OIL COMPONENTS DISTRIBUTION IN SOIL - MICROMORPHOLOGICAL APPROACH

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Abstract

The paper pointed out, by the aim of chemical and micromorphological analysis, the manner of leaching and deposition of different components of oil (asphaltenes, aliphatic and aromatic hydrocarbons) in a polluted soil, which induce major modifications to soil properties.

Soil material polluted with oil from the two types of experiences (a long term experience settled down in the green house of ICPA Bucharest, as well as a laboratory experience) was analysed. The soil material used in the experiences were originated in a Luvisol (Preluvosol Roșcat - SRTS-2012; Chromic Luvisol - WRB-SR-1998)

Analytical data as well as micromorphological observations emphasise preferential distribution of oil fractions down the soil. The experimental results suggest that different components of oil had distinct behaviour in soil. The heavy fraction of oil (asphaltenes), which appear black isotropic, impregnated and coated soil aggregates, due to their strongly adsorption by the soil groundmass components. Thus, hinder their translocation down the soil and render impermeability to the soil. The lighter fraction (the aliphatic and aromatic hydrocarbons) remained captive into the pore space, and appeared as drops into the simple packing voids. This pointed out weakly or no connections between the groundmass components (clay, organic matter, sesquioxides, etc.) which permit to these hydrocarbons their translocation. The pores which entrapped the hydrocarbon drops could be inaccessible to plant roots.

Key words: micromorphology, soil pollution, oil pollution, oil fractions

INTRODUCTION

Oil pollution has such a negative influence on the ecosystem integrity, exceeding all the other anthropic impacts in intensity.

Under the condition of pollution with crude oil, oil products, wastes and salty water (brine), the soil becomes unproductive, being completely taken out of the economical circuit (Toti, 1997). Thus, because of oil, the soil properties are strongly modified.

The literature mentions few aspects concerning soil components and oil fractions in relation with soil constituents. Alexander (1994) suggests that many polycyclic aromatic hydrocarbons and other non-polar pollutants are adsorbed chiefly by the native organic matter rather than the clay constituents of soils and sediments.

Organic pollutants may also interact with soluble humic substances or high-molecular weight substances, in aquatic environments.

The micro-morphological study could emphasise the oil components distribution down the soil (Răducu et al., 1999).

For better understanding the impact of pollutants on soil components, as well as their distribution down the soil, a complete study that includes micromorphology analysis is necessary.

The paper emphasizes, following an experimental study in the green house and laboratory, the leaching and the deposition of different oil components (asphaltenes, aliphatic and aromatic hydrocarbons) in the soil architecture.

MATERIAL AND METHOD

The researches have been performed on soil material originated in a Luvisol (Preluvosol Roscat - SRTS-2012; Chromic Luvisol - WRB-SR-1998), sampled from two types of experiences, carried out in the green house of ICPA Bucharest:

- A long term experience achieved in the green house (of ICPA Bucharest). The soil material from Am horizon was homogenised, treated with oil and afterwards put in the pots.
- A laboratory experience where undisturbed soil material collected (in micromorphological boxes) from Am and Bt horizons have been treated with oil, to saturation.

The polluted soil materials (from both types of experiences) were characterized using chemical and micro-morphological analysis.

For chemical analyses, soil samples have been collected, from 0 - 10 cm and 40 - 50 cm depths of the pots.

For oil extraction, Soxhlet method has been used, while oil fractions were analysed by the aim of the gravimetric method with separation on silicagel column.

For micromorphological analysis, undisturbed soil samples (from the same pots and depth as for the chemical analysis) have been collected. All samples were air dried and impregnated with epoxidic resins and thin sections were prepared (25 - 30 μm), which have been studied afterwards with the Documator (20 X) and the optical microscope (50 - 500 X) in PPL and XPL. Bullock et al. (1985) terminology was used.

The soil characteristics were analyzed and interpreted according to the ICPA Methodology (1987).

RESULTS AND DISSCUSIONS

The data of ***the chemical analysis*** emphasised the preferential distribution of oil components down the soil (Fig. 1). Thus, the main part (26.69%) of the asphaltenes remained in the upper layer of the soil and a smaller part (4.59%) either leached or was transformed in aliphatic and aromatic hydrocarbons.

The resins were uniformly distributed down the soil (29.07% in the upper part and 26.54% in the bottom part). The major part of aliphatic and aromatic hydrocarbons of oil, as well as that one resulted from asphaltenes transformation, leached.

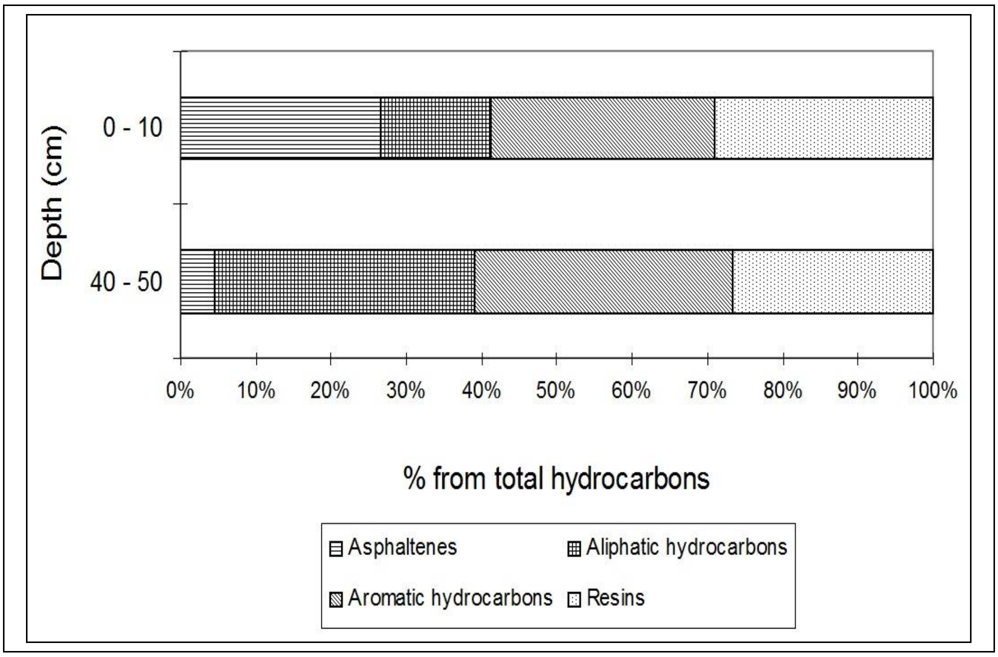

Fig. 1. Fractionation hydrocarbon data of polluted soil from pots.

The micromorphological analysis pointed out that the general characteristics of the soil material (from the green house pots) showed a subangular blocky structure (2 mm) with a very good degree of pedality. The pore space is very high and resulted from the random distribution pattern of the sieved aggregates. Almost all the aggregates preserved their integrity during the wetting-drying cycles.

Many vegetal remains appear either in pore space or into the aggregate groundmass. The vivianite [$Fe_3(PO_4)_2 \cdot 8H_2O$] is also very frequent, as coatings, on different groundmass components, or as radial aggregates in the groundmass.

The microbial activity is emphasized by the presence of many spores.

Mineral grains are partially covered by clay±Fe coatings resulted from weathering. The birefringence of these coatings had been partially masked by the oil films adsorbed on their surfaces.

Drops of lighter fraction of oil appear sporadically in the pore space (Fig. 2).

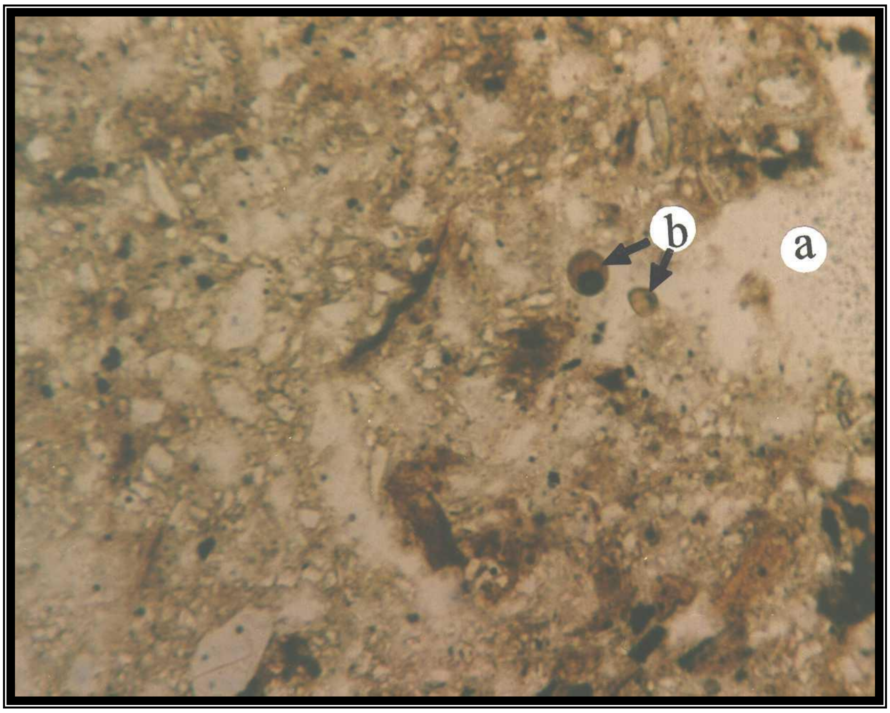

Fig. 2. Pores (a) with drops of lighter fraction of oil (b).

In the case of treated soil aggregates, micromorphological analysis pointed out that oil fractions have been divided in soil, thus:

- The heavy fractions (asphaltenes) were adsorbed by the soil groundmass components. They appear as black isotropic thick coatings that covered the entirely surface of the aggregates and also impregnated aggregate groundmass (Fig. 3). The adsorption of asphaltenes emphasised that strongly bonds have been established between heavy fractions of oil and soil components (clay, organic matter, sesquioxides, etc.). This aspect could explain why asphaltenes do not leach and remain in the surface layers, rendering them impermeable.
- The lighter fraction (aliphatic and aromatic hydrocarbons) appears as drops into the interpedal and intrapedal pores (Fig. 3). This pointed out weak or no connections between the groundmass components and these hydrocarbons that permit their movement in the soil. In optimum conditions, the hydrocarbons could be biodegraded, while in the anaerobic conditions the process is hobbled.

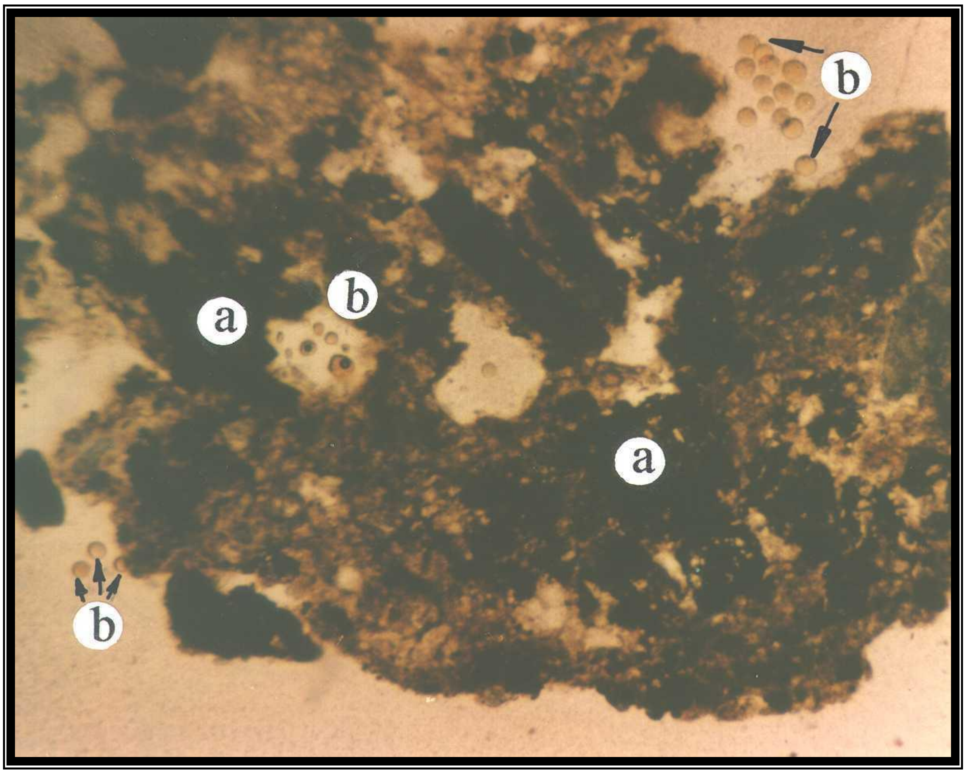

Fig. 3. Asphaltenes (a) adsorbed by the soil groundmass components; drops of lighter fraction of oil (b) in the intra- and interpedal pores.

When the hydrocarbon drops remain entrapped in the pores, they impede the plant roots to explore and develop into these pores, preventing plant development.

The clay coatings on the Bt aggregate surfaces seem to adsorb oil fractions and hinder the aggregate desiccation, thus forming a halo. This could prove that pollutant film rends impermeable the aggregate walls.

CONCLUSIONS

The chemical and micromorphological results suggest that different fractions of oil have distinct behaviour in soil as well as preferential distribution. Thus:

- asphaltenes either formed thick coatings which covered the aggregate surface or impregnated soil groundmass, due to their strong adsorption by the soil groundmass components, hindering their leaching;
- the upper layer of soil became impermeable and impeded aerobic activity and further plant root and specific biota development;

- aliphatic and aromatic hydrocarbons appeared as drops into the pore space. This fact pointed out that weak or no connections with the groundmass components established, which favoured their leaching.
- The pores which entrapped hydrocarbon drops could be inaccessible to plant roots.

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