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Intrinsic processes influencing organic matter and water repellency in heated soils as revealed by laboratory experiments

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It is well established that soil heating during wildfires can result in major changes in soil wettability. Depending on the temperature reached, soil water repellency (WR) can be increased or can be destroyed. Our contribution will address links between soil WR elimination and thermal changes affecting soil organic mater (SOM).

The first group of samples was taken from soils under pine forests (*Pinus sylvestris* L.) in the northern part of the Borska Nizina lowland, the largest area of aeolian sand in Slovakia. The aeolian sands consist mostly of fine sand with $<$15% silt and clay. They typically contain up to 90% of quartz. The soils used in this study belong to Dystric Regosol, Arenic Umbrisol and Haplic Gleysol (WRB, 2006). The second group of samples was taken in the High Tatras Mts. in the northern Slovakia, 1221 m above the sea level. The forest soils were developed under spruce forest (*Picea abies* L.) from Quaternary moraine gravel and classified as Dystric Cambisol (WRB, 2006).

Persistence of WR was assessed by the widely used water drop penetration time (WDPT) test. For heat treatments, each sample was placed into an oven that had been preheated to the selected temperature. Samples were heated at temperatures of 125, 175, 200, 225, 250, and 275˚C for durations depending on the time required for WR elimination. Thermal analysis of soil samples was performed on a TGA–DTA sys-

tem (SDT 2960, TA Instruments, New Castle, DE) in standard air from 20 to 1000˚C. Measurements were carried out at five different heating rates: 2.5, 5, 7.5, 10, and 15˚C/min. The results are presented as TGA (thermogravimetric analysis), DTA (differential thermal analysis), and DTG (derivative thermogravimetric analysis) curves. FTIR spectra were measured on a NICOLET Magna IR 750 spectrometer before and after WR elimination by heating. Infrared spectral analysis was carried out in mid-infrared region. Each soil sample was ground to powder and pressed into potassium bromide pellet before the spectral analysis.

Results of laboratory experiments enable insight into the processes underlying thermal changes of soil wettability. Laboratory heating experiments showed that kinetic laws control WR elimination at temperatures above 175˚C. Heating experiments under isothermal conditions demonstrated an exponential relationship between heating durations and temperature thresholds. Results of thermal analysis and FTIR spectroscopy show that WR elimination due to soil heating is associated with the thermal decomposition of a more thermally labile pool of SOM. The results suggest that the loss of soil WR is primarily caused by the selective degradation of aliphatic structures. Additional results suggest that under non-isothermal conditions, heating rate (the speed at which temperature rises during heating) significantly affects degree of SOM decomposition at the selected temperature. Increasing heating rate increases the temperature at which a certain level of SOM decomposition is reached. Based on the presented results we can understand why heating has variable impacts on soil wettability. For heating under wildfire conditions, the complexity of observed impacts is enhanced by the general occurrence of non-isothermal conditions in soils.