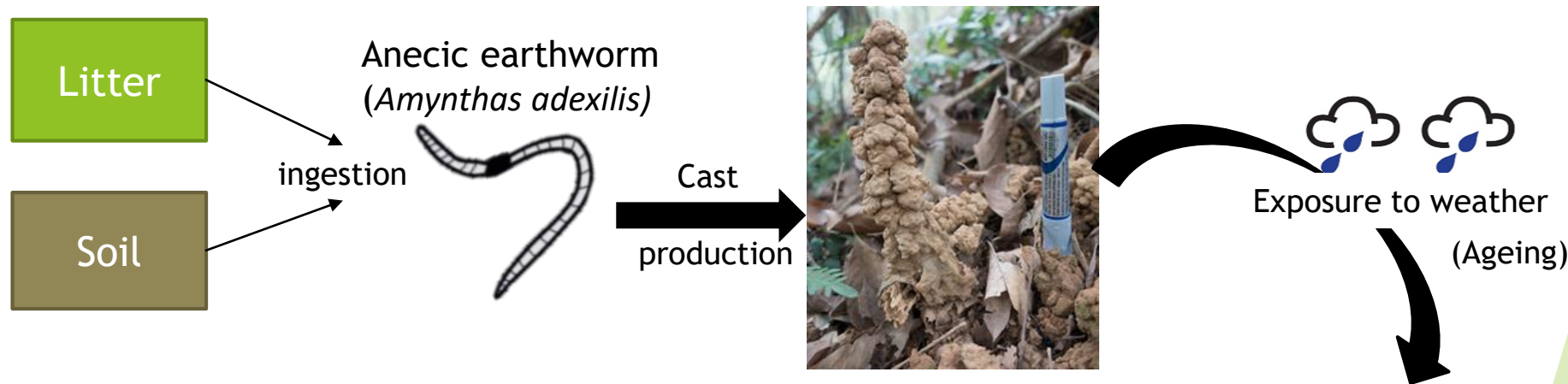


Effects of ageing under field conditions on soil organic matter in earthworm casts produced by the anecic earthworm *Amyntas adexilis* in northern Vietnam

Puche N.J.B.
Rumpel C.
Bottinelli N.
Tran T.M.
Mazurier A.

Context

Earthworms ingest organic matter (OM) and soil materials that they mix in their gut and produce casts. Casts are usually enriched in particulate OM (POM) occluded in aggregates and in OM associated with minerals, compared to surrounding soil. However, the dynamic of OM and its protection from mineralization during ageing in the field are not well understood.



In this study, we investigated the effects of ageing under field conditions on the OM dynamics contained in casts produced by the anecic earthworm *Amyntas adexilis* compared to control soil aggregates



Link physical properties (from X-ray microtomography) of different casts ageing stages and CO₂ emissions (OM mineralization) measured during an 80 days laboratory incubation experiment

Puche N.J.B.^{a, b}
Rumpel C.^a
Bottinelli N.^{b, c}
Tran T.M.^c
Mazurier A.^d

Effects of ageing under field conditions on soil organic matter in earthworm casts produced by the anecic earthworm *Amyntas adexilis* in northern Vietnam

Introduction

Results

Study site

Materials and methods

Conclusion and
perspectives

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Introduction

- Earthworms are recognized to play a key role in :
 - the structure of soils
 - dynamics of organic matter (OM) in soils
- **However**, changes in physical and chemical composition during their ageing and due to weathering are not well understood

Earthworms casts are usually enriched in OM and may reduce its degradability by protecting OM from mineralization through :

- chemical recalcitrance
- organo-mineral interactions
- micro-organisms community shifts through passage in earthworm gut
- OM accessibility and physical protection by 3D organisation of POM and pores

During ageing, casts structures and compositions are modified

- How much OM is protected?
- For how long?

What are the effects of ageing under field conditions on the OM dynamics contained in casts produced by the anecic earthworm *Amyntas adexilis* in North Vietnam?



Materials and methods 1/2: Ageing under field conditions

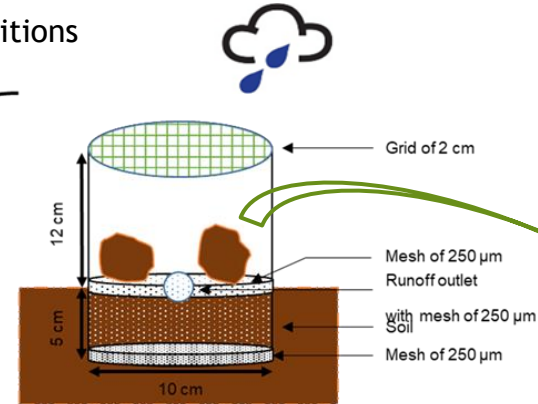
1) Ageing of casts and controls (soil aggregates) under field conditions

Fresh cast material sampling



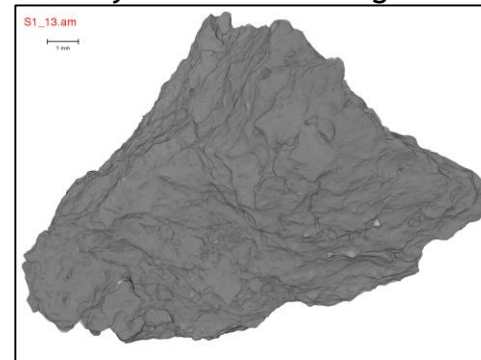
Amyntas adexilis cast

Ageing under field conditions



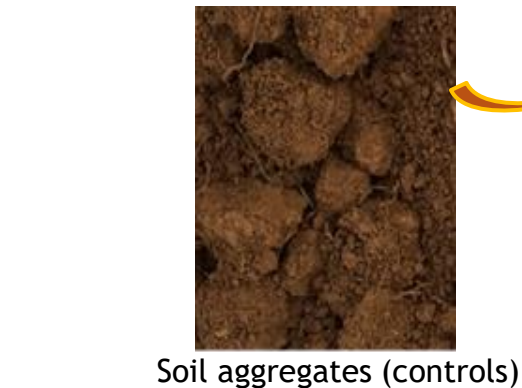
5 sampling dates over 1 year

Casts and soil aggregates
X-ray microCT scanning



For each ageing stage we sampled
~1cm diameter fragments from:

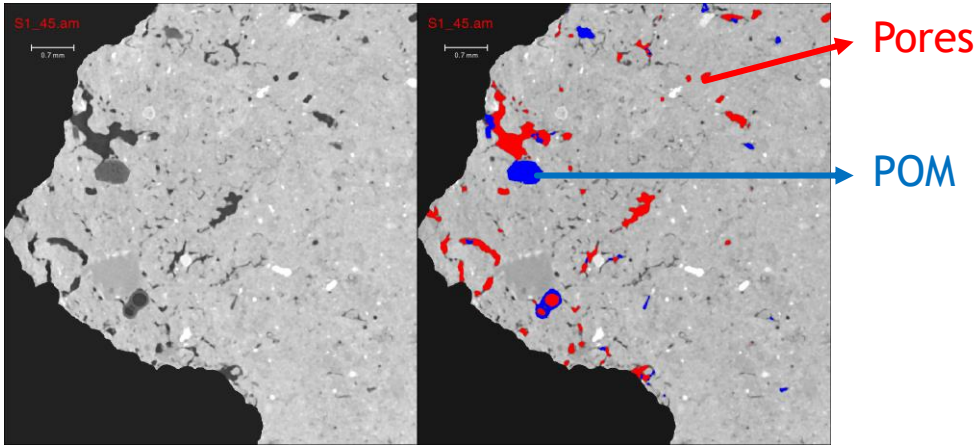
- 5 earthworm casts
- 5 controls (soil aggregates)



Soil aggregates (controls)

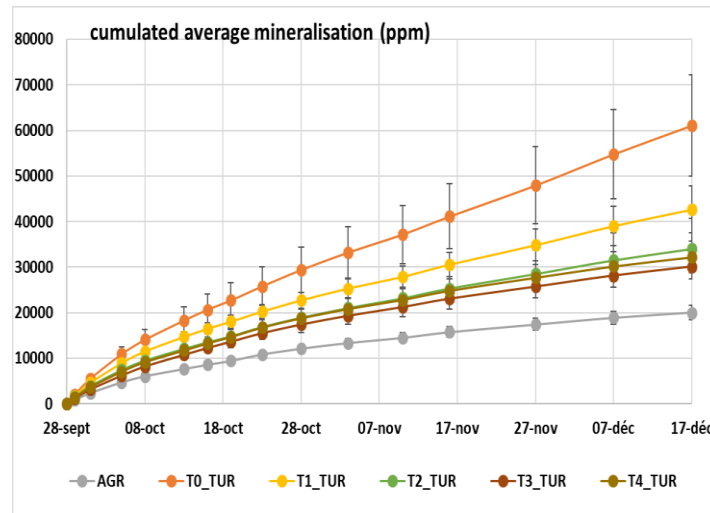


2) POM and Pores segmentation



- 50 samples (5 ageing stages, 5 replicates, 2 types: soil and casts) were scanned by X-ray microtomography
- Manual segmentation of POM and Pores based on greyscale levels
- POM and Pores volumes quantifications

3) Lab incubation and OM mineralisation



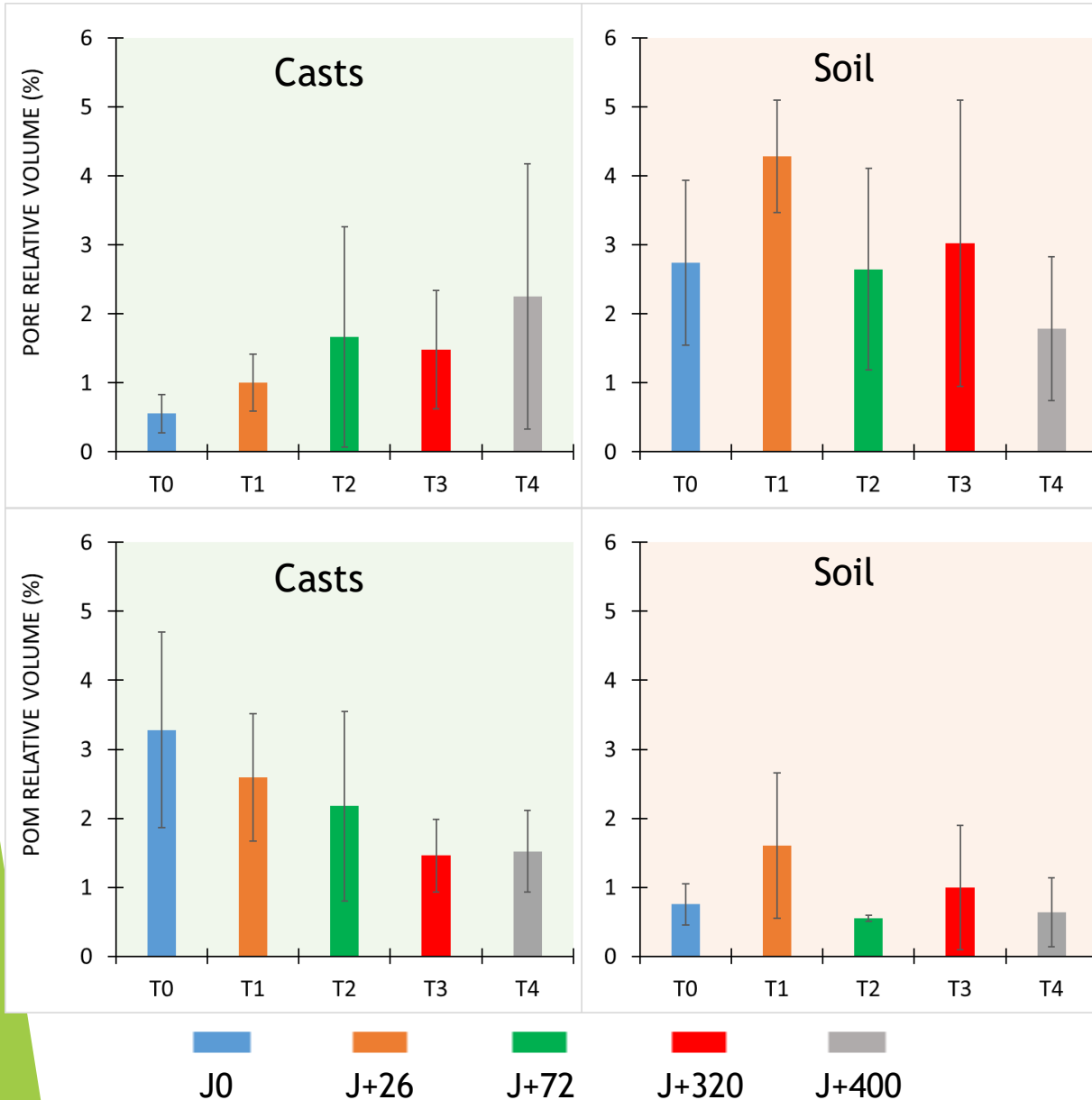
- We incubated the same aggregates that were scanned by X-ray microtomography
- Incubation in the dark, 70% FC, 20°C, for 80 days with regular CO2 measures with a microGC
- The mineralization process of samples was simulated with a first-order dynamic model

$$C_t = C_0 \times (1 - e^{-kt})$$

C_t (g kg⁻¹) accumulated mineralization amount after t days, C_0 is the potential value of OM mineralization (g kg⁻¹), and k is the turnover rate (d⁻¹)



Results 1/4: POM and pores segmentation



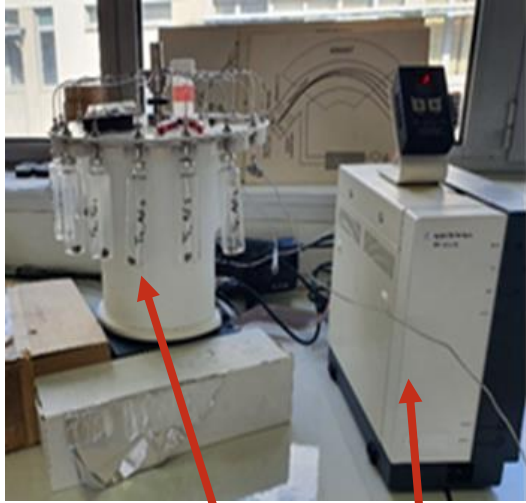
→ During the 400 days of ageing under field conditions

- The average porosity is always higher for soil aggregates than for casts.
- Important variability between ageing stages replicates
- Total porosity increase for **casts**, but not for control **soil** aggregates during ageing.
- POM content decrease through time in Casts (-50% over 400 days) and we don't see any clear trend for control Soils.

→ POM contained in fresh casts are degraded over time leading to an increase of the porosity in aged casts

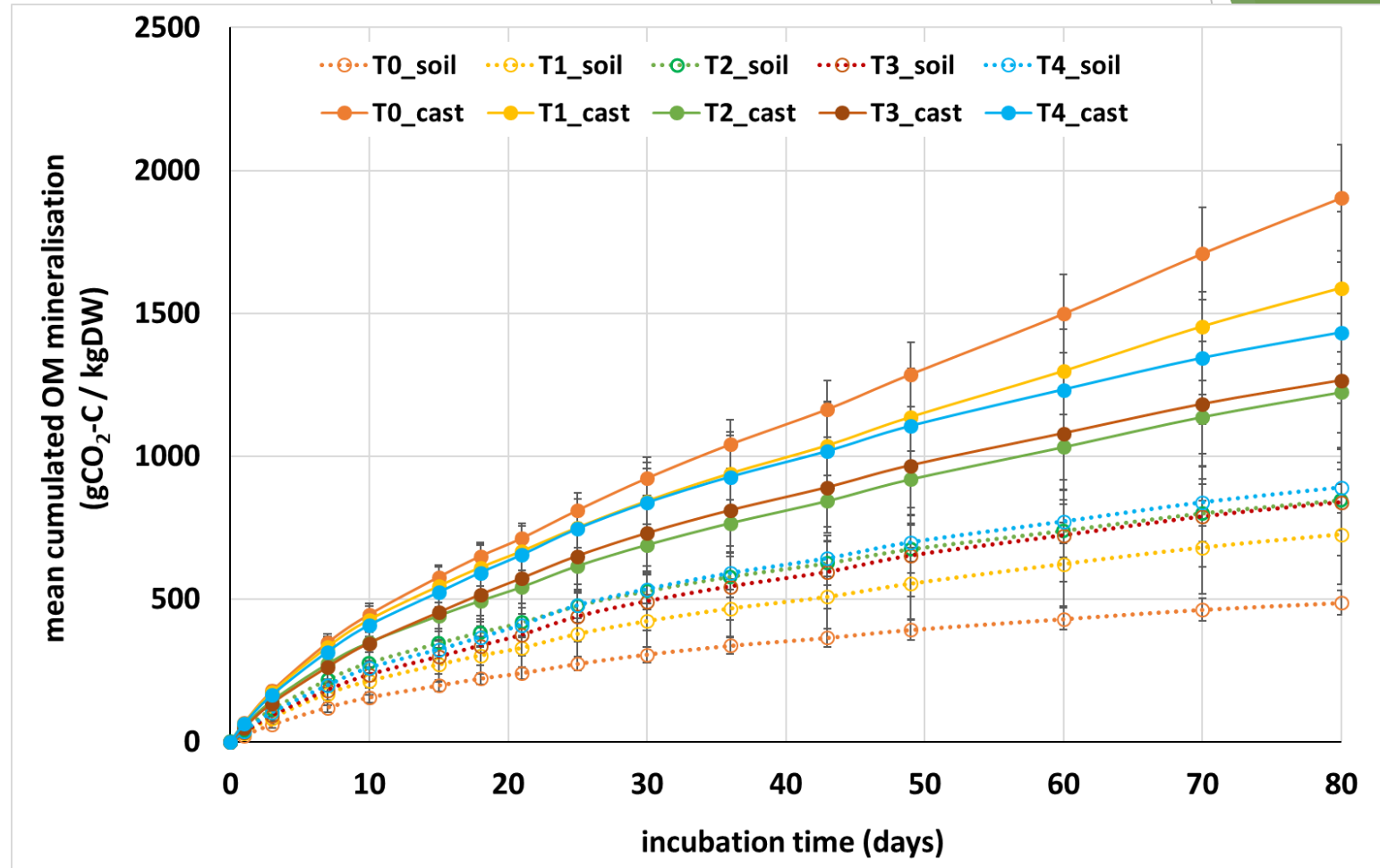


Results 2/4: OM mineralisation



microGC

Intact soil and cast aggregates in incubation vials



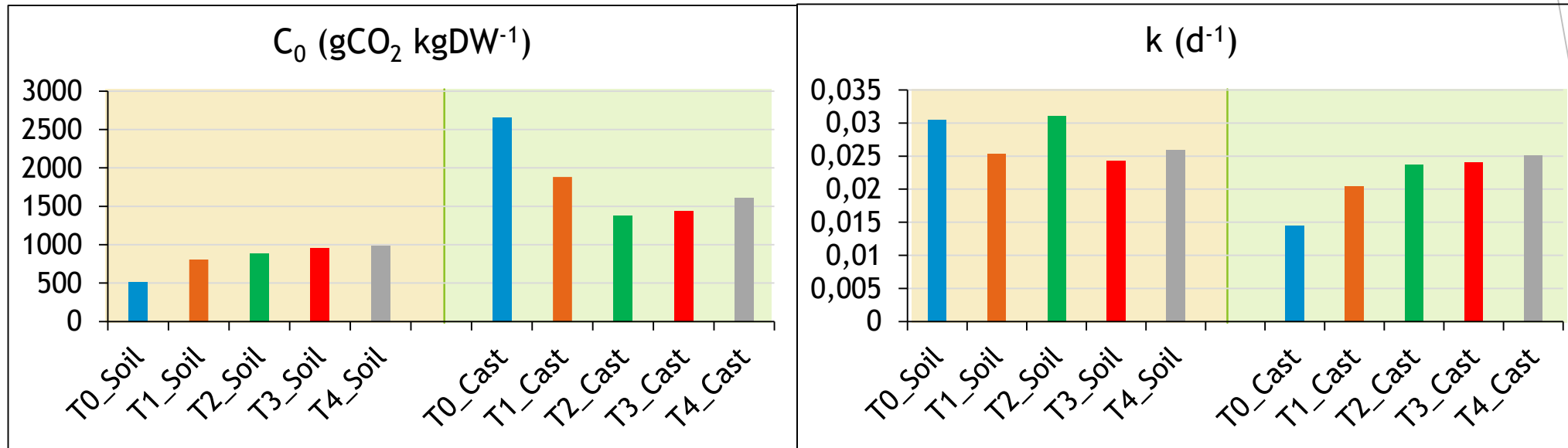
On average cumulated mineralisations are higher for casts than for soils under all ageing stages

Results 3/4: OM mineralisation (suite)

- first-order dynamic model used to simulate mineralization process of samples

$$C_t = C_0 \times (1 - e^{-kt})$$

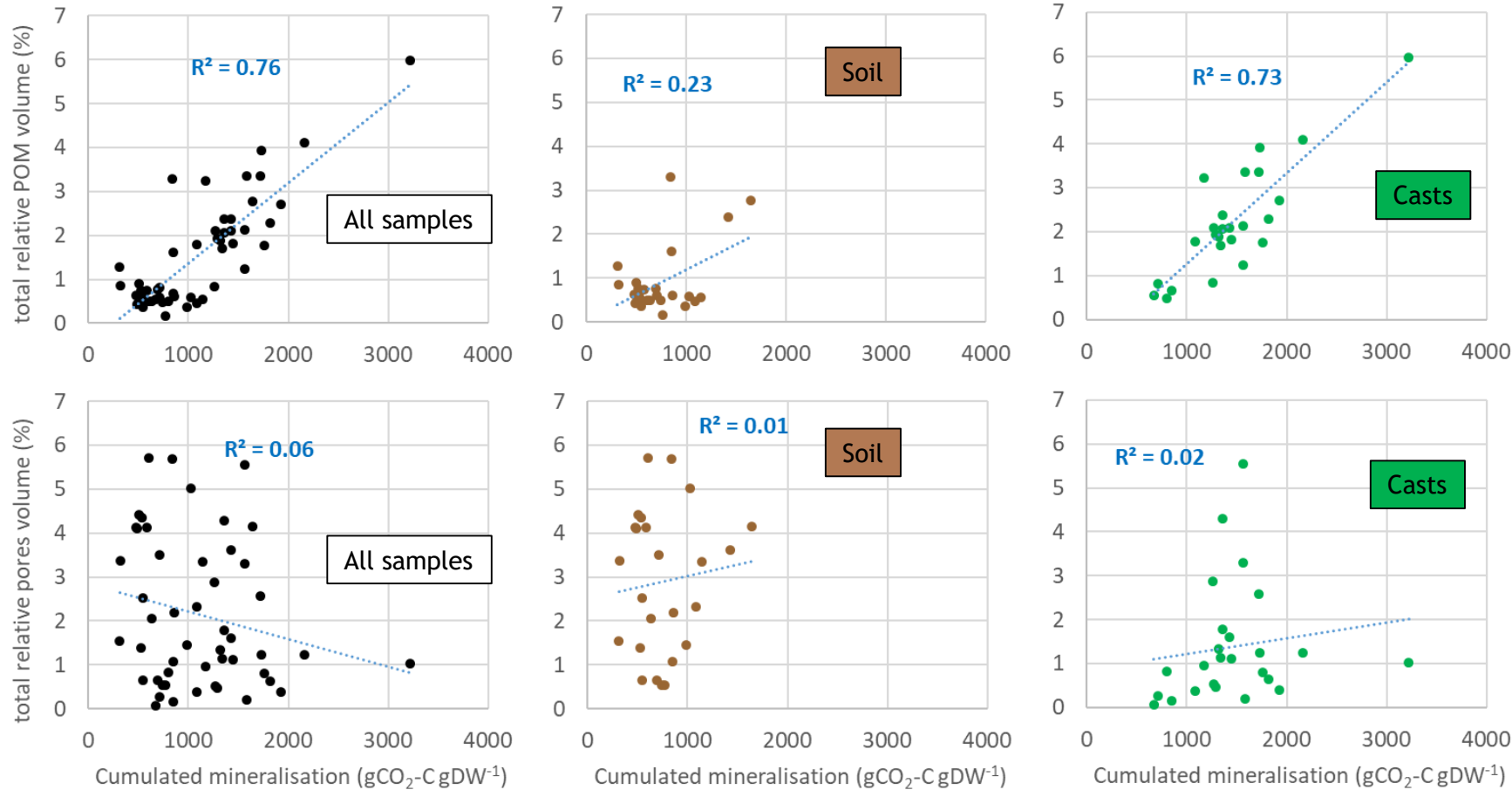
C_t (g kg⁻¹) accumulated mineralization amount after t days,
 C_0 is the potential value of OM mineralization (g kg⁻¹),
 k is the turnover rate (d⁻¹)



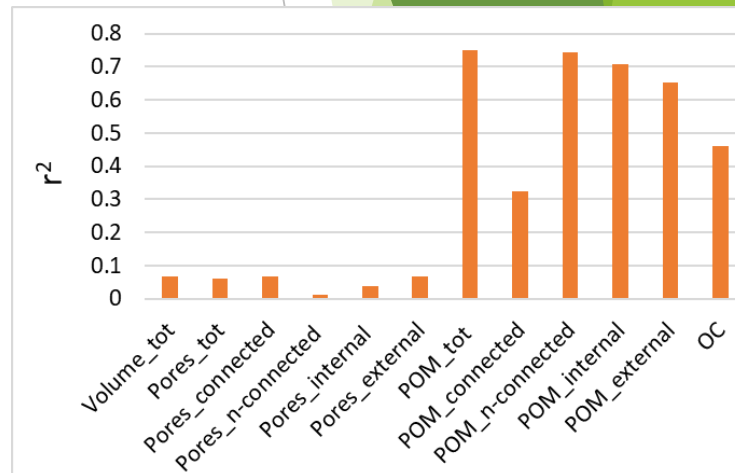
- Lower potential OM mineralisation (C_0) for all soils ageing stages compared to casts
- Higher C_0 for fresh casts and reduction of C_0 with ageing
- Higher turnover rate (k) for all soils ageing stages compared to casts
- Lower k for fresh casts and increase of C_0 with ageing



Results 4/4: aggregates characteristics vs OM mineralisation



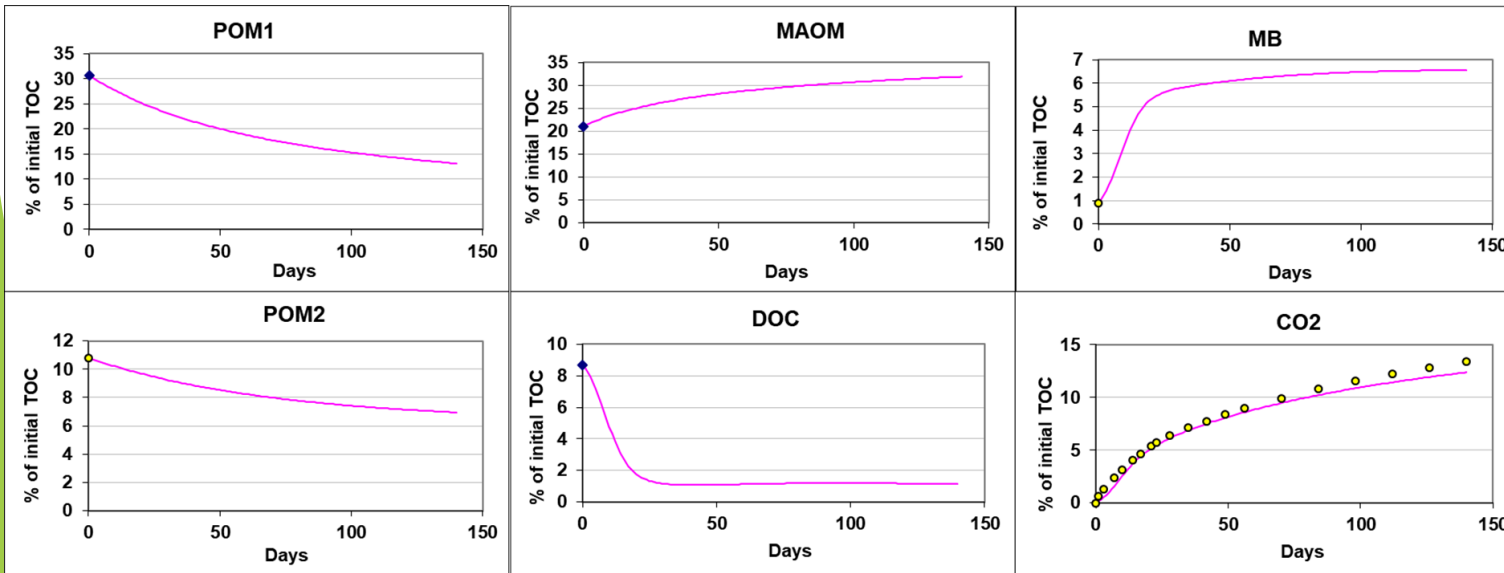
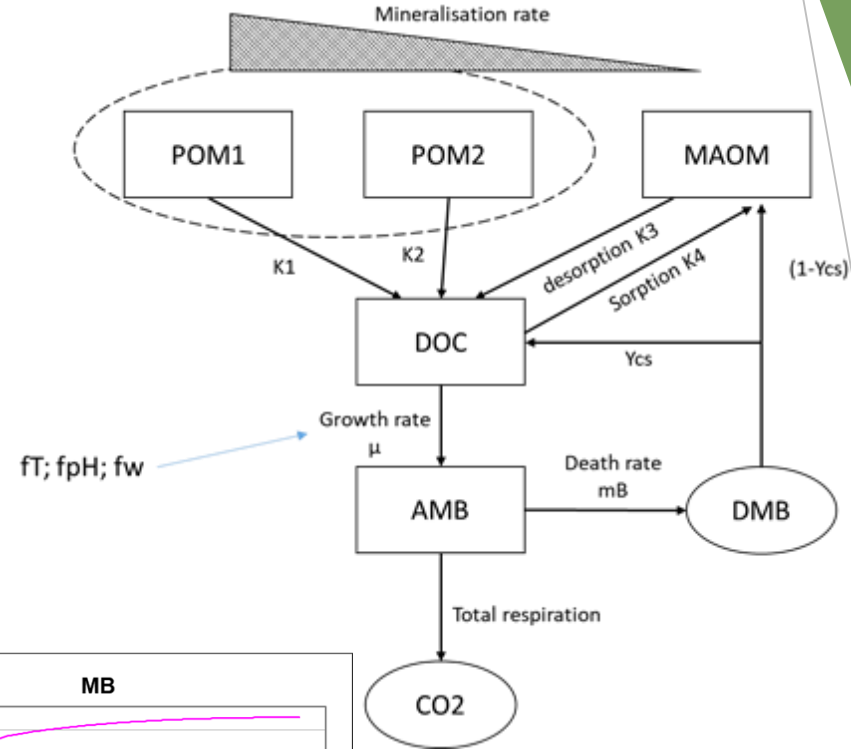
- high correlation between relative POM volume and OM mineralisation for all samples and ageing stages
- higher correlation between relative POM volume and OM mineralisation for casts than for soil samples
- Weak correlation between total relative porosity and OM mineralisation for all samples and ageing stages



All variables derived from X-ray μCT images processing

Perspectives

- Develop a biophysical mechanistic model able to simulate the dynamics of OM in soils aggregates and earthworms casts according to their physicochemical characteristics

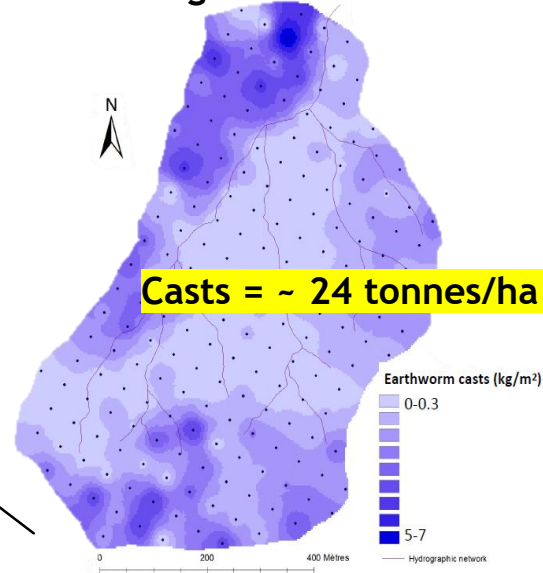


Study Site

Dong Cao catchment location



Map of casts distribution on the Dong Cao catchment



- Dong Cao catchment (50 ha), North Vietnam (50 km West of Hanoi)
- Climate subtropical humid (1800 mm/year rain)

- 3 main vegetation cover (woodland, shrubland and meadow)



- Large activity of *Amyntas adexilis*

