Fe(II)-catalyzed transformation of Fe (hydr)oxides in particle-size soil organic matter from amended agricultural soils

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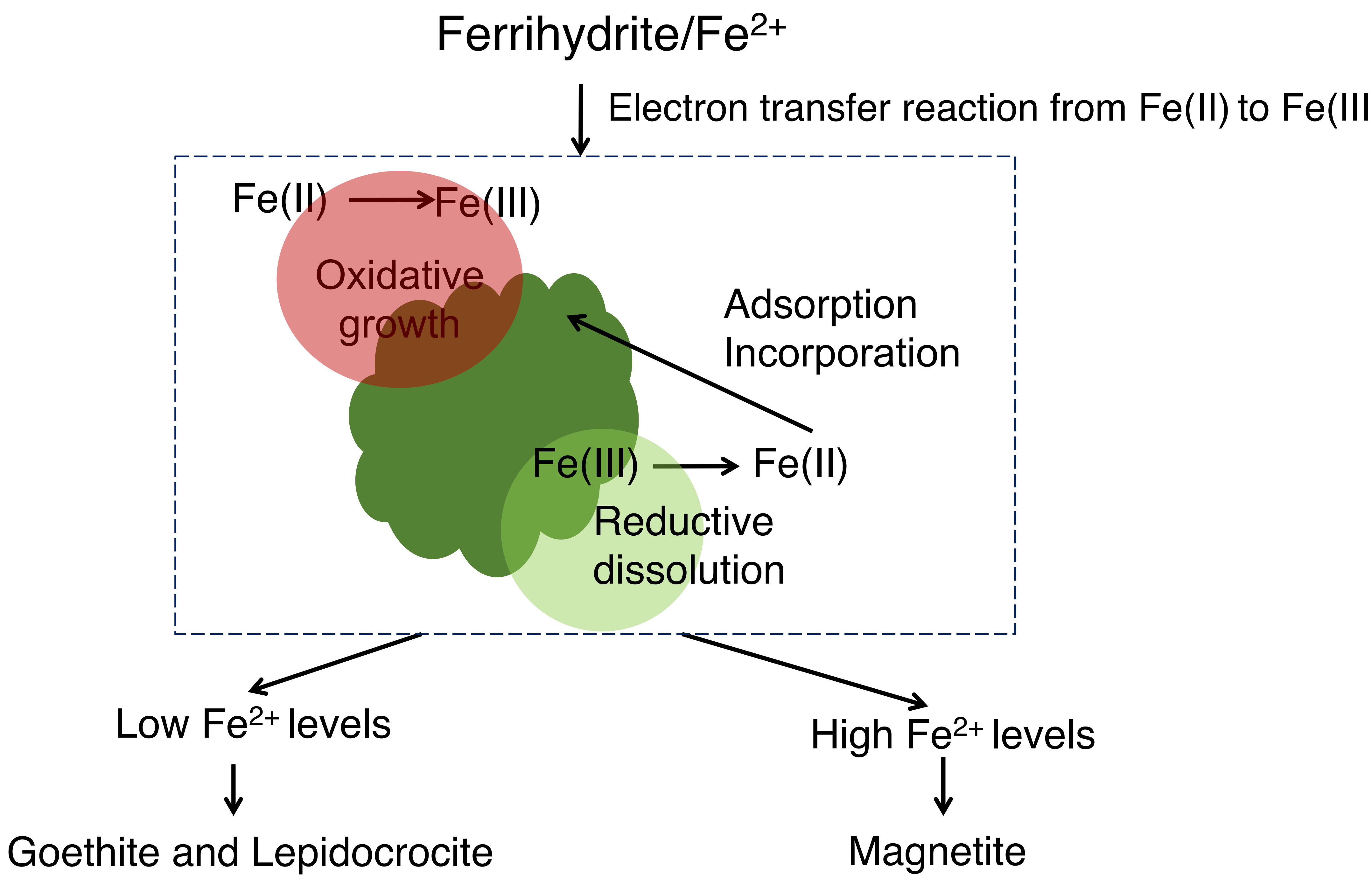
01 AQUEOUS Fe(II)-CATALYZED FERRIHYDRITE TRANSFORMATION



- Which are the effects of **organic matter** on the extent and pathway of **Fe^{2+}-catalyzed transformation**?
- The Fe^{2+}-catalyzed transformation is an unexplored pathway for C mobilization or sequestration.

02 OBJECTIVES

HYPOTHESIS:

Soil organic matter (SOM) quantity, quality, and **distribution between different pools** can affect **Fe(III) oxides transformation** under **reducing conditions** by altering **Fe atom exchange kinetics.**

MAIN OBJECTIVES:

- To determine the effect of ***organic amendments*** on the ***Fe(II)-induced abiotic transformation of Fe(III) minerals*** in an ***agricultural soil (simulated temporary anoxia).***
- To investigate the influence of ***of Fe-OM associations*** on mineral ***transformations across particle-size SOM pools.***

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CENTRE TECNOLÒGIC FORESTAL DE CATALUNYA

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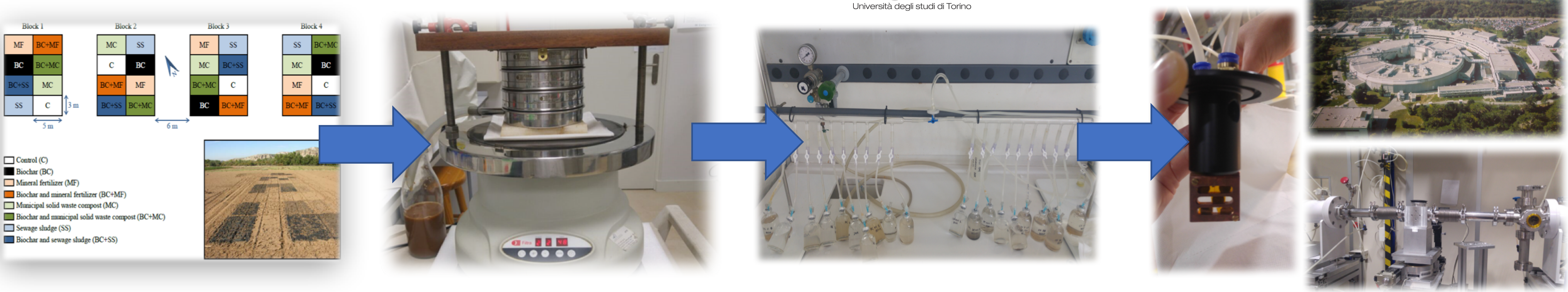
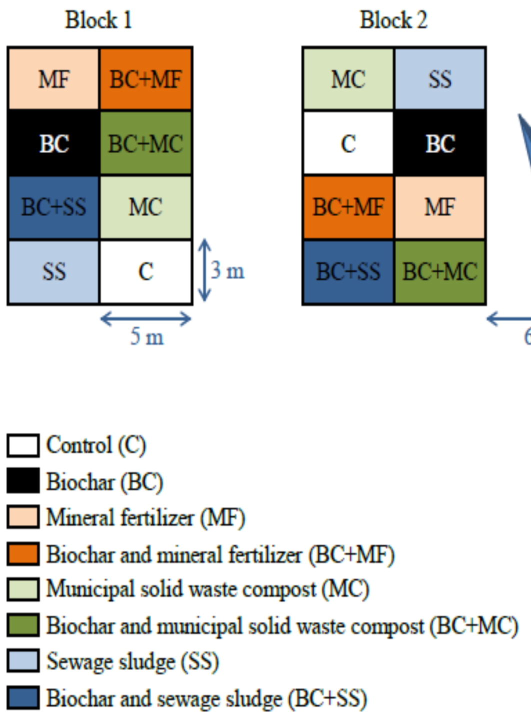


Fe speciation in SOM pools under agricultural soils subjected to biochar and organic fertilizers amendments.

- Unamended agricultural soil **(UN)**.
- Municipal solid waste amended soil **(MC)**.
- Biochar amended soil **(BC)**.
- Biochar and municipal solid waste amended soil **(BC+MC)**.
- Bulk, fine sand **(FSa)** and fine silt plus clay **(FSi+Cl)** fractions.



Plaza et al. 2016

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SOIL SAMPLE
(air-dried, 2mm sieved)

Mechanical sieving
Ultrasonic dispersion

DISPERSED SOIL

Sieving centrifugation

Organic fragments
2000-200 µm

Organic fragments
200-50 µm

Organic fragments
50-20 µm

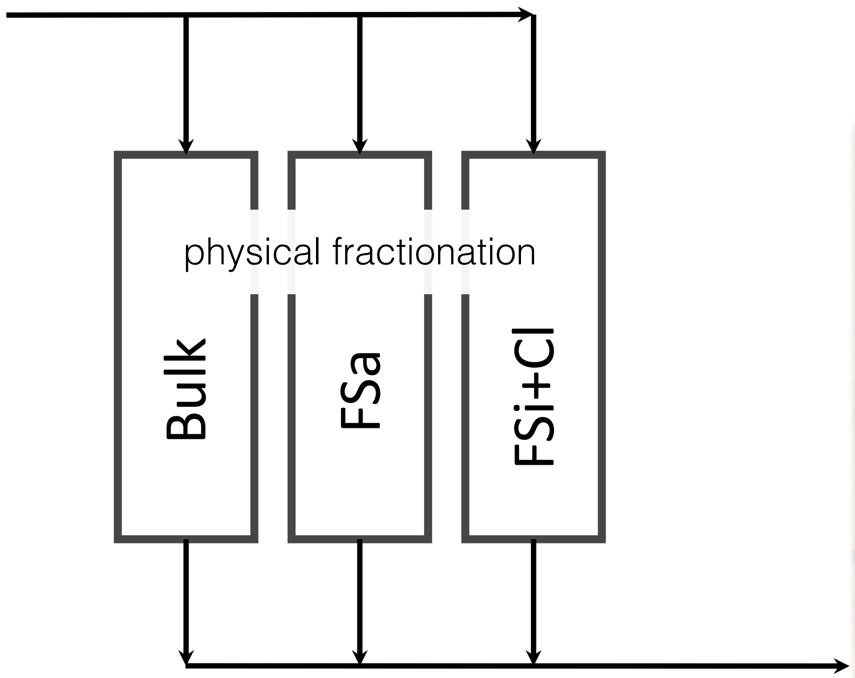
Organo-mineral complexes
<20 µm

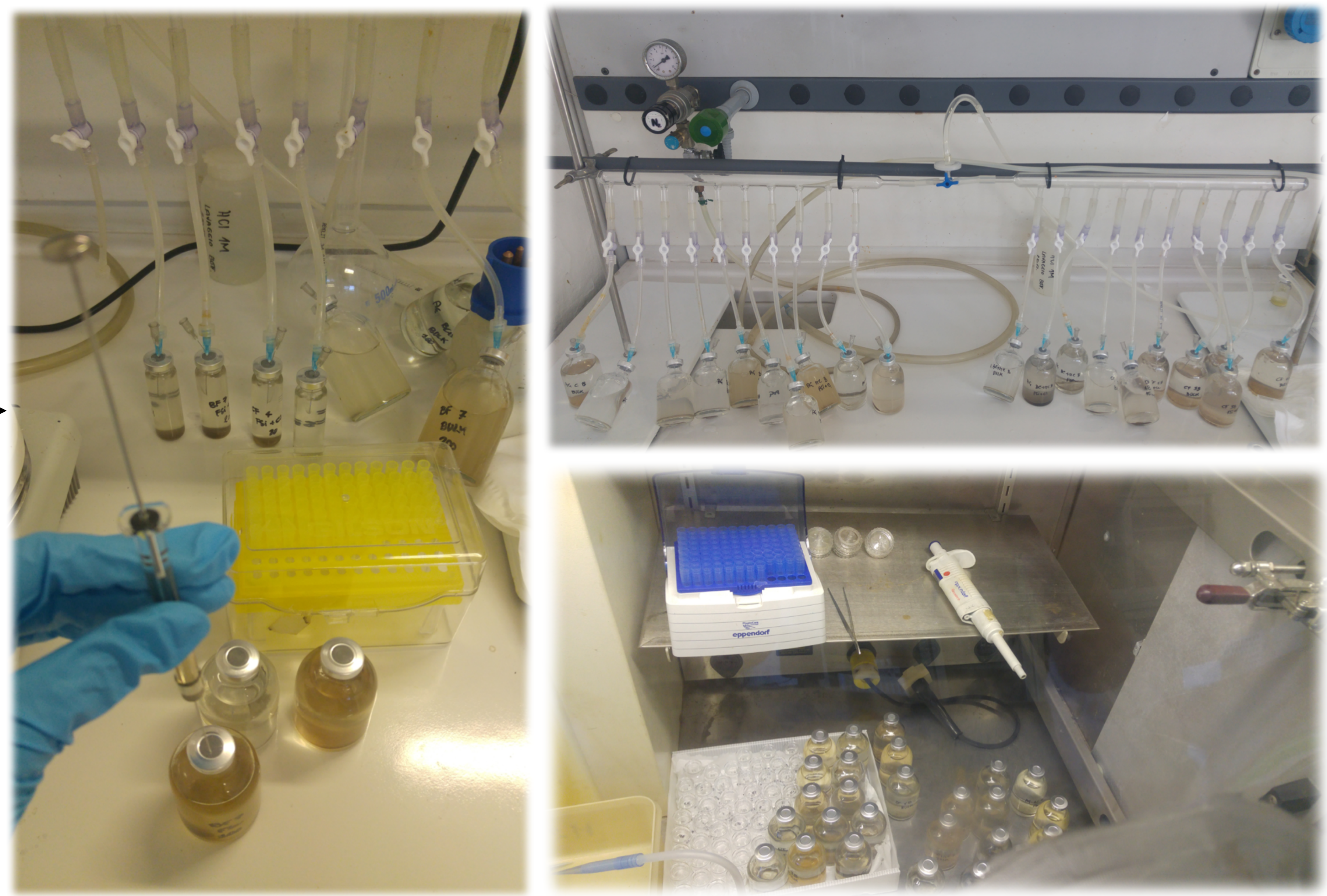
Particulate organic matter
(POM > 20 µm)

CENTRE TECNOLÒGIC FORESTAL DE CATALUNYA

Lopez-Sangil and Rovira, 2013
Giannetta et al. 2019

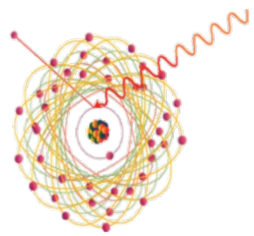
05 Fe(II) SPIKING

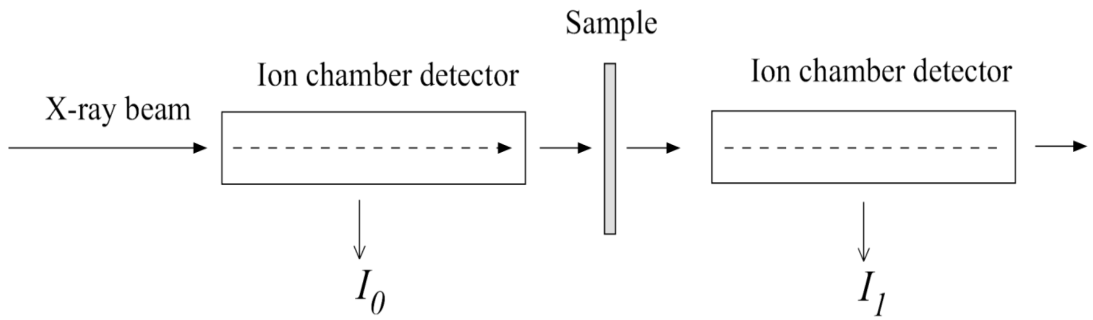




06 Fe SPECIATION: Fe EXAFS

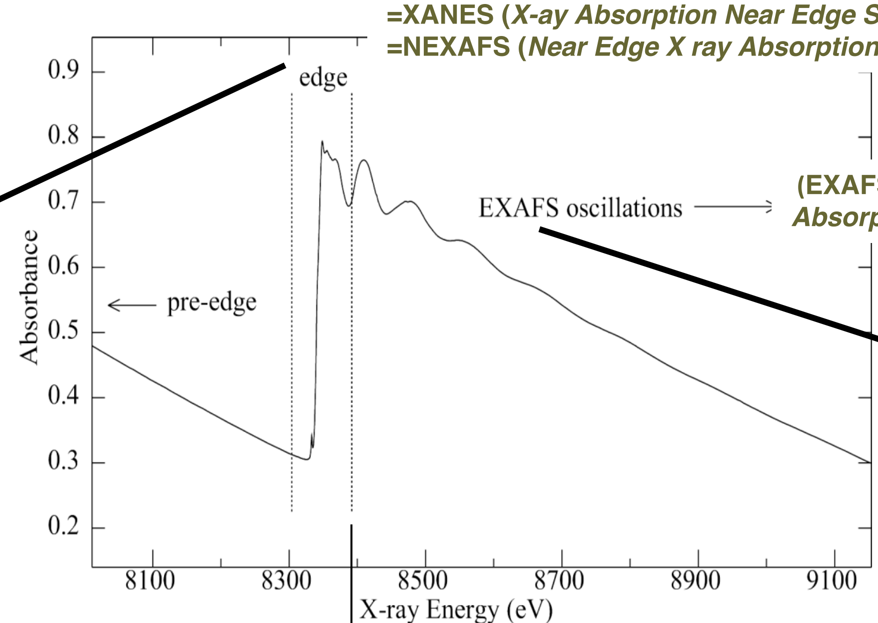
Basic Experiment :





=XANES (*X-ay Absorption Near Edge Structure*)
=NEXAFS (*Near Edge X ray Absorption Fine Structure*)

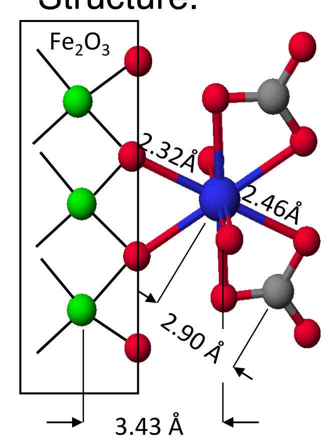
XANES / NEXAFS
Oxidation state,
Molecular structure,
Electronic structure.

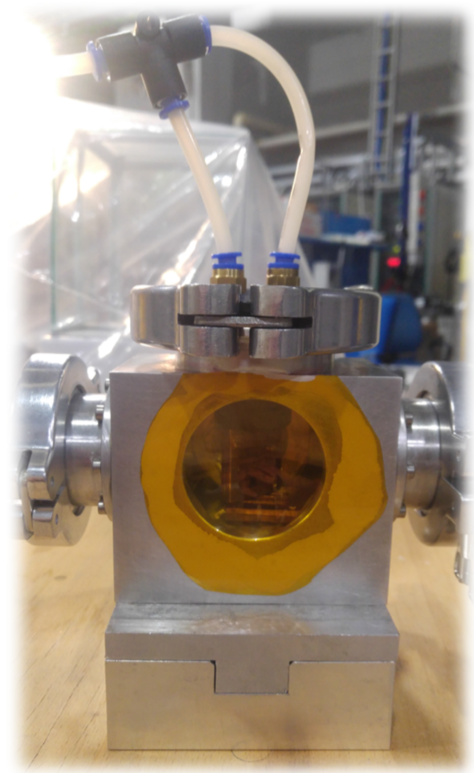


(EXAFS = *Extended X ray Absorption Fine Structure*)

Core electron binding energy, E_o

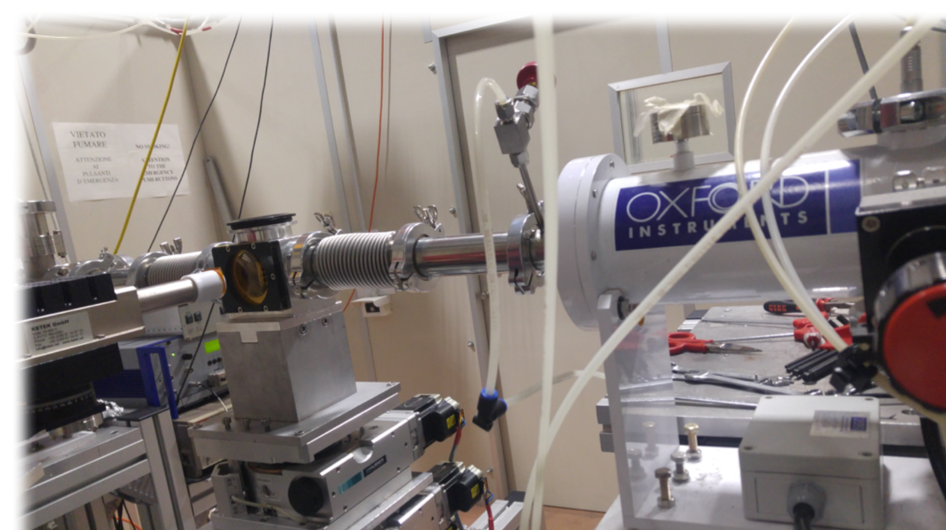
EXAFS
Quantitative Local Structure.



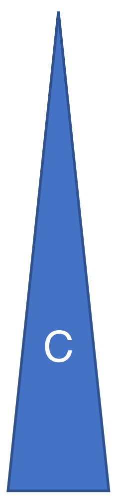


Elettra Sincrotrone Trieste

Experimental station: XAFS.

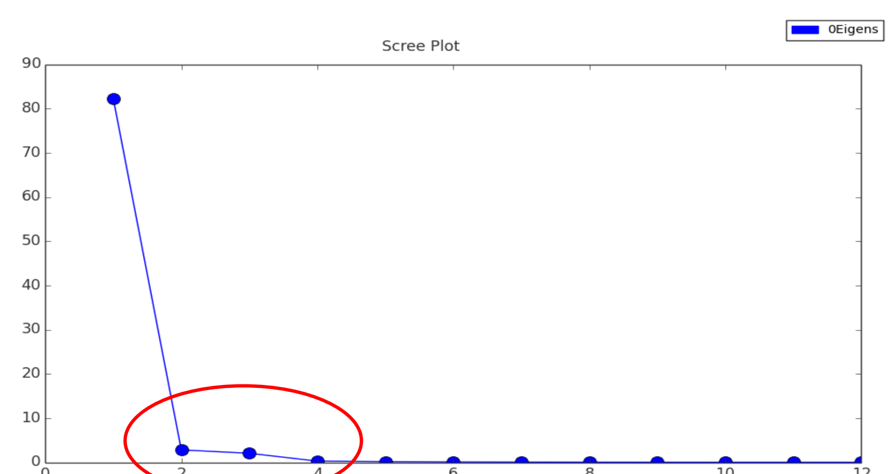


RESULTS: Fe EXAFS Bulk soils



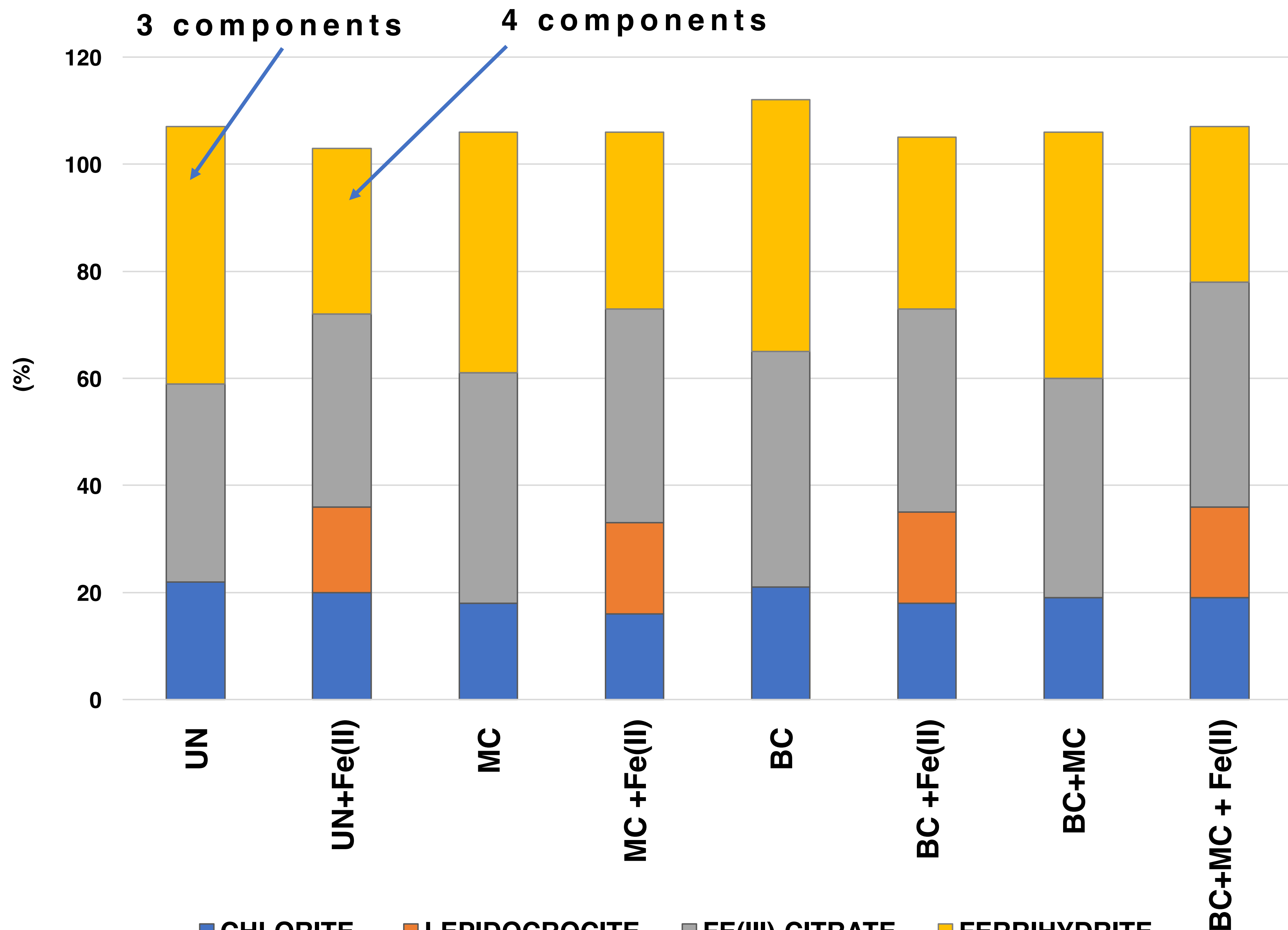
	n. components	COMPONENT 1	COMPONENT 2	COMPONENT 3	COMPONENT 4
UN	3	CHLORITE	LEPIDOCROCITE	FE(III)-CITRATE	
MC	3 and 4	CHLORITE	LEPIDOCROCITE	FE(III)-CITRATE	FERRIHYDRITE
BC	3	CHLORITE	LEPIDOCROCITE	FE(III)-CITRATE	
BC+MC	4	CHLORITE	LEPIDOCROCITE	FE(III)-CITRATE	FERRIHYDRITE

- **PCA**
- **TT**
- **SPOIL**
- **R-values**
- **F-test**
- **LCF**



Giannetta et al. *2020*

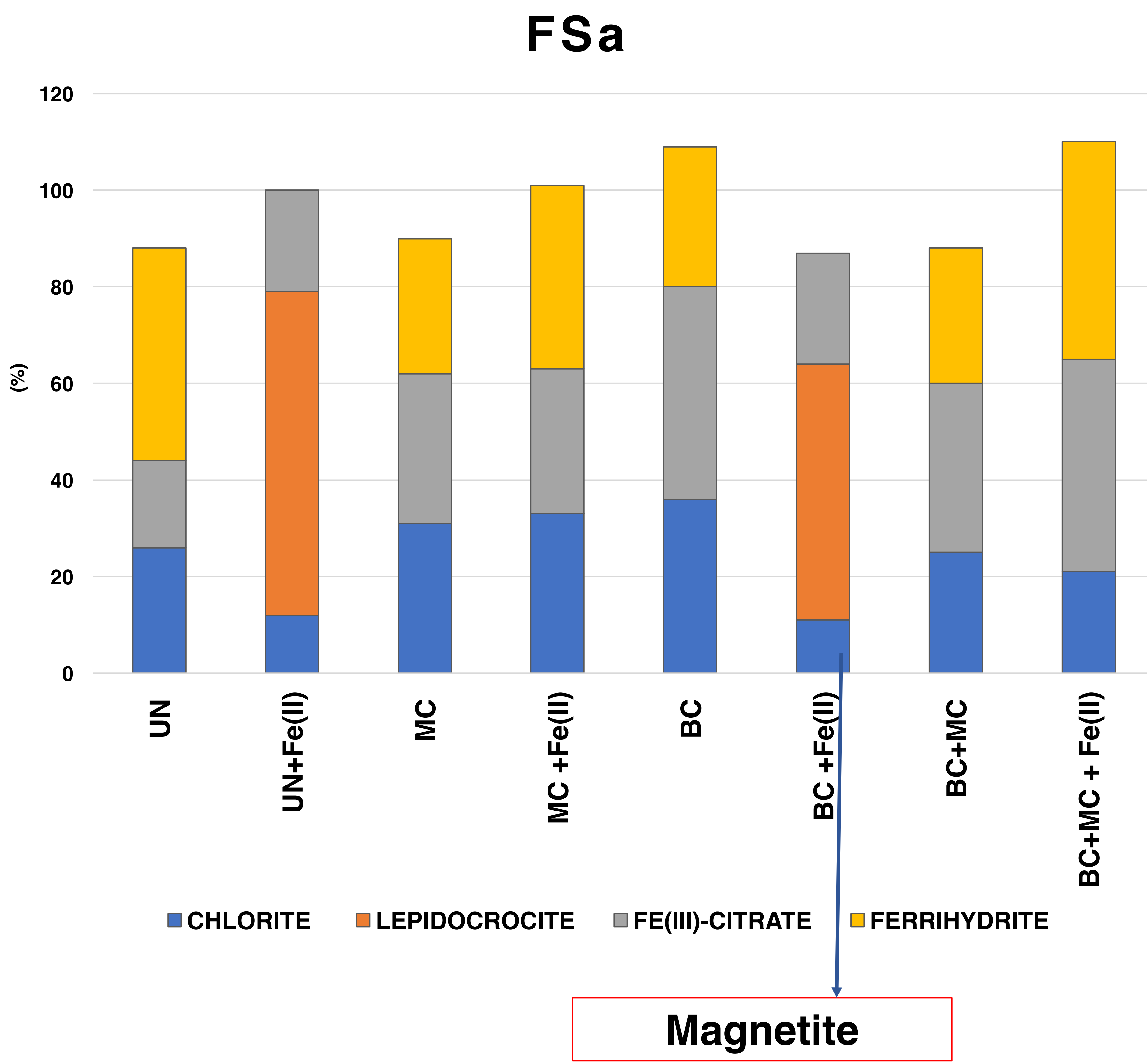
08 RESULTS: Fe(II)-CATALYZED OXIDE TRANSFORMATION IN THE FSi+Cl FRACTION



FSi+Cl

- FSi+Cl fraction before Fe(II) addition: 3 components.
- FSi+Cl fraction after Fe(II) addition: 4 components.

Ferrihydrite was transformed to lepidocrocite. The percentage of lepidocrocite remained stable in both the unamended and amended soils.



UN: lepidocrocite formation.

MC: lepidocrocite formation hindered.

BC: biochar functions as an electron shuttle, thus favoring the reduction of the Fe(III) oxyhydroxides.

BC+MC: intermediate situation.

FSa fractions represent an understudied pool of SOM reactive to Fe mineral transformation.

10 CONCLUSIONS

SOM quantity, quality and **distribution between different pools** can affect **Fe(III) oxides transformation** under **reducing conditions** by altering **Fe atom exchange kinetics.**

- The increase in SOM due to organic amendments can contribute to limiting abiotic Fe(II)-catalyzed ferrihydrite transformation.
- This effect of amendment on Fe oxide transformation is less evident in fine with respect to coarse particle-size fractions.
- In this fraction, Fe(II) addition mainly lead to the transformation of ferrihydrite to lepidocrocite, however this depended on organic amendment type.
- With respect to compost, biochar addition favored the formation of both lepidocrocite and magnetite, possibly due to the role of aromatic constituents in electron shuttling.

Thank you for your attention

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