Geophysical Research Abstracts
Vol. 17, EGU2015-1728, 2015
EGU General Assembly 2015

Microbial activity and soil organic matter decay in roadside soils polluted with petroleum hydrocarbons

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It has been demonstrated previously that hydrocarbon addition to soil provokes soil organic matter priming (Zyakun et al., 2011). It has further been shown that petroleum hydrocarbons deposit to roadside soils bound to fine mineral particles and together with vehicle spray (Mykhailova et al., 2014), and that hydrocarbon concentrations decrease to safe levels within the first 15 m from the road, reaching background concentrations at 60-100 m distance (Mykhailova et al., 2013). It was the aim of this study to (I) identify the bioavailability of different petroleum hydrocarbon fractions to degradation and to (II) identify the native (i.e. pedogenic) C fraction affected by hydrocarbon-mediated soil organic matter priming during decay. To address this aim, we collected soil samples at distances from 1 to 100 m (sampling depth 15 cm) near the Traktorostroiteley avenue and the Pushkinskaya street in Kharkov, as well as near the country road M18 near Kharkov, Ukraine. The roads have been under exploitation for several decades, so microbial adaptation to enhanced hydrocarbon levels and full expression of effects could be assumed. The following C fractions were quantified using 13C-CP/MAS-NMR: Carbohydrates, Proteins, Lignin, Aliphates, Carbonyl/Carboxyl as well as black carbon according to Nelson and Baldock (2005). Petroleum hydrocarbons were determind after hexane extraction using GC-MS and divided into a light fraction (chain-length $<C_{15}$), a medium fraction (C_{15}-C_{27}) and a heavy fraction ($>C_{27}$, Mykhailova et al., 2013). Potential soil respiration was determined every 48 h by trapping of CO_2 evolving from 20 g soil in NaOH at 20 ˚C and at 60% of the maximum water holding capacity and titration after a total incubation period of 4 weeks in the lab. It was found that soil respiration positively correlated with the ratio of the light fraction to the sum of medium and heavy fractions of petroleum hydrocarbons, which indicates higher biodegradation primarily of the light petroleum hydrocarbon fraction. Further, soil respiration was positively correlated with the carbohydrate fraction and negatively correlated with the aliphatic fraction of the soil C, while carbohydrate-C and alkyl-C increased and decreased with distance from the road, respectively. It is proposed that petroleum hydrocarbons supress soil biological activity at concentrations above 1500 mg kg^{-1}, and that soil organic matter priming primarily affects the carbohydrate fraction of soil organic matter. It can be concluded that the abundance of solid carbohydrates (O-alkyl C) is of paramount importance for the hydrocarbon mineralization under natural conditions, compared to more recalcitrant SOM fractions (mainly aromatic and alkyl C).

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