36 month doctoral position in France
Aix Marseille University

- **JOB TITLE**

Stimulating the plant-microorganism-mineral continuum to store carbon in soils: focus on the stabilization of root exudates

- **JOB PROFILE/TYPE :**

Contract :
temporary doctoral position (36 months) starting on 1th November 2021

Employer : Aix-Marseille Université

Gross salary 1768 €/month

- **KEYWORDS**

Soil, 4 per 1000 initiative, C stabilization, root exudates, microorganisms, organo-mineral interactions, mineral weathering, MOOC

- **JOB LOCATION**

Aix Marseille University (France): The work will take place alternatively in two laboratories (depending on the periods of experimentation):

- CEREGE (Campus de l'Etoile, Aix en Provence, Les Milles)
- BIAM (Cadarache site, Saint Paul les Durance)

- **ADVISORS**

Thierry Heulin (DR CNRS, BIAM) & Emmanuel Doelsch (DR CIRAD, CEREGE)

- **PI of the project**

I Basile-Doelsch, CEREGE

- **JOB DESCRIPTION**

This 36-months' doctoral fellow is funded by the new **Mediterranean Institute for Environmental Transition** (A*Midex), an interdisciplinary initiative aiming to tackle the challenges of the ongoing climate nexus, and will begin on 1th November 2021

Description of the position:

CONTEXT: In the context of climate change mitigation and global food security, the storage of organic matter (and associated carbon) in soils is a major issue. While it is well established that increasing organic matter inputs is one of the major agro-ecological levers in terms of practices to be implemented, the levers concerning their maintenance in soils (stabilization)

are not well established to date. In the context of the environmental transition, the RhizoCarbone+ project, proposed jointly by BIAM and CEREGE (two AMU laboratories), seeks to remove this obstacle. RhizoCarbone+ aims to test on a Mediterranean soil, in the laboratory, a cultivation practice favorable to C storage by combining the increase of C inputs by root exudates, their transformation into exopolysaccharides by bacteria and the stabilization of this C by organo-mineral interactions. In parallel, the RhizoCarbone+ project will include a training component aiming at proposing an online course (Massive Open Online Course, MOOC) addressing the interdisciplinary complexity of the '4 for 1000' objectives of the COP21.

OBJECTIVES: The experimental objectives will test, under laboratory conditions, a cultivation practice that is highly favorable to C storage by combining the increase of C inputs to the soil with its stabilization by organo-mineral interactions. Such a challenge requires taking into account the central roles of soil microorganisms. Indeed, (1) organic molecules from root exudates are rapidly assimilated by microorganisms that use them to produce exopolysaccharides with reactive functions towards mineral phases and (2) some microorganisms are particularly adapted to carry out the alteration of soil minerals. The products of this alteration are monomers, small metallic polymers (mainly composed of Fe, Al, Si) likely to co-precipitate with organic polymers. The altered mineral surfaces are also reactive and likely to adsorb the organic polymers. Thus, the chain of processes photosynthesis-rhizodeposition-microbial synthesis on the one hand and biotic alteration of minerals on the other converge in soils to lead to the formation of organo-mineral associations (by adsorption and co-precipitation) that stabilize soil C. These two aspects will be the subject of the work of two PhD students who will work in close collaboration.

The proposed topic of this PhD will aim to form organo-mineral associations using natural rhizodeposition processes associated with the supply of reactive mineral phases. The objective is to compare the formation of organo-mineral associations using millet (Pennisetum glaucum) lines that have been characterized for their ability to produce contrasting amounts of exudates. In parallel, in collaboration with the other component of the project, it will characterize the organo-mineral associations by advanced techniques allowing in situ analysis at the nanoscale (MET-HR, EELS, STXM, nanoSIMS, SEM, micro and nanoCT). In a second step, the formation of organo-mineral interactions will be coupled with the alteration processes of soil minerals.

The final objective of the RhizoCarbone+ project is to show that the concept of optimizing a combination of crop type / biostimulant microorganism / mineral amendment could be developed in agricultural soils to store C in soils with a stable OM deficit.

- **QUALIFICATIONS/SKILLS/EDUCATION & RESEARCH REQUIREMENTS/DUTIES**

The doctorate will be hired for 36 months with the following preferred skills:
The doctoral student will have a scientific background in life sciences. Skills in plant biology and/or microbiology are strongly recommended. Knowledge in mineralogy, physical chemistry and soil science would be also appreciated.

The doctoral student must be fluent in English and have good writing skills.
He/she will take an active part in the creation of a MOOC on the issue of "Interdisciplinarity for the 4 for 1000". A strong taste for teaching and scientific communication using multimedia is also expected.
Note that the same candidate is allowed to apply for both RhizoCarbone+ thesis topics.

- **APPLICATION DEADLINE** (If applicable)

Applications must be submitted by June 29, 2021. For selected candidates, interviews will be held between July 5 and 7, 2021.

- **REQUESTED DOCUMENTS OF APPLICATION AND CONTACT TO APPLY**

A motivation letter, a CV, available M1 and M2 grades (with mention and ranking in the student group; note that at least an AB mention in M2 is required) and a previous internship pdf report (e.g. the one from the last master's degree) should be sent to I. Basile-Doelsch (basile@cerege.fr).
For more information, candidates are also invited to contact Thierry Heulin (Thierry.HEULIN@cea.fr), Wafa Achouak (wafa.achouak@cea.fr), Emmanuel Doelsch (doelsch@cirad.fr).