



## **Biogeochemical investigations of soils detect prehistoric agricultural burning in Northwestern Germany**

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We investigated black soils in the Lower Rhine Basin (NW-Germany) following a 33 km long pipeline trench and at 16 archaeological large-scale (0.5 to 5 ha) excavations. The black soil horizons occurred independently of natural conditions (e.g. parent material) and were always connected with man-made pits filled with dark soil material. Most of the examined 48 pit fillings contained macroscopic charcoal. Our main research questions were: (i) could the investigated black soils in the Lower Rhine Basin have been formed by an input of charred organic matter and (ii) can we prove any human impact on the soil material via organogeochemical analyses?

The proportion of charred material in total soil organic matter was examined by isolation and identification of black carbon in the soil material via UV photo-oxidation and  $^{13}\text{C}$  NMR. Isolated black carbon material and hand-picked macroscopic charcoal was dated by  $^{14}\text{C}$  AMS. Phosphorous (organic and inorganic) concentrations and the distribution of lipids (*n*-alkanes) were compared for the dark material and the surrounding soil material.

Large proportions of the soil organic matter taken from the black soil material consisted of charred organic matter, detected as black carbon (19 to 46 % of total organic carbon). The AMS radiocarbon ages of charcoal and black carbon indicated the presence of fires from 7530 – 7200 calBC to 675 – 780 calAD. In most cases the amount of phosphorous was higher in the black soil material than in the surrounding soil. The proportion of total lipids compared to total organic carbon was lower in the black soils

than in the surrounding Luvisols. Some samples showed a particular high abundance of short-chain and even carbon-numbered *n*-alkanes.

Temperate deciduous forests could not be easily ignited by natural causes. Thus, mainly human induced fires are very likely the sources of the charred organic matter. An increased input of organic matter, e.g. from manure or food waste was inferred by higher phosphorous concentrations in most pit fillings. The unexpected distribution of *n*-alkanes could result of a still unknown process of decomposition of plant material. Probably, these patterns are due to degradation during biomass burning. We conclude that the investigated black soils are relicts of prehistoric agricultural burning activities in Northwestern Germany.