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Towards understanding heat-induced contaminant reactivity across a serpentine soil toposequence in Southwestern Oregon

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Fire affects the Earth's surface more than any other landscape disturbance and is expected to increase in severity and extent due to anthropogenic climate change. Several studies have observed increased concentrations of inorganic contaminants after a wildfire in air, unpolluted soils, and surface waters in the Western United States. However, there has yet to be a thorough investigation into the landscape controls on geochemical transformations that occur in post-fire systems, particularly in locations with naturally high concentrations of redox-sensitive metal contaminants. The primary goal of this research was to understand the influence of burn severity and hillslope position on the generation, transformation, and reactivity of Cr and Cr-reactive minerals (V, Co, Ni, Mn, and Fe) in serpentine soils. Soils were sampled across a serpentine toposequence in the Rogue River-Siskiyou National Forest; then, we employed laboratory-based experimentation and a suite of chemical and spectroscopic analyses. Chemical extractions revealed that 400 °C soils from the summit position generated the most solid-phase Cr(VI) (332.64 mg kg^{-1}), which decreased down the hillslope until the toeslope. XAS spectroscopy and µ-XRF multi-energy maps confirmed Cr(VI) trends and revealed the presence of Cr(VI) around chromite-rich particles and within the mineral matrix of burned soils. Soil transport experiments on 400 °C soils were used to quantify contaminant export from burned soils, and regardless of hillslope position, Cr(VI), Ni, and Mn were released at concentrations that exceeded drinking water standards for the duration of the experiments. Chemical extractions and XRD analyses of reaction products demonstrated the dependence of contaminant reactivity on amorphous mineral associations of Cr, Fe, Mn, Co, and Ni and transformation towards more crystalline phases with increasing burn severity. Collectively, these results provide novel insights about Cr and mineralogical reactivity in fire-impacted soils across a landscape and can serve as a basis for managing contaminant risks for the many people who live near serpentine soils that experience wildfires.