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Volcanic (lava tube) caves water chemistry influenced by high magnitude wildfires on surface.

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Wildfires have been found to impact surface vegetation, soils, and hydrological processes, but little is known about their effects on subsurface environments such as caves. The Caldwell (2020) and Antelope (2021) fires in northern California affected 97% of the surface area at Lava Beds National Monument (LABE), which protects numerous volcanic caves. In this study, we analyzed the impacts of high-magnitude wildfires on cave water chemistry by comparing post-fire water samples from four caves in burned areas at LABE with pre-fire data collected from these caves between 2017 and 2019. Water and soil samples were collected from unburned, partially burned, and completely burned areas of LABE. A total of 70 cave water samples from six caves were collected four, nine, and 13 months after the second fire, along with 22 surface soil samples collected directly above the caves for a soil-water leaching experiment. Water samples were analyzed for pH, temperature, specific conductance, major inorganic ions, trace elements, dissolved organic carbon (DOC), and total dissolved nitrogen (TDN). Pre-fire water chemistry was characterized by a pH of 7.76 ± 0.25 and specific conductance of 76 ± 16 µS/cm, with concentrations of Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, NO_3^-, and SO_4^{2-} at 7 ± 2, 1.2 ± 0.2, 1.7 ± 0.8, 1 ± 0.4, 4 ± 0.4, 4 ± 2.5, and 2 ± 0.3 mg/L, respectively. Post-fire water chemistry in the same caves showed a decrease in pH to 6.55 ± 1.17, a slight increase in specific conductance to 82 ± 21 µS/cm, a decrease in Na^+ and Cl^- concentrations to 3 ± 1.7 and 0.6 ± 0.3 mg/L, respectively, and an increase in Ca^{2+} and NO_3^- concentrations to 5.7 ± 3.3 and 10 ± 6.5 mg/L, respectively. These findings suggest that high-magnitude wildfires can alter cave water chemistry by decreasing pH and monovalent ion concentrations and increasing Ca^{2+} and NO_3^- concentrations. This work was supported by NSF EAR Award #2203517 and National Park Service CESU agreement P17AC01031, with assistance provided by the Cave Research Foundation (U.S.) and local LABE rangers and staff during field campaigns.