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Simulation of contaminant redistribution during wildland fires: Combustion wind tunnel and bench-scale experiments

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Wildland fires are increasing in both frequency and intensity across the globe, posing significant environmental risks. Moreover, certain areas present additional hazards due to metal(loid) contamination from industrial activities such as mining and smelting. Fires in these regions cause the redistribution of contaminants that can be released into the atmosphere, mobilized in the soil profile, or subsequently transported into water bodies.

In this study, we aimed to develop a method to investigate the behavior of smelter-derived metals and metalloids in topsoils during wildland fires. Under laboratory conditions, flue dust from smelters was deposited on biomass (eucalyptus litter). Placed on custom-made stainless steel trays (0.16 m²) within the fuel bed (3 m^2), these samples were combusted in a wind tunnel (Pyrotron, CSIRO, Australia) under controlled conditions (fuel load, wind speed, fuel moisture, and the level of contamination). This setup enabled post-experimental sampling of tar and ash, and enabled monitoring of mass loss. Following combustion, the resulting ash and tar were analyzed to assess the redistribution of these elements.

Reference experiments were performed using a benchtop combustion setup, where individual minerals were subjected to gradually increasing temperatures with subsequent ICP-OES detection of selected potentially toxic elements, providing detailed insights into the release and transformation of contaminants during combustion.

By integrating bench-scale and wind tunnel combustion experiments, this ongoing research enhances our understanding of how fires in polluted regions affect the mobility and transformation of potentially toxic elements.

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