Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25926

Unraveling Nanoparticle Dynamics in Wildfire-Affected Soils: Elemental Interactions, Liberation and Mobility

CRISTIAN SUAREZ[1], NIRINA TARACONAT[1], MICKAEL THARAUD[2] AND MARC F. BENEDETTI[2]

[1]Institut de Physique du Globe de Paris, Université Paris Cité
[2]Université Paris Cité, Institut de Physique du Globe de Paris, CNRS

Wildfires have become increasingly frequent and intense, profoundly altering terrestrial and aquatic ecosystems through the release and mobilisation of inorganic nanoparticles (NPs) and trace metals. Post-fire soils contain complex mixtures of metal-bearing nanoparticles (e.g., Fe, Mn, Zn, Pb or Ti among others), which influence geochemical cycles, soil degradation, and pollutant transport mechanisms. Understanding NP behaviour in fire-affected environments is critical for assessing contamination risks, ecosystem recovery, and soil remediation strategies.

This study investigates the formation, composition, and environmental mobility of nanoparticles in wildfire-impacted soils from several ecosystems highly susceptible to recurrent fires. A combination of field sampling, laboratory-controlled combustion experiments, and high-resolution ICP-TOF-MS analysis was employed to characterise NP size distributions, elemental associations, and post-fire geochemical transformations.

Field samples were collected from unburned soils, burned soils, and ashes-burned soil mixtures, capturing spatial variations in fire exposure and metal redistribution. Nanoparticles were analysed in terms of their number concentration, mass distribution, elemental composition and evolution through wildfire intensity, allowing their classification into distinct families, including monometallic and multi-metallic NPs. Controlled combustion experiments at 400°C and 550°C replicated wildfire conditions, demonstrating that higher temperatures enhance NP formation, promote the evolution of complex multi-metallic structures, and increase the mobility of volatile metals.

Results indicate that fire-induced nanoparticles exhibit long-term environmental mobility, affecting soil fertility and water quality. The presence of bioavailable metal-bearing nanoparticles raises concerns regarding ecosystem health, particularly in agricultural and drinking water sources. By integrating laboratory and field approaches, this research advances our understanding of post-fire contaminant dynamics and provides a framework for developing mitigation strategies and soil restoration policies in fire-prone regions.

Acknowledgments

The authors gratefully acknowledge the financial support of the Post-FIRE project, funded by the French National Research Agency (ANR) under grant number ANR-23-CE34-0010.