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The effect of soil properties on the fate of perfluorooctanoic acid (PFOA) as benchmark for perfluoroalkyl acids.

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Per- and polyfluoroalkyl substances (PFAS) are a family of fluorocarbon molecules classified as persistent organic pollutants. The best-known species are perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), both perfluoroalkyl acids (PFAA). Due to their negative impact on human health and the environment, remediation is necessary, but has been the subject of heavy discussions. Current techniques include excavation and disposal of contaminated soil as well as in–situ immobilization of PFAA. In both cases, understanding the sorption of PFAA is crucial to prevent future leaching. The goal of this study was to identify the key soil characteristics responsible for PFAA retention in the soil with due attention to sorption reversibility. As a benchmark for PFAA, ^{14}C-labeled PFOA adsorption tests were performed to determine the adsorption soil-solution distribution constant ($K_{d,ads}$) on a wide selection of Belgian soils (n > 100) with contrasting physiochemical properties. Statistical analyses showed that the adsorption of PFOA significantly increased with increasing soil organic carbon content, while it decreased with increasing soil pH. The former can be explained by the hydrophobic interactions between the fluorocarbon tail of the PFOA and the organic carbon, while the latter is a result of fewer availability of positive binding sites for the carbonate group of the PFOA to bind at. In addition to the adsorption tests, desorption tests were performed by first spiking soils at field capacity with low doses of PFOA, followed by incubation and extraction. The desorption soil-solution distribution constant ($K_{d,des}$) was a factor 2-3 larger than the corresponding $K_{d,ads}$, suggesting considerable ageing of PFAA in soils even after merely two weeks of soil incubation. The effect of ageing on the retention of PFAA plays a crucial element in the legislation around PFAS contamination as their fate is currently determined using freshly spiked soils, while in reality contaminations have been present in the soil for decades.