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Effects of wildfires on organo-mineral associations as a function of bedrock lithology in California chaparrals

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Robust projections by climate experts indicate that the risk of wildfires will continue to increase as global warming continues. Climate-induced disturbances to fire regimes will have significant implications for key soil biogeochemical processes, such as mineral transformation, microbially-mediated soil organic matter (SOM) decomposition, and elemental mobility and contaminant transport (e.g., Ca, Mg, K, Fe, Mn, S, Cr, Ni). While some studies have characterized the speciation of metals and OM in ashes and soils, we lack an integrative framework for a mechanistic understanding of the impact of wildfires on elemental transport and SOM-mineral associations. In this study, we seek to (1) quantify the impact of wildfire on metal solubility, organic matter chemistry, and mineralogy across different lithologies; 2) characterize differences in micro- and bulk-scale organo-mineral associations between burned and unburned soils; and 3) identify landscapes at risk of toxic metal solubilization and transport after wildfire. Leveraging paired burned/unburned sites in chaparral landscapes that burned in some of the largest and most destructive fires in California’s history, our proposed research centers on three interconnected hypotheses: 1) thermal decomposition of SRO minerals during wildfire will increase the potential for (toxic) metal solubilization; 2) carbon association with SRO minerals will initially decrease after wildfire due to the combined effects of thermal mineral decomposition and molecular fractionation of DOM; and 3) recovery of microbial activity post-fire (as measured by CO_2 flux) will be closely linked to development of non-aromatic, mineral-associated carbon and/or regeneration of SRO phases (Fe, Al hydroxides). We use both traditional geochemical techniques as well as synchrotron-based advanced molecular scale characterization studies to probe the metal-organic associations in wildfire affected soils as a function of depth and lithology. Preliminary data from our study sites show a consistent increase in soluble carbon across soil types and a persistent loss of soil microbes after wildfire. Results from this study can be used to better parametrize existing models of fire effects and improve our current understanding of soil quality, vegetation, carbon budgets and metal-organic-mineral dynamics which in, turn, will inform management practices to mitigate wildfire impacts.