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Wildfire-Generated Chromium(VI) Associated Nanoparticles in Soils

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Wildfires are increasing in frequency and severity, as evident in the western U.S., and can impact the formation, transformation, and dispersion of toxic nanoparticles in smoke, post-fire dust, soils, and water. Soil-borne Cr(III), for example, can be oxidized into toxic Cr(VI) and incorporated on the surface or into the structure of soil nanoparticles during wildfires. Because of their extremely small size, high surface area, and high reactive surface sites, soil nanoparticles control Cr(VI) mobilization in soil and water; they also threaten human health, primarily through inhalation. However, the chemistry of soil nanoparticles and their impact on Cr(III) oxidation during wildfires are only partly understood. We explored the fire-induced formation of Cr(VI) and its association with soil nanoparticles. Soil samples were collected from serpentine soils at the Jasper Ridge Biological Preserve (San Mateo County, CA). The samples were heated to temperatures ranging from 200 to 800 °C for 2 h in a preheated muffle furnace, simulating a range of burn severities, and characterized using X-ray diffraction (XRD), X-ray fluorescence spectrometry (XRF), UV-vis spectroscopy, and scanning electron microscopy (SEM). A significant increase in Cr(VI) was observed in the burned samples. While more than 6% of the unburned soils were composed of Fe, XRD did not show evidence for Fe mineralogical phases. Using SEM, we found that Fe phases occurred in nanoparticles (<100 nm), which explains their suppression in XRD signals in the presence of micro-sized and crystalline soil particles, which are prevalent in soil samples. Energy dispersive X-ray spectroscopy (*EDS*) of SEM images showed that Cr is primarily associated with Fe nanoparticles, which increased in the burned samples. This information will help to elucidate the risk to human health from metal-bearing nanoparticles during wildfire events, which is necessary to determine solutions to mitigate respiratory exposure risk to firefighters, restoration and fire-safety workers, recreationalists, and local communities.