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Oxidized charcoal contribution to the humic material of deeper soil horizons in selected soils of the Doñana National Park, Spain

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The Doñana National Park is located at the mouth of the river Guadalquivir in Southern Spain and represents one of the largest marshlands reserves of Europe. Although vegetation fires are now prevented as far as possible, some of the areas were formerly subjected to frequent prescribed fires since 1628 (approximately every 25-30 years). The so formed pyrogenic organic matter (PyOM) is supposed to compose a major proportion of the slow-cycling carbon pools in soils and as such it is expected to affect quality and quantity of the soil organic matter (SOM) in the present reclaimed soils.
In order to test this, the SOM of three profiles (Humaquepts) within the protected center region were analyzed by solid state 13C NMR spectroscopy. The respective pyrogenic organic carbon (PyOC) content was elucidated, using the chemical oxidation method. Two of the selected profiles had experienced no fire since installation of the park in 1969. Here, no major quantities of PyOC were recovered in the O layer, but an increase of aromaticity correlating with PyOC contents was revealed with soil depth. At both sites, PyOC accounted for more than 15% of the Ctot in the A/C horizon (> 50 cm). This clearly evidences a downward translocation of charcoal within the soil profile. The third profile suffered a severe fire in 1985. The fire combusted all of the O layer (0-20 cm), but after 19 years, it recovered to approximately 15 cm, although only minor contributions of PyOC were revealed. Whereas directly after the fire, the soil at a depths of 55 cm contained only 3 mg g-1 organic C without any evidence of PyOC, after 16 and 19 years a clear increase of Ctot (10-15 mg g-1) with a considerable contribution of PyOC (12% of Ctot) was revealed. Although the absolute concentration of PyOC did not decrease in the lower depths, its relative contribution to Ctot declined. This may be explained by the constant input of fresh litter l, which on a long term masks the presence of char. Alternatively, a more efficient downwards transport and subsequent stabilization of PyOC may have occurred. In summary, the studied profiles clearly demonstrate that not only in tropical soils but also in fire-affected soils of the temperate climatic zones, PyOC has an important contribution to the chemical composition of humic material in deeper horizons.