22. Aging of black carbon in Mediterranean soils

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Black carbon (BC) is supposed to compose a major proportion of the slow-cycling carbon pools in soils. This view is supported by the observation that charcoal is still detectable in buried fossil soils and at archeological sites. However, Masiello (2004) stated that measurements of BC production and losses are not balanced. She speculated further, if BC had been produced since the last glacial maximum via biomass burning at the same rate as nowadays, BC should account for 25% to 125% of the total soil organic carbon pool. Although a few measurements indicated BC contents as large as 25%, even the lower bound is unrealistic for the entire soil carbon pool. In order to bring some light onto the fate of charcoal during the recovery period, soils of two chronosequences were analyzed for the SOM composition and charcoal contents.

The first chronosequence (Histic Humaquept) derived from the Donaña National Park in Southern Spain. Samples were taken at directly, 15 years and 19 years after a severe fire and from locations, that remained unaffected. The fire combusted all of the O layer (0-20 cm) but increased the char content in the A horizon. In the lower soil region no charcoal was identified. After 19 years, the O layer recovered to approximately 5 cm, but only minor contribution of charcoal were identified after oxidation with acid dichromate. The mineral soil, on the other hand revealed charcoal C contents of up to 18% of the total C at depths > 30 cm. This clearly evidences a downward translocation of charcoal within the soil profile during the recovery time. A translocation into deeper soil regions was also observed in a Cambisol from Piedravales, Central Spain already one year after a severe fire. With recovery time, the calculated char content decreased from 30% after 1 year to 24% after 24 years in the A horizon. NMR spectroscopy revealed high carboxyl C content of the charcoal indicating that oxidation of the aromatic ring structure occurred with aging. The formation of carboxyl groups increases the polarity and therefore also the water solubility, allowing the observed char movement. The higher polarity of the aged char is likely to increase also its susceptibility to microbial attack, which could at least partly explain the decrease of char levels in most fire-affected soils over time.