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Title: Chemistry of Fire Induced Soil Water Repellency

Abstract:

Despite numerous studies, chemical nature of post-fire Soil Water Repellency (SWR) is still poorly understood on a molecular level. In this research, we investigated the chemistry of SWR through conducting several laboratory-based experiments on organic acids including abietic and fulvic acids that are representatives of plant wax components and soil organic matter. To examine the impact of temperature and heating duration on the formation of SWR during fires, organic-free test sand was treated with the selected organic acids and heated at different temperatures (22 - 300 °C) and exposure times (20-60 minutes). The results for these soil samples were compared with samples from a real fire (Beckwourth Complex Fire), Whittell soil, and Courtyard burn samples in terms of chemical analysis and SWR results. Water Drop Penetration Time (WDPT) and Apparent Contact Angle (ACA) techniques were used for measuring SWR levels. For chemical characterization of the organic compounds associated with inducing SWR in the samples, Transform Infrared (FTIR) and Proton Nuclear Magnetic Resonance spectroscopy (^{1}H-NMR) techniques were applied. Based on goniometry results, abietic acid showed a stronger SWR (ACA: 89.93º–104.90º) than fulvic acid (ACA: 51.95º–89.76º) that were heated 22℃-300℃ for 40 minutes and both organic acids maintained SWR up to 300℃. Laboratory-generated and real fire soil samples also showed significant increase in SWR (ACA) between the burned and unburned samples (~22%–~159% increase). Fulvic acid exhibited constant decrease (~10%–~24%), while abietic acid didn't change over the exposure time range of 20-60 minutes. Based on ^{1}H-NMR and FTIR results on chemical functional groups, we concluded that most likely, the formation of aromatic functional groups and the decarboxylation (COO^{-}) processes are the main reasons for SWR formation during fires.