Sorption of PAHs to carbonaceous soil amendments reduces their dissolved concentrations, limiting toxicity but also potentially biodegradation. Therefore, the maximum abiotic desorption of freshly sorbed phenanthrene (≤5 mg kg⁻¹) was measured in three soils amended with activated carbon (AC), biochar or compost. Total amounts of phenanthrene desorbed were similar between the different soils, but the amendment type had a large influence. Complete desorption was observed in the unamended and compost amended soils, but this reduced for biochar (41% desorbed) and AC (8% desorbed). Cumulative amounts mineralized were 28% for the unamended control, 19% for compost, 13% for biochar and 4% for AC. Therefore, the effects of the amendments in soil in reducing desorption were also reflected in the extents of mineralization. Modeling was used to analyze key processes, indicating that for the AC and charcoal treatments bacterial activity did not limit mineralization, but rather desorption into the dissolved phase.