Contribution of organic artefacts to carbon sequestration in Technosols.

Victor Allory, Geoffroy Séré, François Baudin, Stéphanie Ouvrard

CONTRIBUTION OF ORGANIC ARTEFACTS TO CARBON SEQUESTRATION IN TECHNOSOLS

Victor ALLORY [1], Geoffroy SÉRÉ [1], François BAUDIN [2], Stéphanie OUVRARD [1]

victor.allory@univ-lorraine.fr

[1] Université de Lorraine, INRAE, Laboratoire Sols et Environnement
[2] Sorbonne Université, CNRS, ISTeP

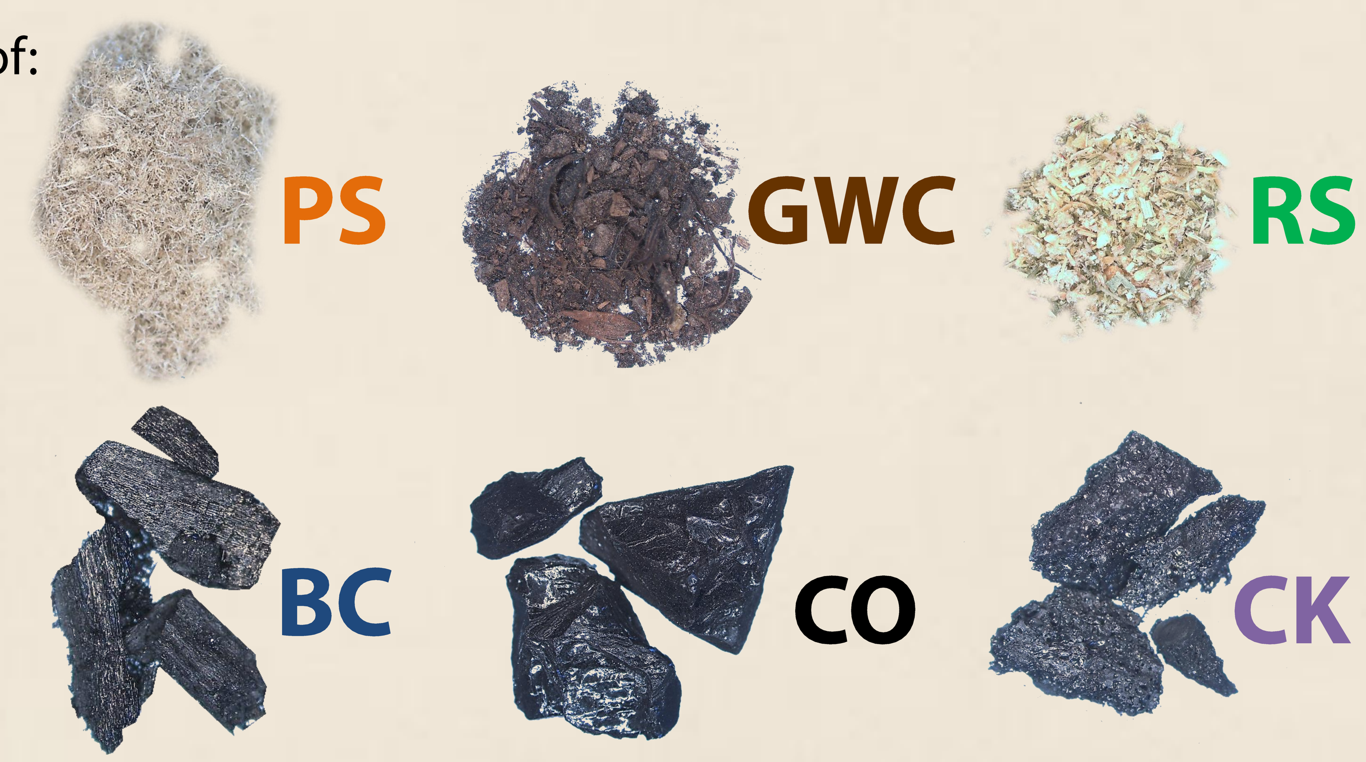
INTRODUCTION

Artefacts are materials that have been created, substantially modified or brought to the surface by humans. They can be found in all soils but are archetypal of strongly anthropized soils: Technosols. In some Technosols, artefacts can represent a large portion of the soil organic carbon stock. However, their degradability and potential interactions with natural organic matter remain largely misunderstood.
Our work aims at understanding the **short to mid-range fate of the most common organic artefacts** encountered in Technosols, in order to provide preliminary information on whether Technosols behave as sink or source of carbon.

MATERIALS AND METHODS

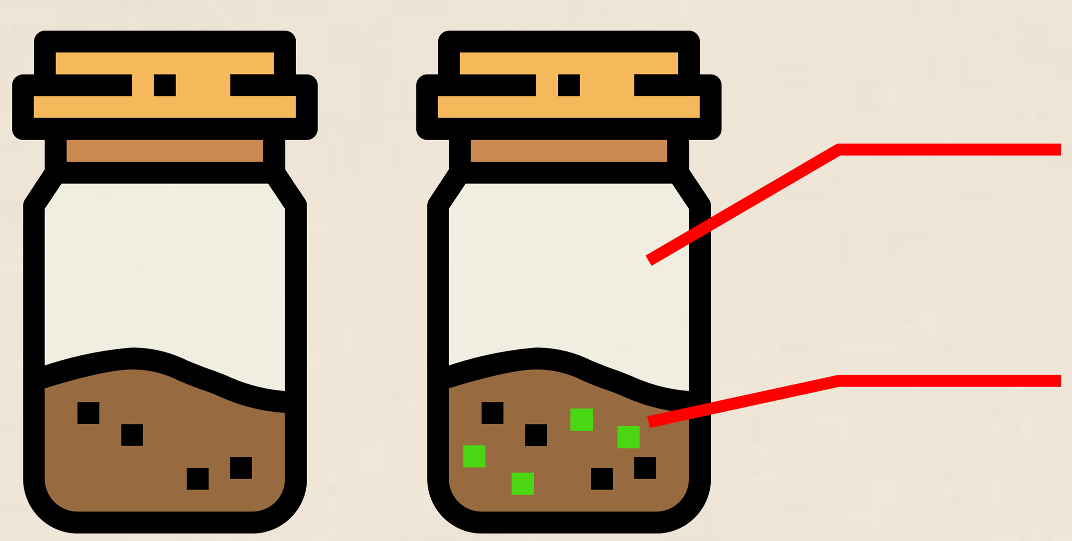
We made artificial soils composed of:

- One organic artefact (5%, w/w)
  - **Papermill sludge (PS)**
  - **Green waste compost (GWC)**
  - **Biochar (BC)**
  - **Coal (CO)**
  - **Coke (CK)**
- Mineral phase (95 %, w/w)
  - ¾ fine sand (quartz)
  - ¼ clay (kaolin)



stereoscopic microscope observation of artefacts and natural organic matter (x8)

We also made soils with natural organic matter (**crushed roots and shoots of sorghum**, RS) and mixed natural and anthropic organic constituents (2.5% each).
We **inoculated** these soils and **incubated** them at 20°C **for two months**.

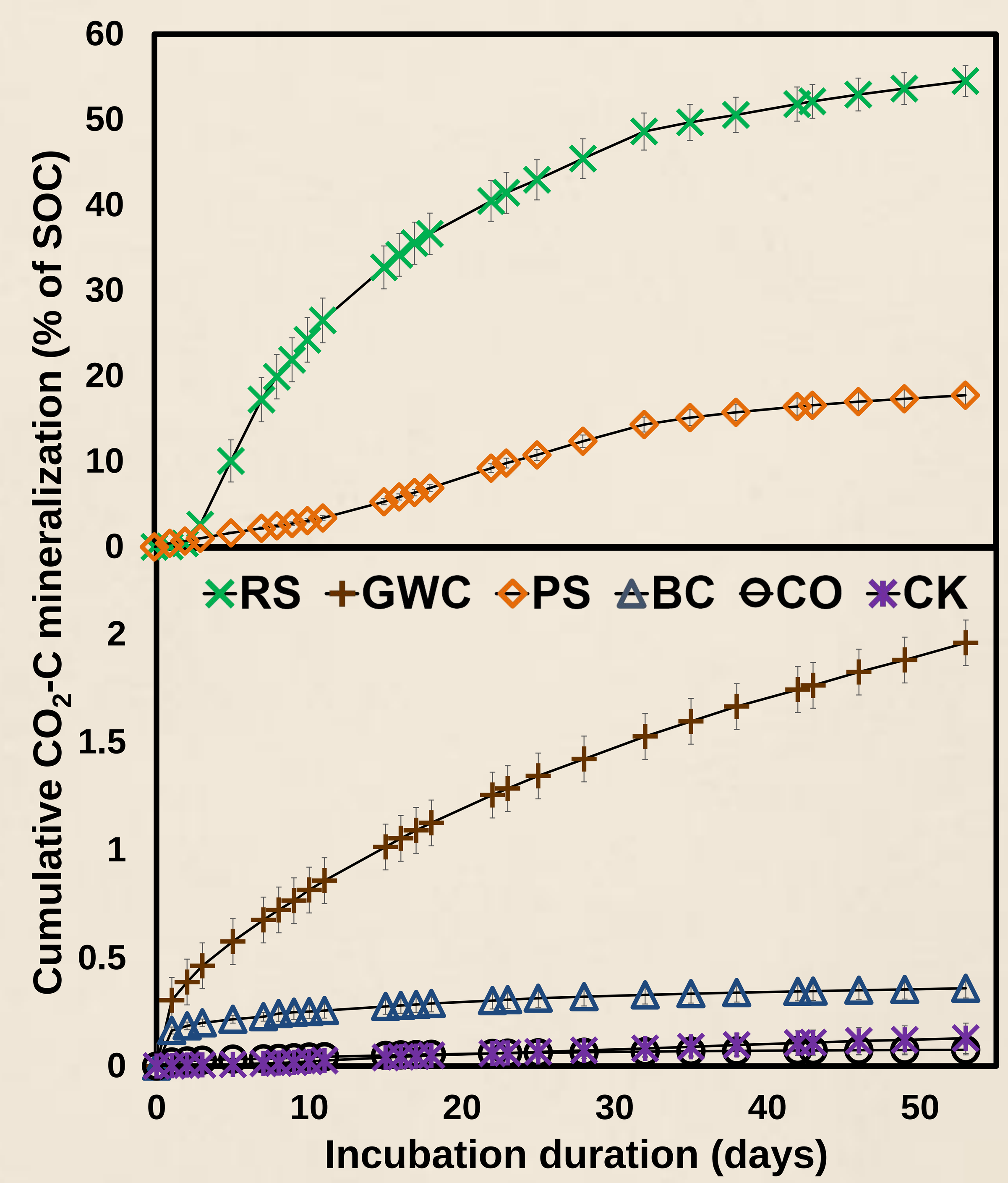


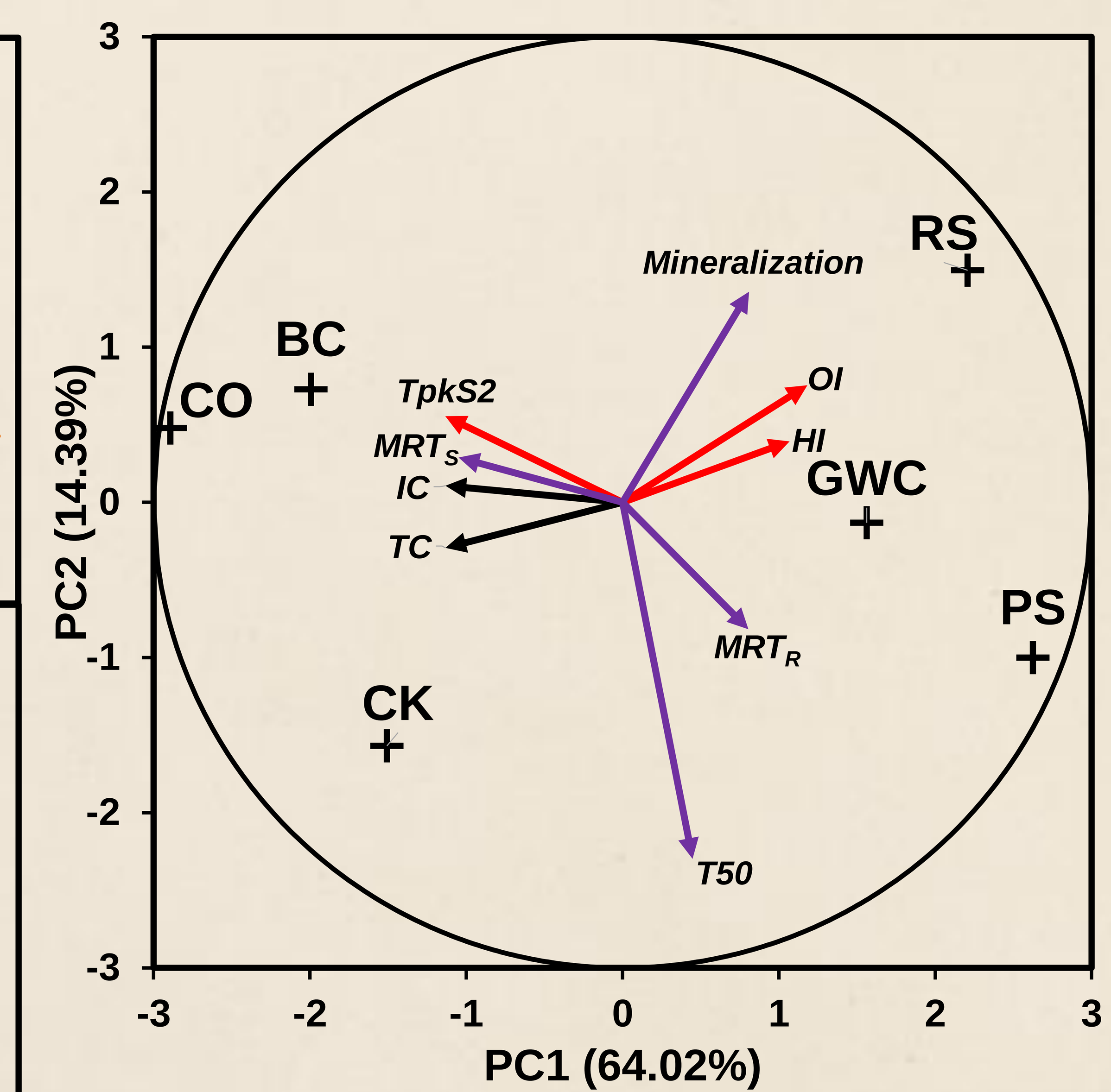
Several additional analysis were made on soils: Rock-Eval analysis which led to **hydrogen index (HI)**, **oxygen index (OI)** that are linked to H/C and O/C ratios and **temperature of peak S2** (**TpkS2**, linked to thermal resistance to degradation); modeling of CO_2 emission curves with double first order exponential model, each component of the model corresponds to a rapid and slow carbon pool associated to **rapid** and **slow mean residence time** (**MRT_R** and **MRT_S**), time to achieve 50% of the mineralization is noted **T50**.

RESULTS AND DISCUSSION

Results from cumulative CO_2-C mineralization over the 2-month experiment permits a first ranking of artificial soils in terms of global degradability:

RS >> PS >> GWC >> BC > CC ≈ CK.





MRT_S range from 1 year for PS, 10 years for GWC, about 90 years for BC and CK and **more than 300 years for CO**.

There is a **link between chemical constitution and thermal resistance properties** (Rock-Eval, red arrows) and **resistance to biodegradation** (modeling of mineralization, purple arrows)

Rock-Eval parameters show high HI and OI for RS, PS and GWC but low TpkS2, it is the opposite for BC, CO and CK.

Artificial soils with mixed artefacts and natural organic matter led to either higher mineralization than expected (GWC and PS) or lower than expected (BC, CO and CK). Additional $\delta^{13}C$ analysis (not shown) indicate **reduced mineralization of both natural organic matter and artefact** in the latter cases.

CONCLUSION

Our results show that **biochar, coal and coke have very high resistance to biodegradation**, and even show **potential to sequester additional carbon**. Compost, and paper mill sludge have lower resistance to biodegradation although the integration of such artefacts into Technosols may still result in carbon storage.
Overall, the **contribution of Technosols to global carbon storage should be reconsidered**!

GENEVA Eurosoil 2021
Grand Est ALSACE CHAMPAGNE-ARDENNE LORRAINE
INRAE
LABORATOIRE SOLS & ENVIRONNEMENT
UNIVERSITÉ DE LORRAINE