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Impacts of wildfire on volcanic (lava tube) cave water chemistry

SAUGATA DATTA[1], HARSHAD V KULKARNI[1], JOSEPH MEDLEY[2], JENNIFER HATHAWAY[2], CHARITY M PHILLIPS-LANDER[3] AND DIANA E NORTHUP[2]

[1]University of Texas at San Antonio

[2]University of New Mexico

[3]Southwest Research Institute

Presenting Author: saugata.datta@utsa.edu

Wildfires of high magnitude are known to cause complete destruction of surface vegetation, soil sterilization, and alteration in physical, chemical and hydraulic properties of soils. However, their impacts on subsurface environments, such as vadose zone, shallow aquifers, and caves are relatively understudied. Recent Caldwell (2020) and Antelope (2021) wildfires in northern California destroyed 97% of the surface vegetation of Lava Beds National Monument (Lava Beds, N. California), which hosts volcanic (lava tube) caves. These caves provide shelter for diverse groups of microorganisms, invertebrates, mammals (bats), host a variety of speleothems, and, therefore, are an important ecosystem. Meteoric water entering into the caves via cave openings, cave overburden and surface soils and sediments chemically interacts and provides nutrients for the growth of cave microbes. In this study, we aim to understand the impacts of high magnitude wildfires on the cave water chemistry by analyzing water samples from four caves from burned area at Lava Beds (collected in December 2021), a control cave, and comparing these data with pre-fire data (August 2017-2019) from these caves. Pre-fire water chemistry was characterized by pH 7.76±0.25, specific conductance 76±16 µS/cm, concentrations of Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, NO_3^-, and SO_4^{2-} as 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 cave showed pH 6.55±1.17, specific conductance 82±21 µS/cm, and concentrations of the same ions as 3±1.7, 1.1±1.2, 5.7±3.3, 2.1±0.8, 0.6±0.3, 10±6.5, and 1.1±1 mg/L respectively. These results suggested that in post-fire samples there was a decrease in pH, concentrations of monovalent ions (Na^+ and Cl^-), and an increase in Ca^{2+} and NO_3^- concentrations. Drastic surficial disturbances due to wildfires alter in cave water chemistry. We hypothesize these changes may also influence the cave ecosystem. Additional analyses of these samples to determine dissolved concentrations of trace elements, water isotopic signatures, characteristics of dissolved organic matter, surface soil geochemistry, and geochemical modeling are underway. This work was supported by NSF EAR Award # 2203517 and National Park Service CESU agreement P21AC12062-00.