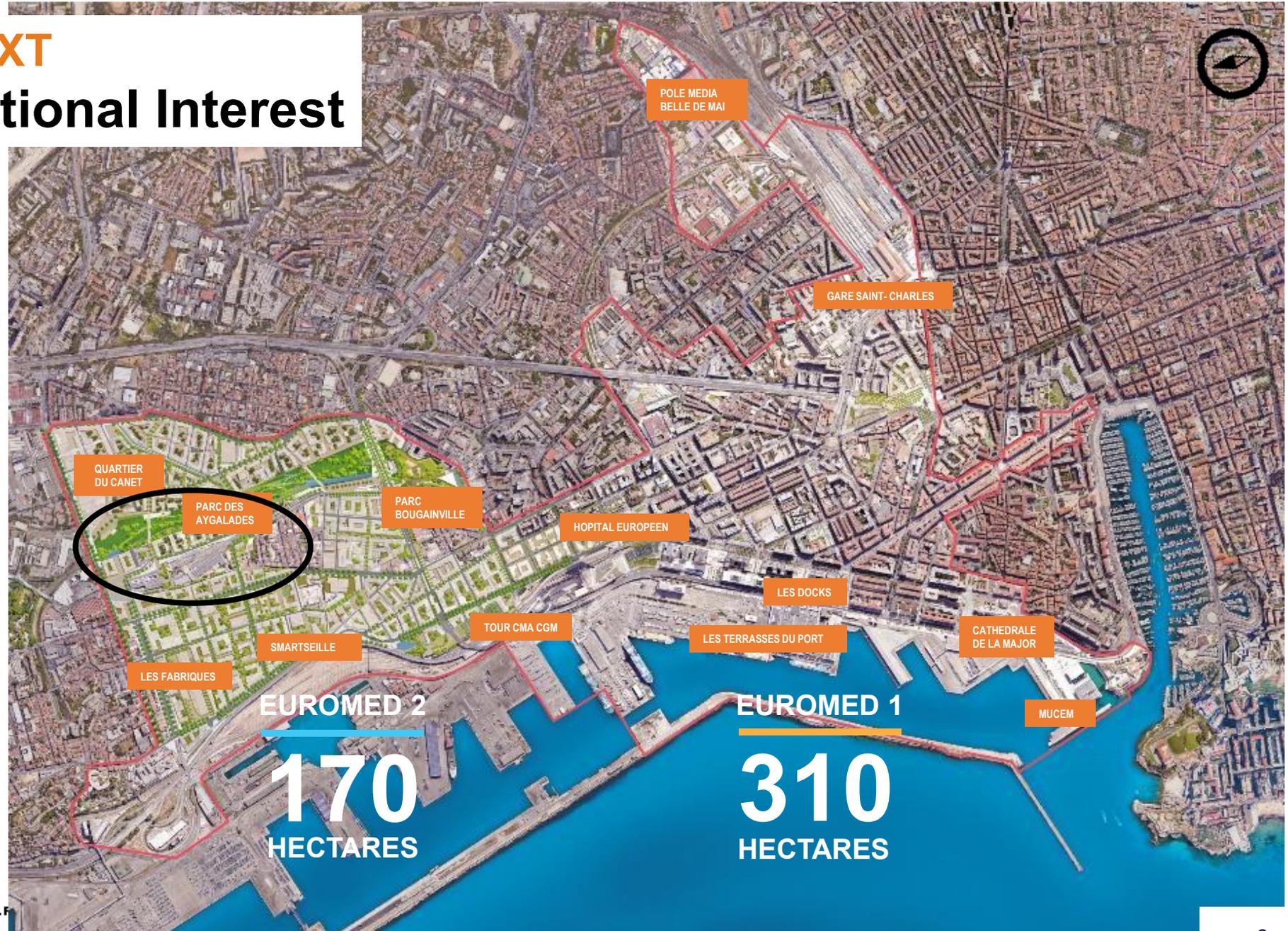
GENERAL CONTEXT

Operation of National Interest



CREATED IN 1995 BY THE STATE AND LOCAL AUTHORITIES

The Euroméditerranée Public Development Agency (EPA) designs, develops and builds the sustainable Mediterranean city of tomorrow in the heart of the Aix-Marseille-Provence metropolis.



GENERAL CONTEXT

Development of the « Parc du ruisseau des Aygalades »

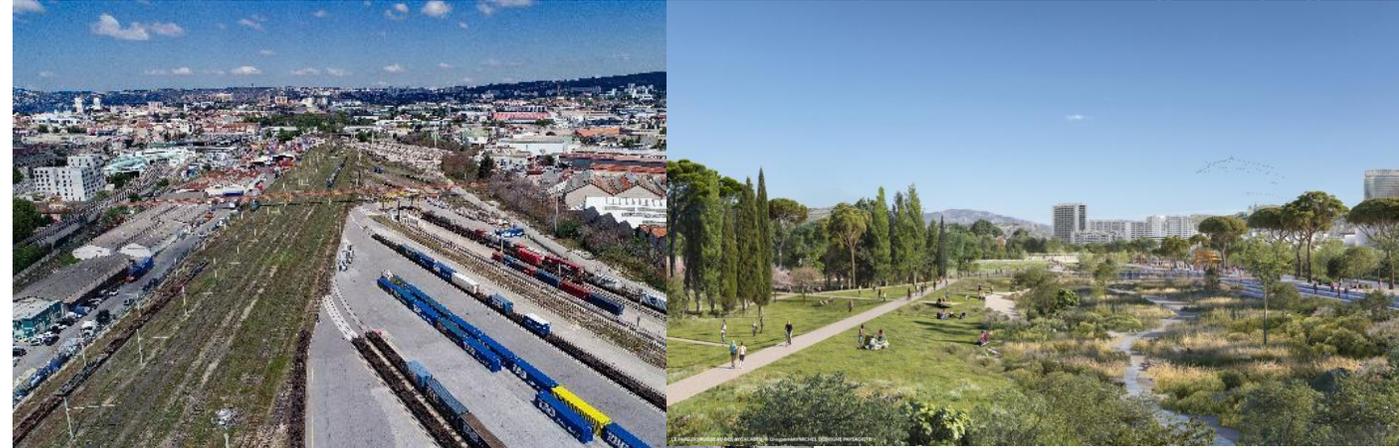
© Groupement Michel Desvigne Paysagiste

Brownfield redevelopment and circular economy

Aim

- Create a 20-hectare park for 2031 on the site of former railway activities north of Marseille

[FRICHECO | Recherche Ademe](#)



In this context:

- Promote the reuse of urban materials (excavated soil, silt, dredged sediments, etc.) to rehabilitate degraded areas and carry out urban landscaping projects

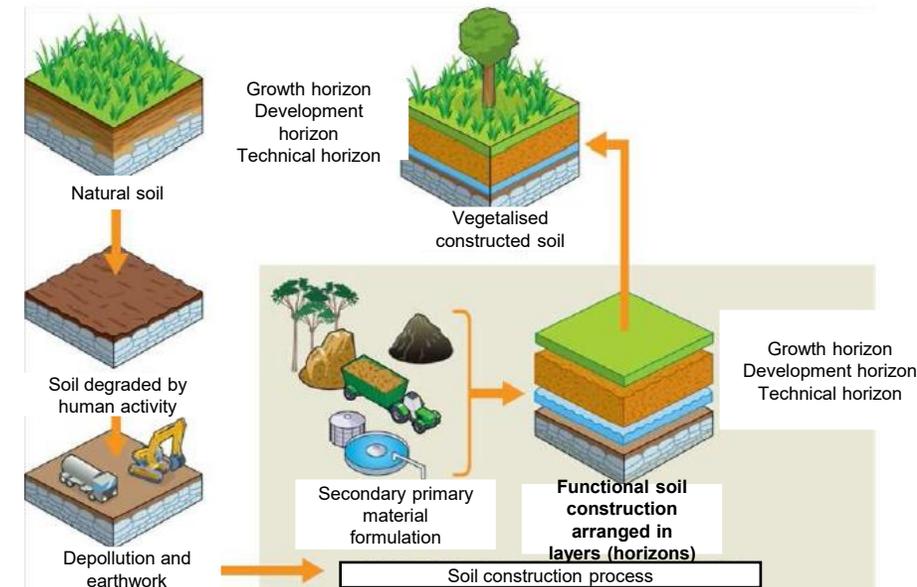
Field test

- Project pilot site – Parc des Aygalades: testing formulations to create 45,000 m³ of fertile soil by recycling excavated material from the site using an on-site platform.

Summary diagram illustrating the integration of the soil construction process (INRA/INPL/TVD patent) for the restoration of degraded environments. © BRGM



current site and after conversion



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Identification of alternative materials

Decision –making tool

- Mapping of alternative materials

Industriel

Material: compost
 Classification: resource
 Function: provides organic matter/nutrients and other minerals

- Other materials in the urban metropolis are characterised to serve as a correction,
- This is the basis of the ‘**small soil cycle**’ that we want to make operational.

Produit ● Clay ● Compost ● Silt ● Pilot site



Drinking water production
 Deposits: silt (agronomic capacity)
 Classification: K2 and possible downgrading to K3+ (depending on lagooning time)
 Function: particle size corrector, organic matter, clay

Potter Ravel
 Deposits: clays
 Classification: K3
 Function: mineralogical clay corrector

quarries and other industrial operators
 Carrier: Sterile material and other co-products
 Classification: K3 or K3+
 Function: base material or possible corrective deposit (currently being refined)



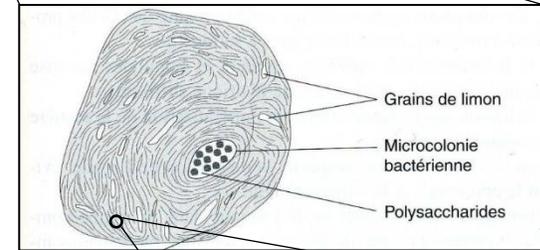
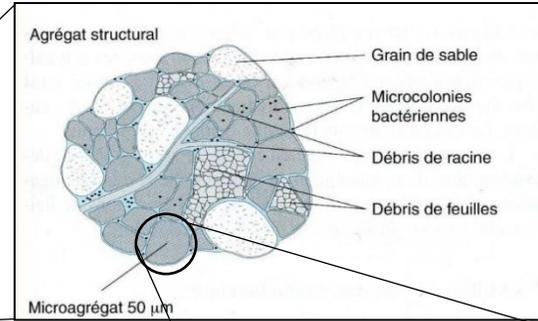
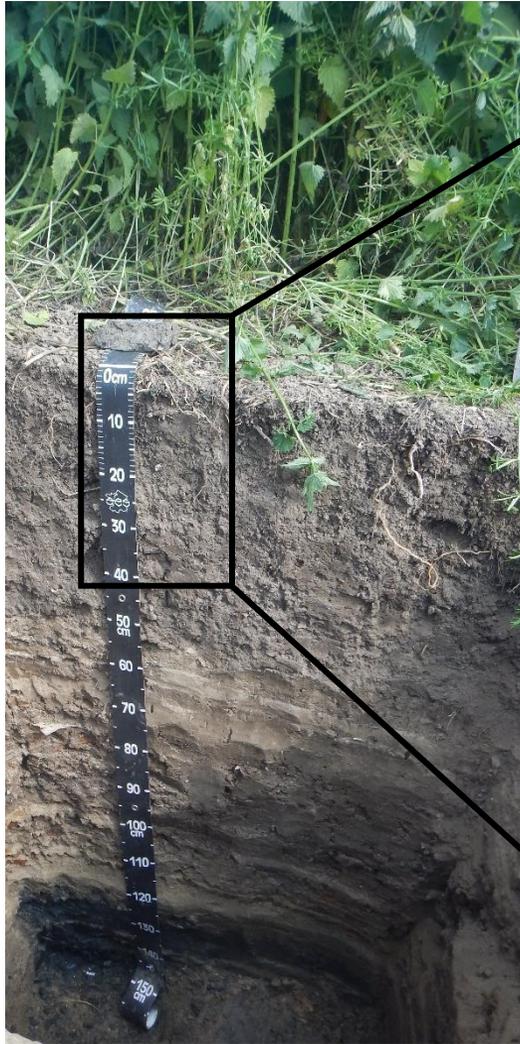
#02

ARE THE MATERIALS ON THE SITE
SUITABLE FOR BE USED AS SOIL?

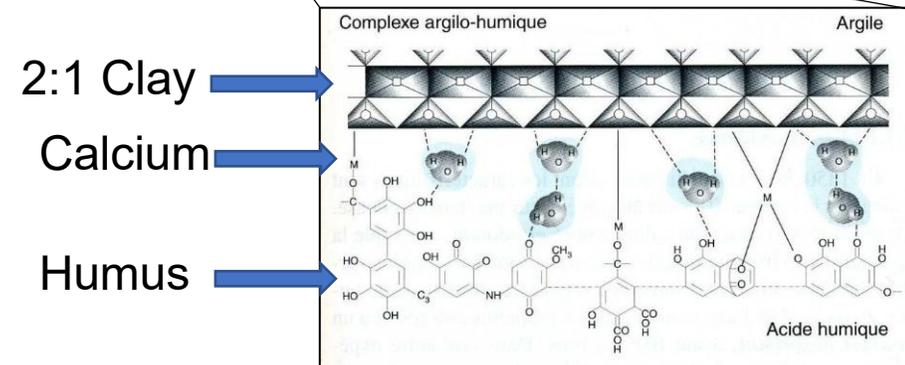


BRGM APPROACH FOR SOIL CONSTRUCTION

A brief look at soil fertility : organo-mineral associations, the key to soil fertility !



This reactive structure was formerly known as the "clay-humus complex".



Source: Le sol vivant - Bases de pédologie, biologie des sols. Gobat J.-M., Agagno M. et Matthey W., 2003, Presses polytechniques et universitaires romandes

RESEARCH PROJECT

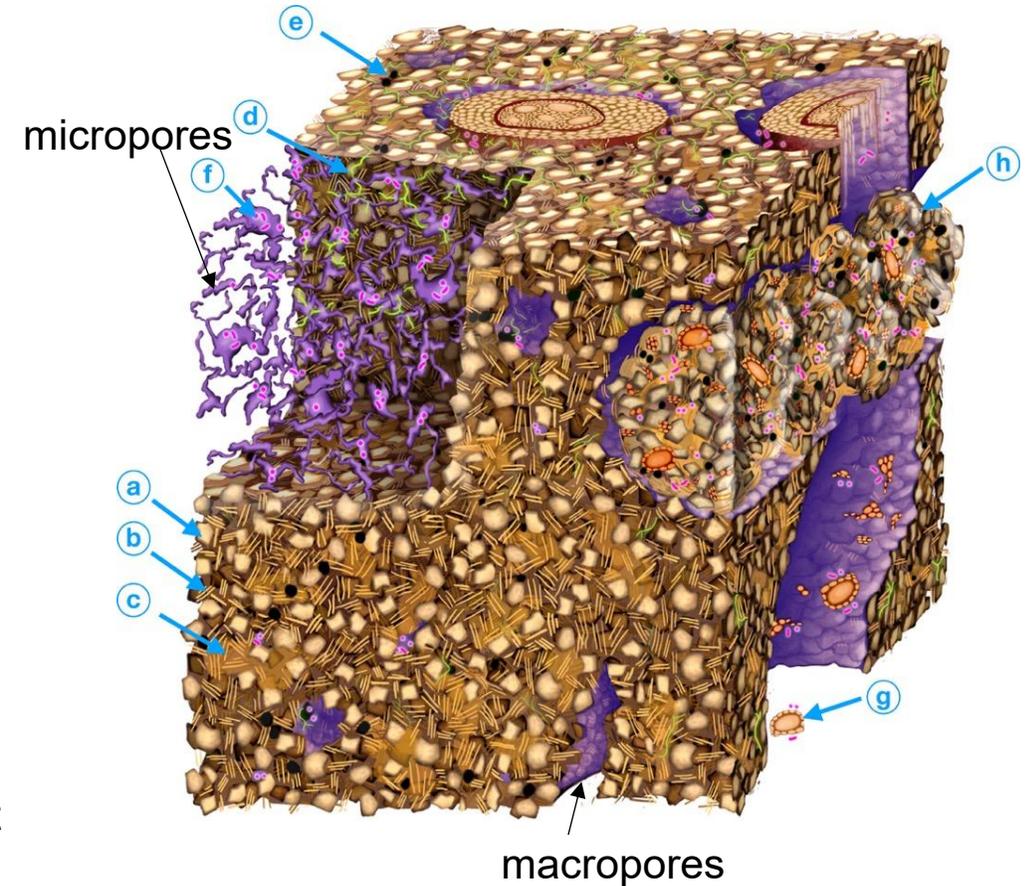
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Soil regeneration : Technosols construction or pedological engineering

The approach developed to build fertile urban soils is based on the following principles:

- Correct **texture**,
- Correct **organic matter content**,
- Correct the mineralogy, with a focus on the **type of clays** and carbonated materials,
- **Structure** the mixtures and superimpose **layers** (horizons) of different natures to give the future soil the porosity it needs to allow water, air and roots to pass through.

The objective is to formulate a mixture with high organo-mineral aggregation potential.



The 3D architecture of the soil

Source : Vogel et al., 2021, A holistic perspective on soil architecture is needed as a key to soil functions –European J Soil Science, Volume: 73, Issue: 1, DOI: (10.1111/ejss.13152) (Graphique : Lisa Vogel, www.lisavogel-illustration.de)

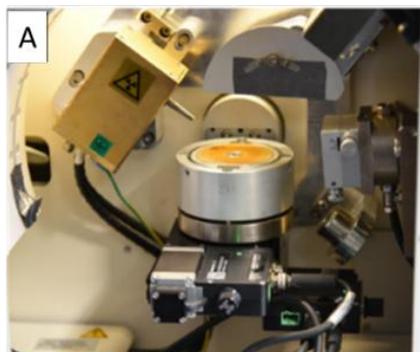
RESEARCH PROJECT

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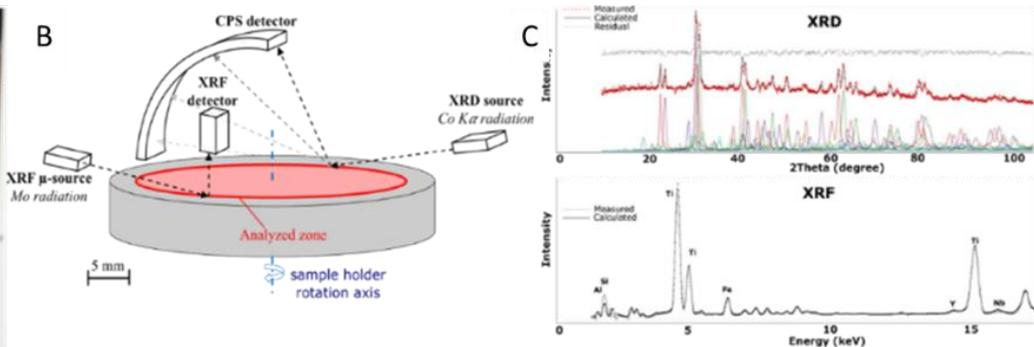
Qualification of earthy materials from the site and the nearest environment

Use of a (new) onboard **XRF-XRD combination device**:

- Give the **chemical composition** of samples (including metal contaminants): pXRF
- Give the **mineralogy of samples** (including clays): XRD



© TerrAnalytiX



(Herbelin et al., 2023, modifié de Maestracci et al., 2023)

30
number of characterisations
per day

On field measurements



© BRGM



© BRGM

RESEARCH PROJECT

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Results: materials identification

Three groups of materials identified on the site

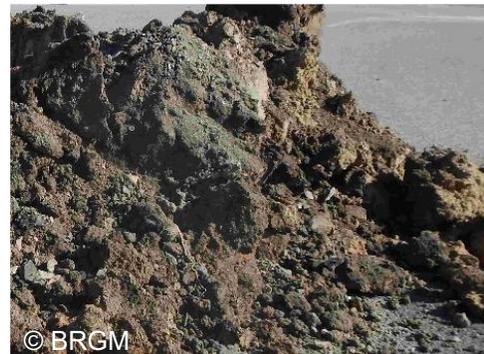
Group 1: sand with slag and coarse ballast



Group 2: sandy mixtures with coarse elements including silty-clay pebbles

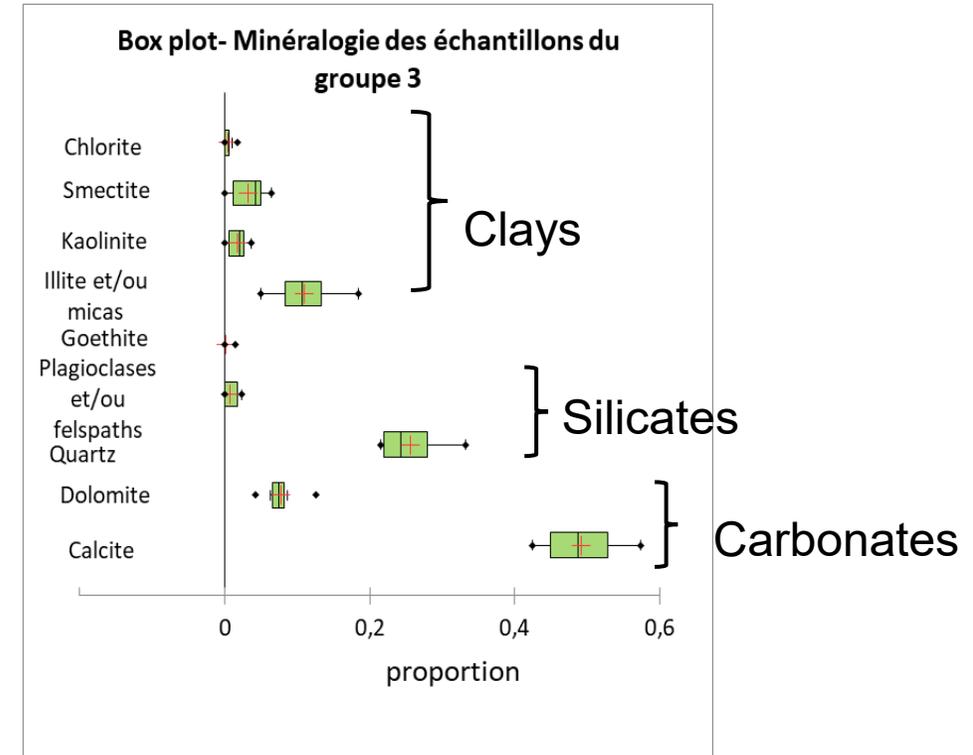


Group 3: more homogeneous materials with a silty-clay appearance



Presence of an interesting formation (G3) on site for soil construction, but:

- Present at 2-3 m depth
- With a deficit of reactive mineralogical clay (less than 15 %)
- Not free from contaminants

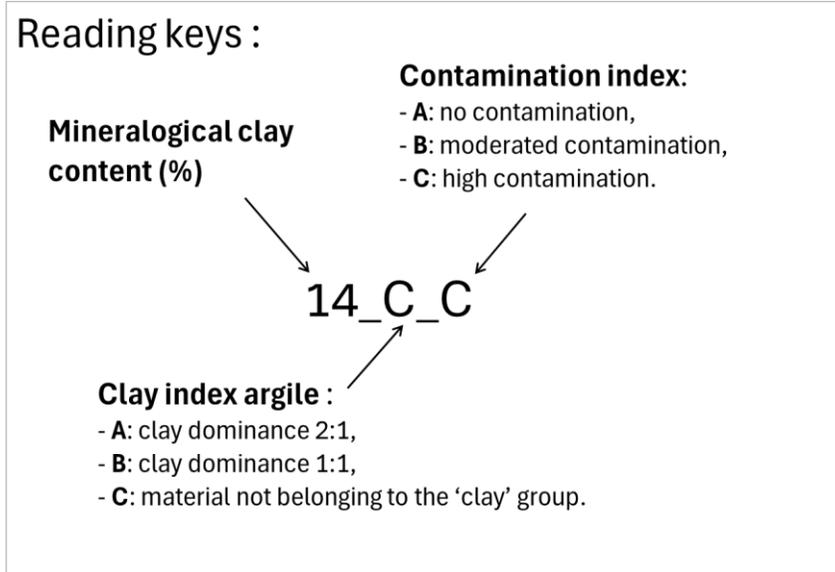


Mineral composition of group 3 material © BRGM

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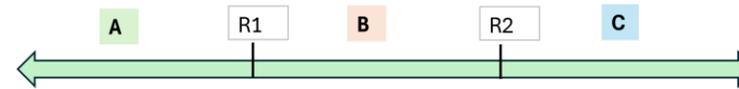
Expression of results to the project manager



	R1 : Level 1 TEX release for urban development projects (mg/kg)	R2 : High value of moderate soil anomalies in France (Baize , 2000) (mg/kg)
As	25	60
Cd	0,4	2
Cr	90	150
Cu	40	62
Ni	60	130
Pb	50	90
Zn	150	250

Coding system is proposed to express the potential of the sample to be transformed into soil using 3 indicators:

- **clay content**
- **type of clay**
- possible **trace element contamination**



Classification limits (in this case, contamination) can be modified according to the context and, in particular, the desired use of the excavated soils.

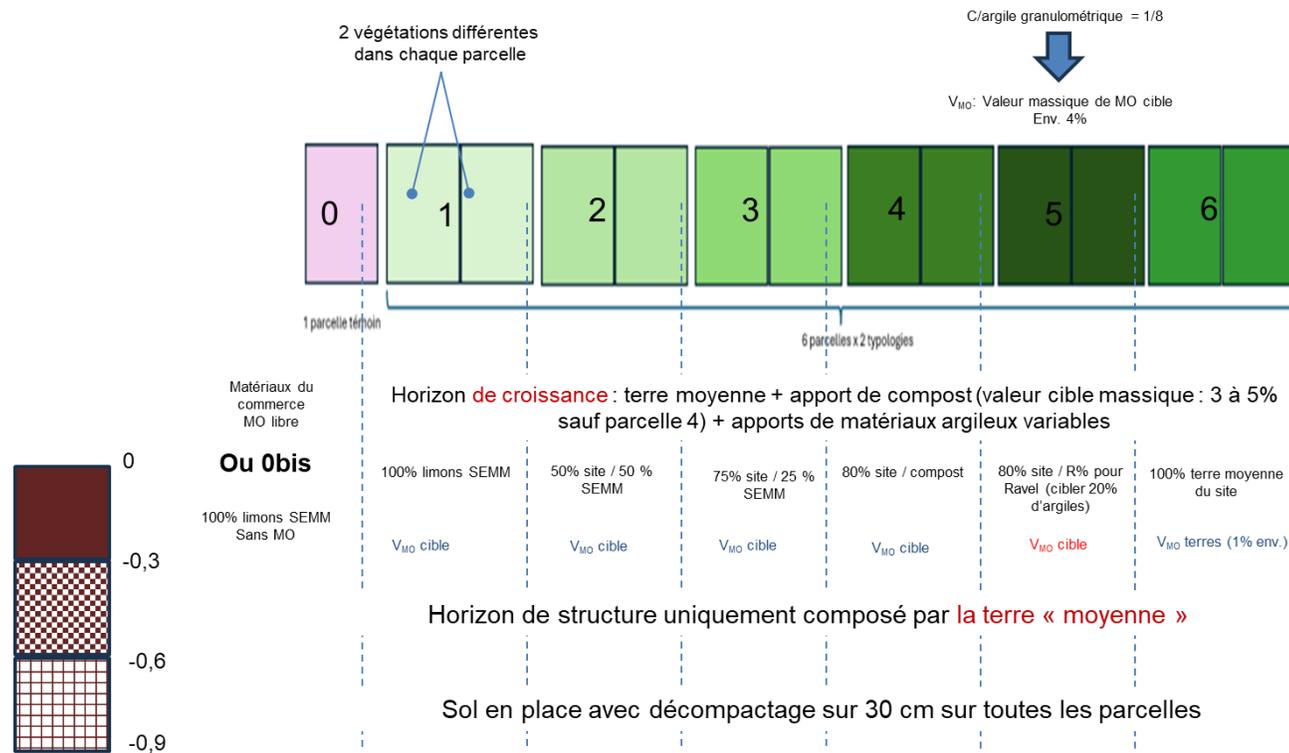


Location of suitable earth material at site © BRGM

RESEARCH PROJECT

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Formulations have been proposed, and the next step is to test them in real-world conditions in an experimental garden, scheduled to be set up in September 2026.





#03

CONCLUSION & PERSPECTIVES

Conclusion : How can we express a material's potential to transform into a “soil” ecosystem?

- Here, we postulate that knowledge of the quantity and type of mineralogical clay is essential,
- To this end, we are experimenting with **the “democratization” of mineralogy measurement using X-ray diffraction** and proposing interpretation keys. ,
- Ultimately, the materials on the site are classified simply according to this potential, and corrective additions are proposed in order to obtain the most balanced formulation possible (TOC, mineralogy, and texture), taking into account the availability of materials on the site and in the surrounding environment,
- Among the indicators in the soil directive that are useful in helping to formulate this, we believe that **the organic carbon/clay (granulometric) ratio** is key, as it expresses the aggregation potential of the mixture:

Soil directive indicator →

TOC/argile ratio	Soil health	Aggregation potential (or expected structural stability)
13	poor	poor
10	average	satisfactory
8	good	Very good

From Johannes et al., *Optimal organic carbon values for soil structure quality of arable soils. Does clay content matter?* *Geoderma*, 302 (2017), pp. 111-121

Perspectives - New project

Towards agriculture in the Orléans region in synergy with its urban environment – ATOU project

BRGM proposal to study the relevance of implementing a “**small soil cycle**” in the metropolitan area to develop soil fertility through the use of urban resources and innovative agricultural practices.

Upcoming program:

- Inventory of excavated earthy materials in the metropolitan area.
- Inventory of needs for “topsoil,” soil amendments, and soil thickening.
- Acculturation of stakeholders to the “small soil cycle” and the recovery of excavated soil (regulatory aspects).
- Deployment of the BDSOLU – a data base dedicated to urban soil.

Context : Call for expressions of interest for “Regional Demonstrators of Agricultural and Food Transitions” - PIA4 (Future Investment Program 4) is a French government funding program launched in 2021, aimed at accelerating innovation and supporting the French economy as part of the France 2030 recovery plan.

Thank you for your attention

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