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Sources of magnetic enhancement of wildfire affected soils under pine forest

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Magnetic enhancement of aerobic soils is a general phenomenon, observed in a wide range of soil types and parent materials distributed in different geographic regions of the world. Pedogenically synthesized fine grained strongly magnetic iron oxides are considered as a result of low-temperature inorganic- or organically – mediated processes of transformation of the initial ferrihydrite. Another possible source of enhancement is also recognized to be the thermal transformation of pedogenic weakly magnetic iron (oxy)hydroxides (goethite, lepidocrocite, hematite) as a result of heating of the mineral soil during wildfires. We have studied two pairs of burnt and non-burnt soils developed under pine forest in central Stara Planina region (forest fire in 2012) and south-west Bulgaria (Pirin mountain) (forest fire in autumn 2017). Burnt soils from both locations are characterized by strong magnetic enhancement in the uppermost 2 – 3 cm, which is several times stronger than that of the observed pedogenic enhancement of non-burnt (natural) forest soils sampled at nearby locations. This increased magnetic signature is typical for both low field magnetic susceptibility, its frequency dependence and laboratory induced remanences (ARM, IRM). Scanning electron microscopy on magnetic extracts and pieces of burnt organic material from fire-affected topsoil levels reveal widespread occurrence of spherules with different grain sizes (between 1 and 20microns) and elemental composition. Most often spherules of Ce and Fe – Si-Al are identified among the bright particles in back scattered electrons mode. The presence of fine grained Fe-containing spherules within the burnt organics may suggest that they have been formed during wood/needles firing and not as a result of thermal transformation of soil minerals. Consequently, vegetation cover and burn severity would be the major factors, which determine the amount of strongly magnetic fire-produced minerals. This study is carried out in the frame of the project DFNI K02/13 granted by the Bulgarian National Science Fund