ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

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PhD Title : Nanoparticle and Metal Ion Interactions with Pyrogenic Organic Matter in Wildfire-Affected Environments

Advisor:
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Team :
IPGP - Biogéochimie à l'Anthropocène des éléments et contaminants émergents UMR7154

Funding : **PhD Contract with or without teaching duties**

Topic : (Maximum 2 pages)

General Context: Wildfires are increasingly frequent and severe due to climate change, causing widespread environmental damage. One significant consequence of wildfires is the formation of pyrogenic organic matter (PYROM), a complex mixture of partially combusted biomass that persists in soils and aquatic systems. PYROM plays a crucial role in post-fire ecosystems, influencing soil structure, nutrient cycling, and pollutant dynamics. The interactions between PYROM and emerging contaminants like nanoparticles and metal ions are not yet fully understood, yet they have critical implications for soil health, water quality, and ecosystem recovery. Understanding these interactions is essential for developing effective land management and remediation strategies in wildfire-affected regions.

Research Summary: This PhD project will investigate the interactions between nanoparticles, metal ions, and PYROM formed during wildfires. Focusing on the environmental fate of these species, the study will assess their role in post-fire nutrient cycling, soil recovery, and water quality through advanced analytical techniques and geochemical modelling.

Objectives:

- Characterize the reactivity of PYROM produced during wildfires.
- Develop analytical methods for detecting and quantifying nanoparticles and metal ions in complex matrices.
- Investigate the interaction of nanoparticles and metal ions with burned organic matter.
- Assess the mobility and bioavailability of metal-nanoparticle complexes in post-fire environments.

Methodology:

- Field sampling in wildfire-affected regions.
- Application of high-resolution mass spectrometry (FTICR-MS, sp-ICP-ToF-MS) for PYROM and nanoparticle analysis.
- Environmental magnetism for characterizing burned organic matter.
- Geochemical modelling to study metal-nanoparticle speciation and mobility.

Expected Outcomes:

- Detailed understanding of nanoparticle and metal ion interactions with PYROM.
- Insights into post-fire nutrient dynamics and soil recovery.
- Advanced techniques for monitoring nanoparticles and metal ions in the environment.
- Contributions to environmental protection and post-fire land management strategies.

This project integrates environmental chemistry, materials science, and wildfire ecology to provide critical insights into the long-term impacts of wildfires on ecosystems.

Skills Required:

- Background in environmental chemistry, materials science, or related fields.
- Experience with mass spectrometry, chromatography, and spectroscopy.
- Data analysis, AI tools, and geochemical modelling proficiency.
- Fieldwork experience in environmental sampling.
- Strong analytical, problem-solving, and communication skills.