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The 2018 Camp Fire (Butte and Plumas Counties, California): Short-term Effects on Mineralogy, Leachable Elements, and Element Speciation in Soils and Fluvial Sediments Across Lithologies

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The November 2018 Camp Fire burned an area of diverse lithologies including ultramafic (serpentinite, podiform chromite ore), volcanic (andesite) and metasedimentary rocks. We collected surface soils and fluvial sediments (0-5 cm approximate depth) in December 2018 and February 2019 to characterize fire-induced changes in mineralogy, particle size/morphology/surface area, leachable elements, and speciation across ultramafic and non-ultramafic lithologies. We further assessed effects of heat severity and duration on the lability, speciation, and mineral residence of potentially toxic trace elements (Cr, Mn, Ni, As) by heating subsamples of the field-collected samples in the laboratory at 200, 400, and 600 °C for 2 hours. Agglomerative hierarchical cluster analysis of 67 XRD patterns (of the < 250 micron sieved, hand-ground fraction) revealed substantial changes in mineralogy after heating at 400 and 600°C for serpentine; andesite and metasediment protoliths showed changes even at 200°C. The XRD patterns of the field-collected samples from historic chromite mines were similar to patterns of lab burned soils, likely because they are dominated by spinel group oxides (chromite, magnetite) which are stable at 200-600°C. A deionized water leach was used as a proxy for metal lability under a post-fire rain event scenario: with a few exceptions, As and Cr were not strongly leached until 400 or 600 °C, whereas Mn was highly leached after 200 °C heating for nearly all samples. Ni leachability was generally highest in field-collected fractions; further heating reduced its leachability. Synchrotron-based bulk and micro-scale X-ray absorption spectroscopy (XAS) and microscale X-ray Fluorescence (XRF) mapping showed that the fraction of hexavalent Cr increases from below detection (approx. 2%) up to approximately 20% of the total Cr at 600 °C, similar to findings of Burton et al (2019) [1, 2] . These preliminary results suggest enhanced leachability of potentially toxic elements at least “short-term” post-wildfire (an admittedly ambiguous time period). More research is needed into both short- and long- term effects of wildfire on soil properties, especially for ultramafic soils.

[1] Burton et al (2019) DOI:10.1016/j.envpol.2019.01.094

[2] Our results have not passed internal quality review and approval, therefore are preliminary and subject to change.