11. Environmental impact and evolution of treated industrial soils: in situ lysimetric risk assessment

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Abstract:
Throughout the world, the oil industry generates highly polluted soils heavily contaminated with crude oil or petroleum residues generated by refinery activities. In partnership with the TOTAL company a global strategy starting from treatment and ending with re-use of the contaminated soils has been studied. Indeed, following the treatment the usual practice is to re-introduce the treated material directly in the environment, usually in the excavated pit. However, treatments never achieve a zero contaminant level and this residual contamination impact on the environment needs to be assessed. The objective of the work is to propose a management strategy adapted to the final quality of the treated material, based on its evolution, and minimizing the environmental impact of the residual pollution. We more particularly focus here on the final step of the treatment chain: environmental impact assessment and further pedological evolution of the treated industrial soil once reintroduced in the environment.

The soil studied was a petroleum by-product contaminated soil excavated at about 1.5 m deep on an industrial site. In the first stage it was treated in a biopile. This treatment proved to be efficient enough to decrease by more than 70% the initial organic pollutant load of the contaminated material. The environmental consequences of the remaining pollution and further pedological evolution of this soil was studied with an innovative and in situ device: a large scale (2 m deep, 1 m^2 wide) lysimeter. This experiment shall answer four main objectives: i) assess under realistic conditions the transfers of the residual pollution to groundwater and vegetation, ii) measure the residual contamination levels evolution in the soil profile, iii) check the ability of the treated soil for vegetation support and this plant cover impact on pollution transfer and iv) propose a predictive model giving realistic data for risk assessment.

The lysimeter was filled in April 2007 and planted with ray-grass. It was equipped at three depth (50, 100 and 150 cm) with suction cups for soil water sampling and TDR and tensiometers for water content measurements. The lysimeter was continuously weighted. Leaching water was collected at the bottom and its amount measured. All information (weight, water content, percolating water flow) were recorded on a data logger. Collected water samples were analysed both chemically (major ions, dissolved organic carbon, organic pollutants) and toxicologically (Microtox® bioassay). A more global characterization was also performed with an innovative technique: 3D fluorescence. Soil material was annually sampled and analyzed to check remaining pollution evolution.

On the two year study, soil analysis did not show significant evolution of residual pollution either in quantity or in quality. Planted ray-grass, after a first difficult stage, managed to grow correctly and provided a dense cover with significant effect on water infiltration. Water analysis showed a distinctive evolution through the profile both in chemical composition and toxicity. Some unexpected response to the Microtox® tests and evolution of the 3D fluorescence signature tend to prove that organic compounds (others than the initial pollutant molecules) still evolve in this system with possible environmental concern.

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