Impact of Biopile Remediation of Petroleum Hydrocarbons on Poly- and Perfluoroalkyl Substances (PFASs) as Co-contaminants

Jinxia Liu (jinxia.liu@mcgill.ca) and Subhasis Ghoshal
(McGill University, Montreal, QC, Canada)
Rui Li and Yanan Liu (Donghua University, Shanghai, China)
Gabriel Munoz and Sébastien Sauvé (Université de Montréal, Montréal, Québec)

Background/Objectives. Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are key components of aqueous film forming foam (AFFF) formulations used against hydrocarbon fuel fires. Various lines of evidence have raised concerns about the persistence, bioaccumulation, and toxicity of some AFFF components. Due to the nature of AFFF's applications, coexistence of petroleum hydrocarbons (e.g., crude oils, gasoline and diesel) with PFASs is frequently encountered. For hydrocarbon contaminated soils, biopiling is the preferred bioremediation technology because of its low-cost and easy implementation. However, the great concern is that biopiling environment may be conducive to the accelerated generation of perfluoroalkyl acids (PFAAs) from abundant polyfluoroalkyl surfactants in AFFFs, nullifying the purpose of reducing chemical concentrations by implementing bioremediation. To address such concern, the study investigated the behaviors of a large suit of PFASs as co-contaminants in biopile soils. The implications of the study are discussed.

Approach/Activities. Contaminated soil obtained from a constructed biopile in Lac Megantic (QC, Canada) was aerobically incubated in lab-scale simulated biopiles for 60 days. The biopiles were amended with fertilizers to create high nutrient (CTPH:N:P = 100:10:2) and low nutrient (CTPH:N:P = 100:5:1) conditions and the performance was compared to no amendment controls. TPH in soil solvent extracts were quantified using GC-FID. An improved soil extraction method was used to recover PFASs from the soils, and 36 quantitative PFASs and 18 semi-quantitative and qualitative PFASs in soils were analyzed using two LC-MS/MS systems. The temporal trends of total concentration of each chemical class, as well as some dominant individual PFASs, were analyzed using SAS.

Results/Lessons Learned. Our findings did not support that significant production of PFAAs would occur in biopiling treatment facilities. In our study, both TPH and total PFAS declined over time, but the distinct responses to nutrient amendment signaled that the conditions that are optimal for biodegradation of hydrocarbons might not be optimal for the generation of PFAAs. PFASs from different classes or even the congeners within the same family responded quite differently to nutrient addition, and likely other measures that alter their environments. Therefore, it is quite a challenge to attempt to control the natural progression of PFAS biotransformation, especially for real-world remediation projects. Although the generation of transformation intermediates seems to create additional chemical complexity, we predict that eventually, the number of PFAS compounds will reduce, converging to a dozen of perfluoroalkyl compounds that can be easily analyzed without entailing very specific tools such as high-resolution mass spectrometry. In summary, for the particular set of contaminated soil, biopiling can reduce the total PFAS levels without creating significant amount of PFAAs.