Dynamics of soil organic carbon fractions in olive grove soils of contrasted parent material and under different management practices in Andalusia (Southern Spain)

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Acknowledgments:

CARBOLIVAR project. Balance de Carbono en el Olivar: efecto de la presencia de cubierta vegetal (RNM 296, RNM-7186). Excellence Project. Andalusian Government.

This research was funded in part by the Spanish Ministry of Economy and Competitiveness through project CGL2014-52838-C2-1-R **(GEISpain)**

FPU Program Spanish Ministry of Education and Culture

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

GOBIERNO DE ESPAÑA MINISTERIO DE EDUCACIÓN, CULTURA Y DEPORTE

JUNTA DE ANDALUCIA

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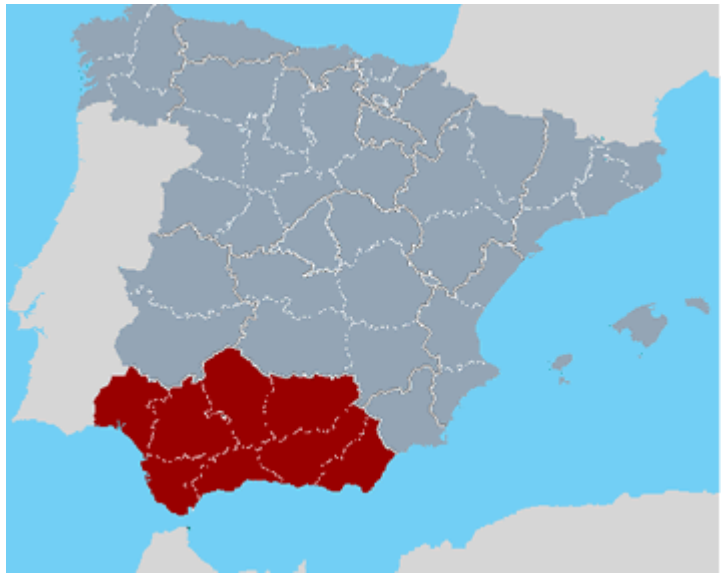
Introduction: some data

- Spain: 2.5 M ha olive groves
- Andalusia: 1.5 M ha
  - 44% of the total crop Surface
  - Jaén province: 44% of the total Surface
  - 63% non-irrigated (irrigation is increasing)



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Introduction: management practices

- **Most common:** tillage with the application of pre-emergence herbicides (**conv. tillage**)
- **Consequences:** low soil organic carbon content (SOC), high erosion and low soil biodiversity & functioning…
- **Sustainable management:** **spontaneous wild annual herbaceous cover** in the inter-row área (mowed in spring once or twice depending on precipitation, controlled by grazing or a reduced tillage)

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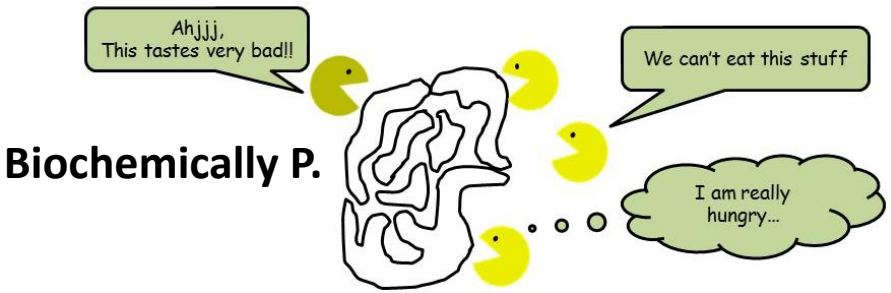
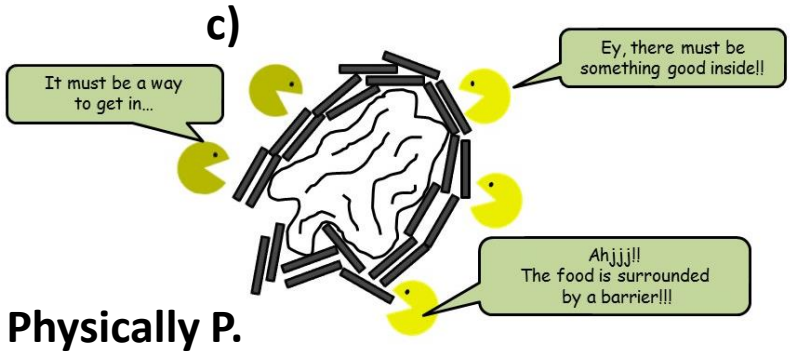
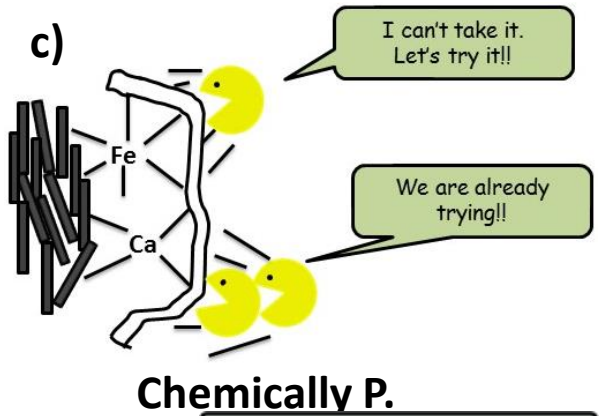
Introduction: SOC fractions

According to the accesibility of the microorgamisms to the SOC (Six et al. 2002):

- **Unprotected C:** fresh organic matter
- **Protected C:** non-accesible by soil microorganismos due to:
  1. The quality of the organic matter (recalcitrant substances, e.g. lignin): **Biochemically protected**
  2. SOC is linked to silt and clay minerals (e.g. cation bridges): **Chemically protected**
  3. The existence of a physical barrier (SOC within soil microaggregates): **Physically protected**
     - Physically protected within microaggregates
     - Chemically protected within microaggregates
     - Free (i POM = internal particulate organic matter)







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Introduction: C saturation-Hypothesis

- Is there a C saturation limit?...And if it exists…for which fractions?
  - Evidences of C saturation have been found for physically and chemically protected pools (Stewart *et al*. 2007, 2008, 2009; Six *et al*. 2002))…**but in Mediterranean cond.?**
- Does this limit depend on the mineralogy (calcareous (basic)/granitic (acid))?
  - We slightly know that texture and type of clay (1:1 or 2:1) affect the amount of the protected SOC pools (Baldock and Skjemstad, 2000; Six *et al.* 2000)
  - However, **we do not know how other geochemical properties affect it (pH, carbonates content, N content, etc).**
- How tillage practices affect SOC fractions dynamics?
  - We know that the presence of a resident vegetation cover in olive groves increases the total SOC content
  - However, **we do not know the proportion of that increase to the different SOC fractions.**

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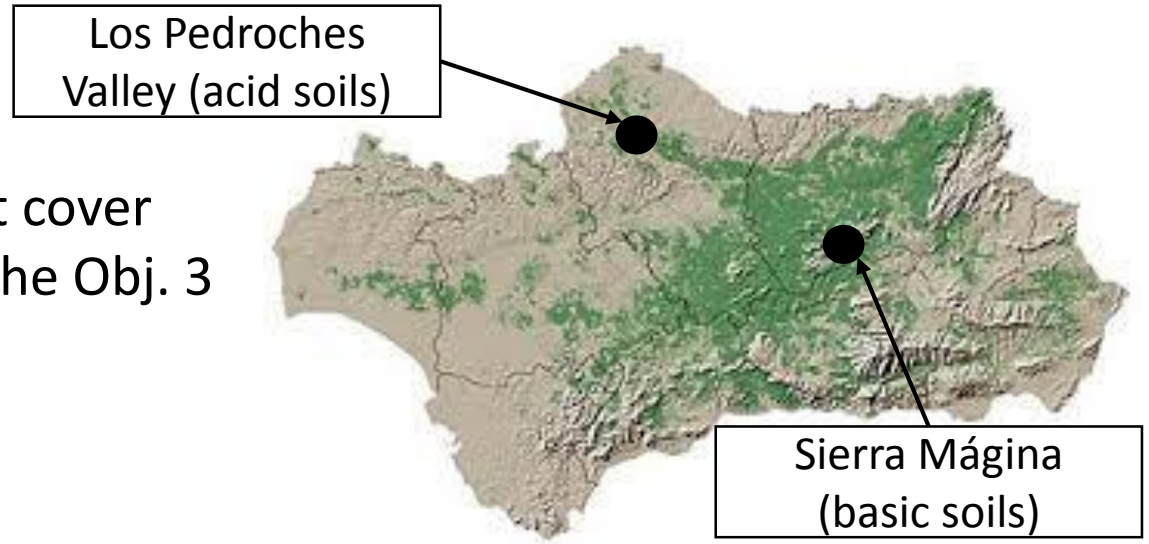
Experimental desing and objectives

- Two managements:
  - Conventional tillage vs Spontaneous plant cover
  - A natural vegetation site was chosen for the Obj. 3
- Two different parent materials
  - Carbonated vs Granitic



OBJECTIVES

1. Assess the influence of the **2 management practices** on SOC fractions
2. Assess the influence of the **2 parent material features** on SOC fractions
3. Test the **saturation hypothesis** for the SOC fractions

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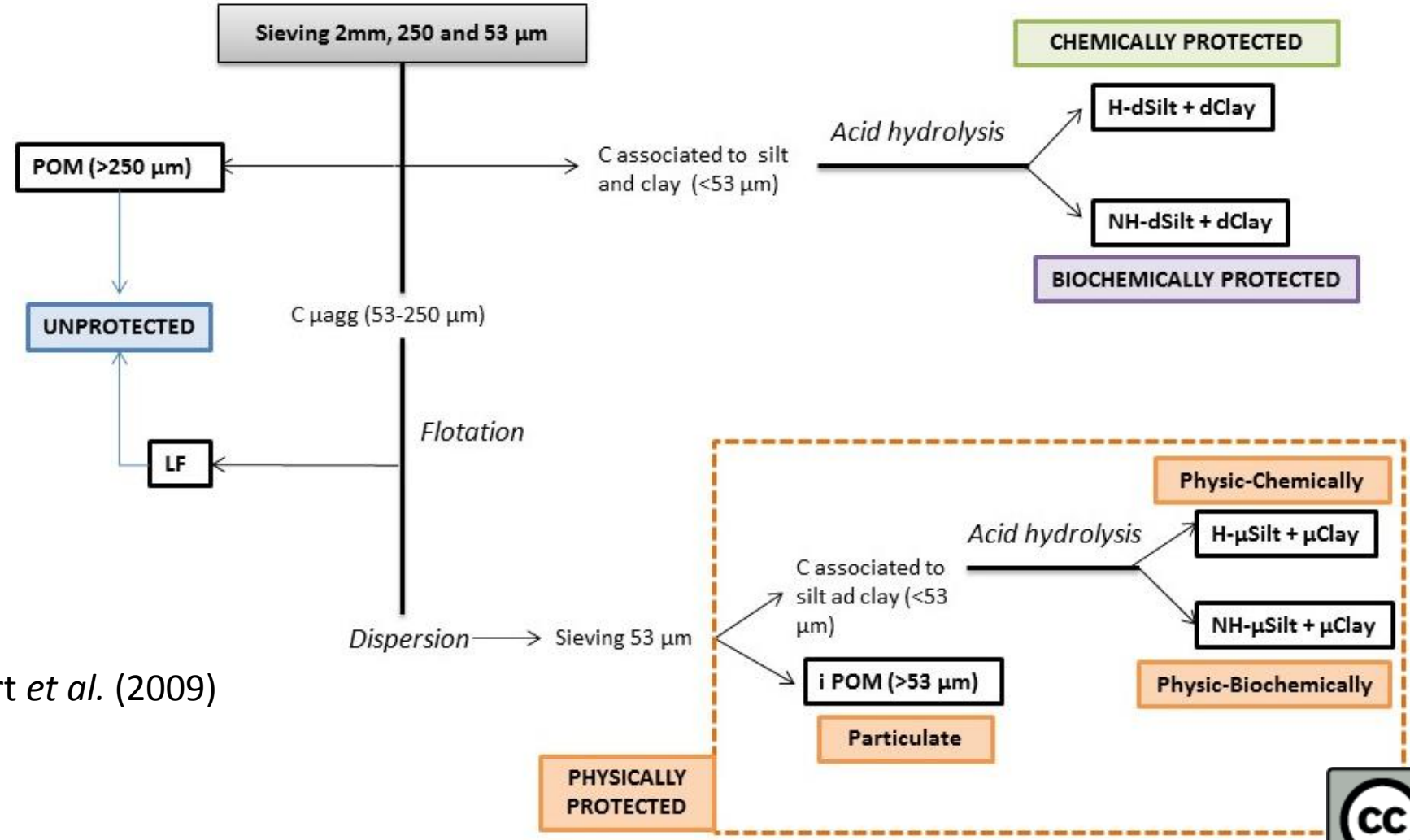
Method: SOC fractionation



Six *et al*. (2002); Stewart *et al.* (2009)

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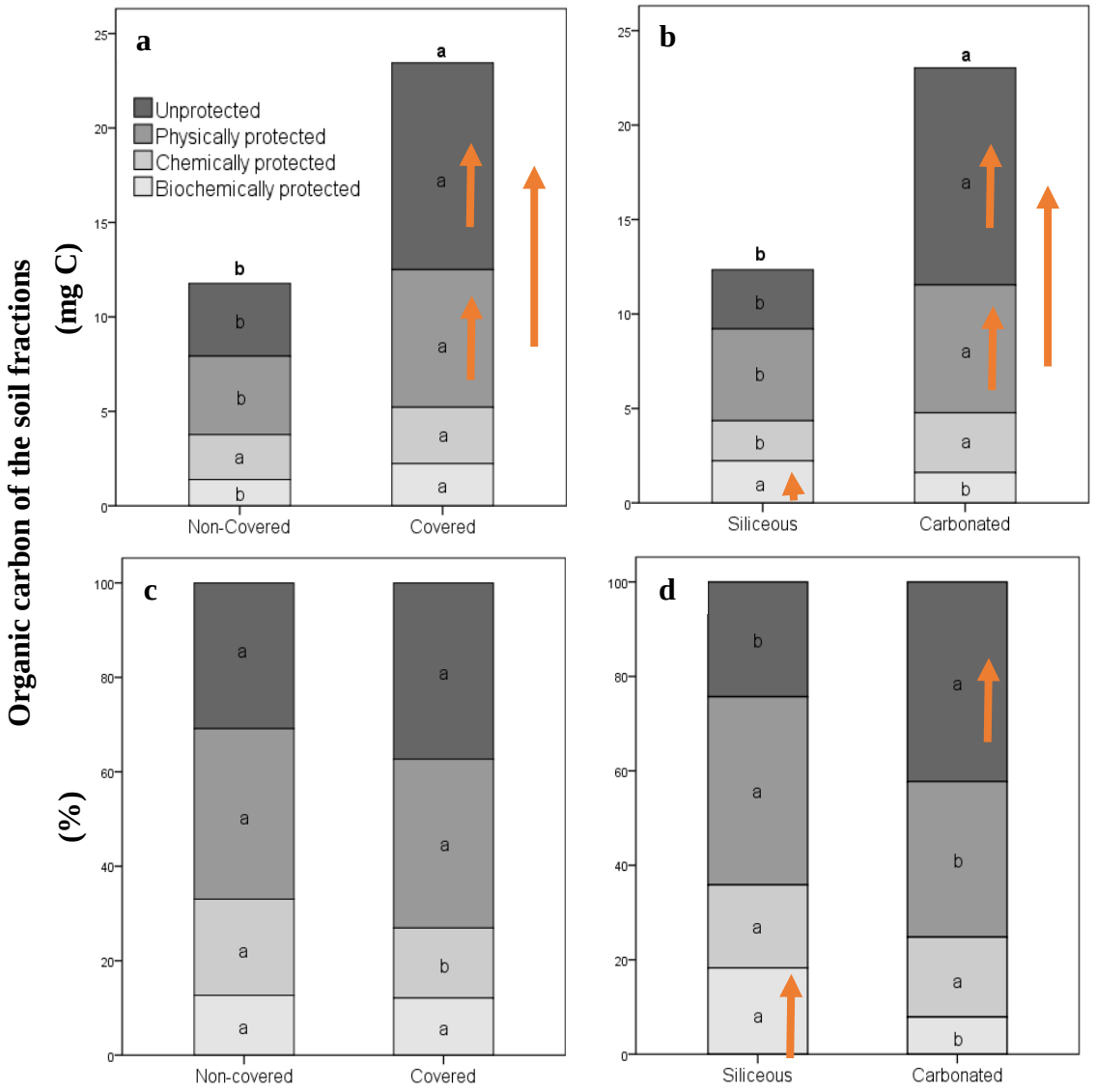
Results and Discussion (obj. 1 and 2):



- The **total SOC content was significantly higher in the covered** and in the **carbonated** plots, and it was due especially to the increase in the SOC content of the **unprotected and physically protected pools.** Nevertheless, **the biochemically protected pool decreased in carbonated plots.**
- The **proportion** of the different SOC fractions, in general, **was not affected by the management**. However, it was **affected by the parent material type** due two facts:
  - The **increase in the unprotected** (fresh organic matter) pool in carbonated sois. More biomass production in carbonated soils?
  - The **decrease** in the proportion of the **biochemically protected** pool in the carbonated plots. (Why? Not only in terms of proportion but also in terms of total amount…)

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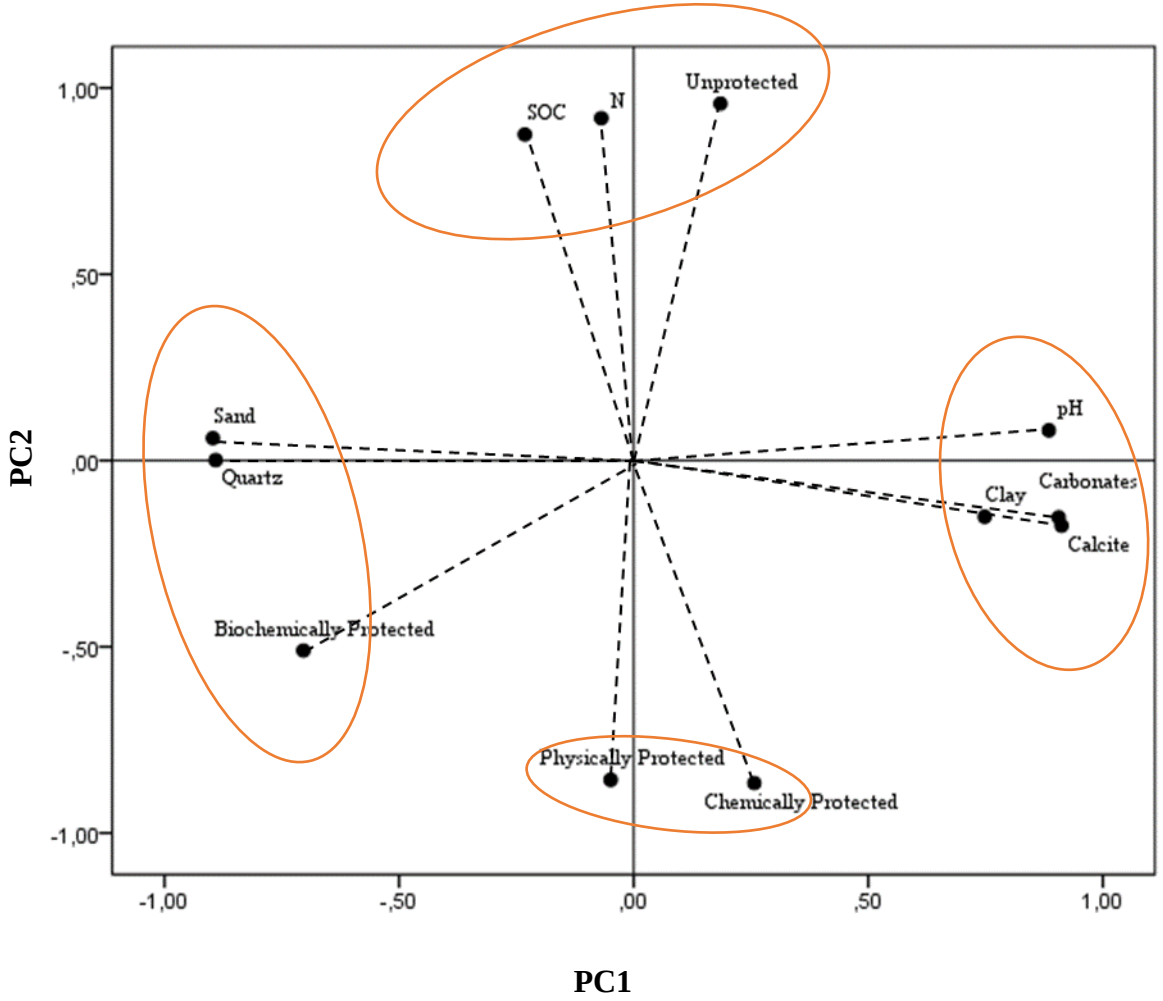
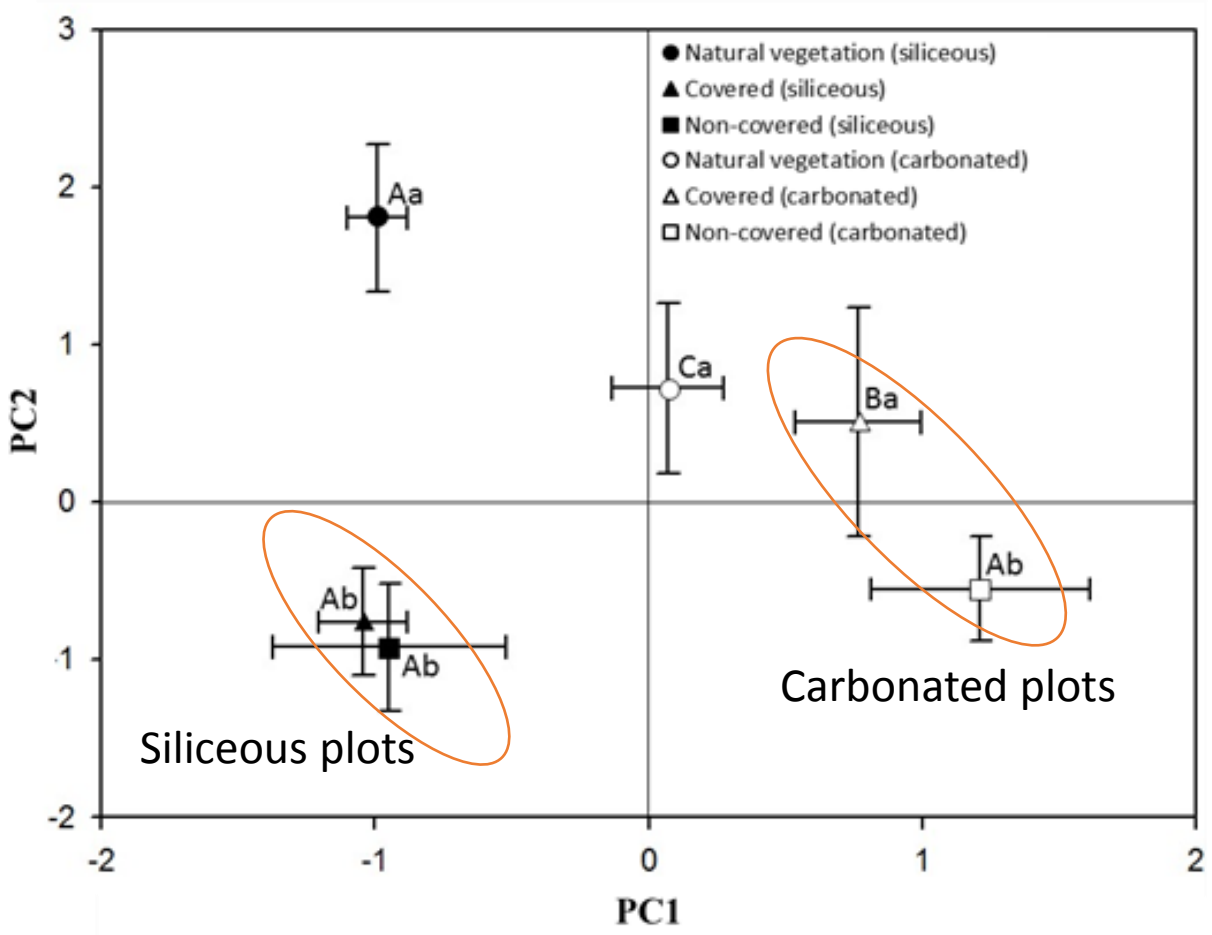
Results and Discussion (obj. 1 and 2): PCA





*Only % of SOC fractions were used to the PCA

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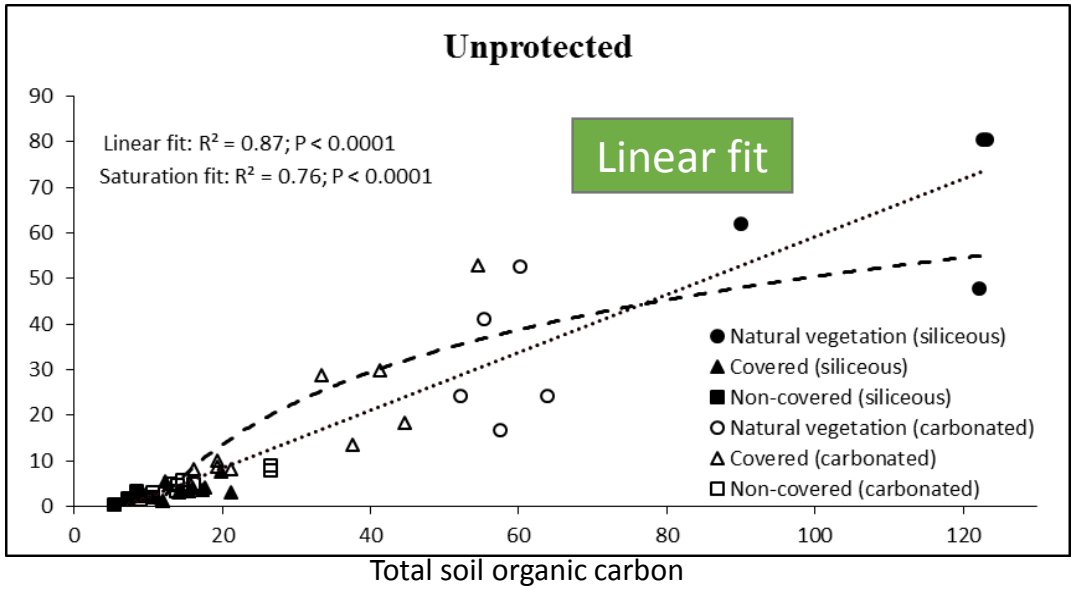
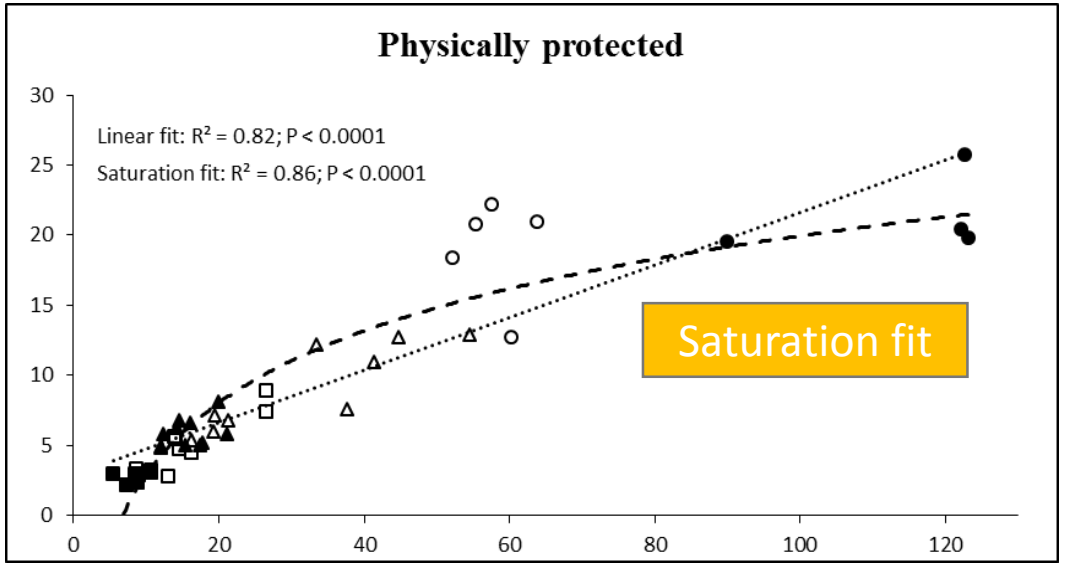
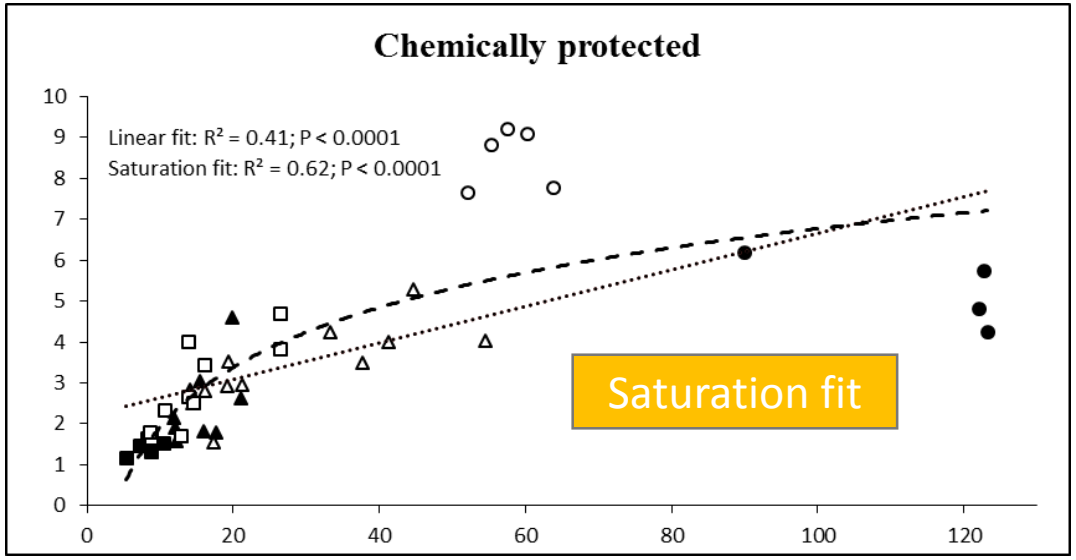
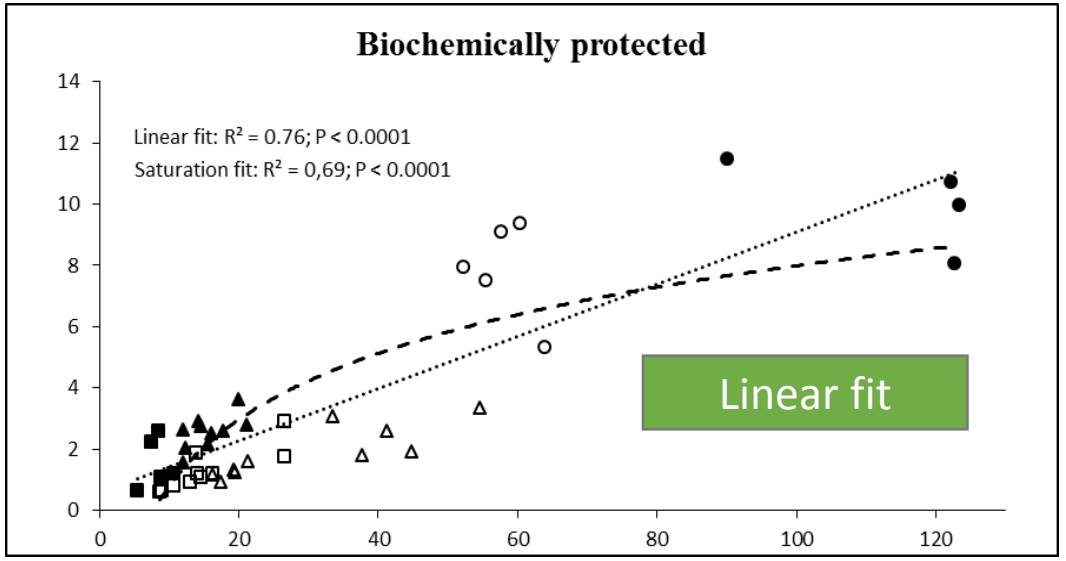
Results and Discussion (obj. 3): SOC saturation?









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Results and Discussion: SOC saturation?

Fraction/Subfraction	Whole set of plots		Siliceous		Carbonated	
	Linear	Saturation	Linear	Saturation	Linear	Saturation
Unprotected	0.87	0.76	-	-	-	-
Physically protected	0.82	0.86	-	-	-	-
iPOM	0.75	0.73	-	-	-	-
Chemically protected within microaggregates	0.26	0.49	0.72	0.79	0.63	0.65
Biochemically protected within microaggregates	0.75	0.66	0.87	0.82	0.73	0.66
Chemically protected	0.41	0.62	0.69	0.79	0.78	0.71
Biochemically protected	0.76	0.69	0.89	0.90	0.72	0.62

The **chemically protected pool in the fine fraction** showed a **linear** behaviour in the **carbonated** plots (**saturation in siliceous**)

→ Probably due to the higher silt and clay content of the carbonated plots

The **saturation behaviour of the physically protected** pool is **due to the chemically protected** within microaggregates pool

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In summary…

- A **spontaneous resident vegetation cover leaded to higher SOC content**, especially in the **unprotected** and **physically protected** pools. And it ocurred in the **carbonated** plots, but not in the siliceous ones.
- All the fractions increased the SOC content due to the plant cover management in the same proportion. **The management did not affected the proportion of the different fractions.**
- Neverthless, **the proportion changed with the mineralogy conditions. Carbonated soils showed higher proportion of the unprotected** pool (due to higher biomass production in the covered soils), whereas **siliceous** soils showed higher proportion of the **biochemically protected** pool.

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In summary…

- The **unprotected** pool showed a **linear behaviour** (that is consitent, since this is formed by fresh organic matter and, therefore, it depends only on the biomass production).
- The **biochemically protected** pool best was fitted to a **linear** behaviour. The content of this fraction does not depend on silt and clay content, so this result is consistent with the theory.
- The **physically protected** pool showed a **saturation** behaviour **due to the saturation fit of the chemically protected** within microaggregates pool. It was especially clear for the **siliceous** soils. **The other sub-fractions** forming the unprotected pool were best fitted to a **linear** function.
- The **chemically protected pool in the fine fraction** was best fitted to a **saturation** behaviour for the whole set of plots. Nevertheless, the **inlfuence of the mineralogy was very strong**.

THANK YOU VERY MUCH

(Looking for a PhD postdoc position from January 2017...)

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