Scientific Papers, USAMV Bucharest, Series A, Vol. LII, 2009, ISSN 1222-5339

MICROMORPHOLOGY AND EVOLUTION OF THE IMPURE CLAY COATINGS IN SOME PHAEOZEMS FROM ROMANIA

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Keywords: *impure clay coatings, micromorphology, Phaeozem*

Abstract

The paper point out, by the aim of micromorphology, the characteristics and the evolution of the impure clay coatings. The study was focused on four Phaeozems from Romania, soils with a high content of organic matter and a relatively intense iluvial process. The micromorphological researches were performed: 1) on soil thin sections (20-30µm) prepared from the undisturbed soil and studied with optical microscope; 2) on soil aggregates, studied with the scanning electron microscope (SEM). The results showed that in the studied Phaeozems many types of illuvial coatings appear: from the impure clay coatings (with organic±mineral impurities) to limpid clay coatings (free from impurities). The observations with optical and scanning electron microscopes showed that the impure clay coatings are colonized by the microorganisms which, in time consume the organic constituents (impurities) having two important results: 1) gives to the coatings a layered appearance; 2) induce the evolution of these coatings which became, in time, limpid clay coatings (after the total consumption of the organic matter). As a result of the microorganism activity, sequences of many types of illuvial clay coatings (with different quantities of impurities) were observed in each studied Phaeozem. All these aspects underlined that biological activity has a very high influence on the evolution of clay coatings, soil being not only a simple habitat for them, but also a result of their activity.

INTRODUCTION

The acquisition of knowledge of the microhabitats and the interaction of microorganisms and soil is a challenging task, as little is known about the related processes at microscale [1]. Micromorphological studies of the spatial relationships between soils and microorganisms have been made since ‘80s [3]. Although there are many approaches to investigate microorganisms in soil [2] the knowledge of distribution and colonization behavior of soil microorganisms is limited [1].

The objective of the paper was to point out, by the aim of optical and scanning electronic microscopes, the micromorphological characteristics and the evolution of the impure clay coatings from some Phaeozems from Romania.

MATERIAL AND METHODS

Four soil profiles were studied:

P_1 - Cambic Phaeozem (Haplic Phaeozem – WRB-SR, 1998) located in Târgu Secuiesc Depression, formed in (stratified) clayey loam deposits; on piedmont relief with 565 m absolute altitude and the water table at 10m; the mean annual temperature (Tma) and the total annual precipitation (Pma) are 7,1^{o}C and 598,7mm, respectively.

P_2 - Cambic Phaeozems (Haplic Phaeozem – WRB-SR, 1998) and

P_3 - Argic Phaeozems (Luvic Phaeozem – WRB-SR, 1998), both located in Suceava Table-land, formed in marly clayey deposits, on the absolute altitude of 380m and the water table at 4-5m; with Tma = 9,6^{o}C and Pma = 675mm.

P_4 - Tipic Rendzinic Phaeozem (Endoleptic Phaeozem – WRB-SR, 1998) located in Miercurea Ciuc Depression, formed in clayey loam alluvo-proluvial deposits, at 690m absolute altitude; the water table is at >10m; with Tma = 5,9^{o}C; Pma = 577 mm. All soil profiles are located on arable land.

For the micromorphological study, undisturbed soil was sampled from each horizon of the four soil profiles, impregnated with polyester resins and used to prepared thin sections (20-30µm and 6x9cm), studied, afterwards, with Amplival microscope. Soil aggregates were also sampled for the scanning electron microscope (SEM) analyzes.

RESULTS AND DISCUSSION

The micromorphological study, aimed on optical and scanning electronic microscopes, emphasized (in each horizon of the studied Phaeozems) the presence of a large number of different types of illuvial coatings: from the clay coatings containing abundant organic-mineral impurities (humons, Fe, etc.) of fine silt-size and known as *impure clay coatings*; to coatings with sporadically or no impurities, the classical illuvial clay coatings, known as *limped clay coatings*.

The presence of such a mosaic of coatings is difficult to be explained only on the base of alternating seasonal climatic conditions or on polyphasic evolution of the soils (in which case, the older coatings should be present in the deeper horizons of the soils).

The most frequent coatings are the impure clay coatings, known (in SRCS, 1980), as “organic-mineral coatings” being also a diagnostic criterion of the Phaeozems (previously named Chernozem-like soils).

The impure clay coatings have a specific morphology: dark color due to the presence of the organic matter impurities, which covered the clay. The dark color of the organic matter (impurities) reflects the specific conditions of its

transformation: a high humidity and the presence of microorganisms, which by autholysis produced blackish, melanized organic plasma (humons). These types of clay coatings are the most frequent coatings in the studied Phaeozems, being practically specific for the mollic epipedon. Such impure clay coatings were also observed in Chernozems (Răducu, 2000).

Together with these coatings appears, relatively frequent, clay coatings with less organic matter. Many of them have layered structure (alternating layers of different composition and color).

The optical microscopes (figure 1 and 2) and SEM (figure 3) observations showed: that the impure clay coatings are colonized by the microorganisms that, in time "biodegraded" the organic constituents (impurities) having two important results: 1) gives to the coatings a layered appearance (figure 1 and 2-a); 2) induce the evolution of these coatings which, in time, became limpid clay coatings (figure. 2-b), after the total consumption of the organic matter [4]. As a result of the microorganism activity, many types of illuvial coatings (with different quantities of impurities) are present in each studied Phaeozem.

The importance of this paper release from: 1) the technique used in the study, based on microscopic tools (optical and electronic microscopes) which are major in the researches of soil processes and pedofeatures and 2) the results, which showed that microorganisms have a huge influence on the characteristics of soil pedofeatures (clay coatings) and their evolution, unknown until now.

It was supposed that the layered structure of the textural pedofeatures is the exclusive result of a successive deposition of illuvial material having different composition and that limpid clay coatings are old illuvial coatings deposited in more humid climatic conditions.

The paper clearly emphasized (also by the aim of the images - figure 1-3) that microorganisms are more than simple soil habitants. They built the soil, according to their needs and together with the others pedogenetic factors, and influenced the characteristics and the evolution of the pedofeatures (impure clay coatings respectively).

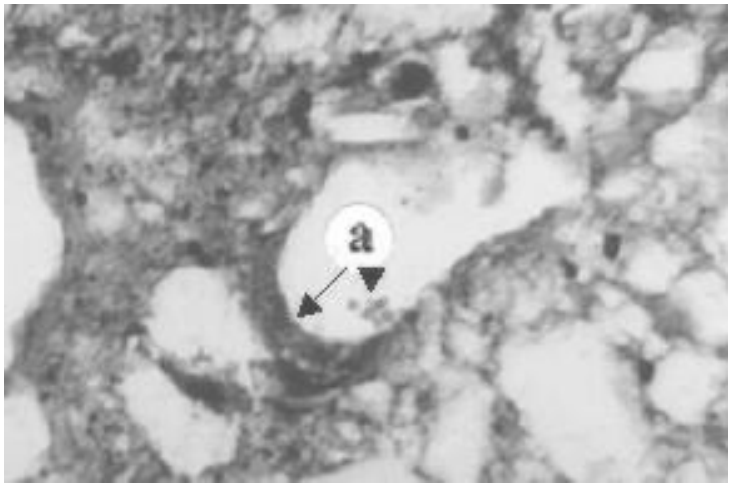

Fig. 1. ***Impure clay coatings with microorganisms (P2); 75X, N II***

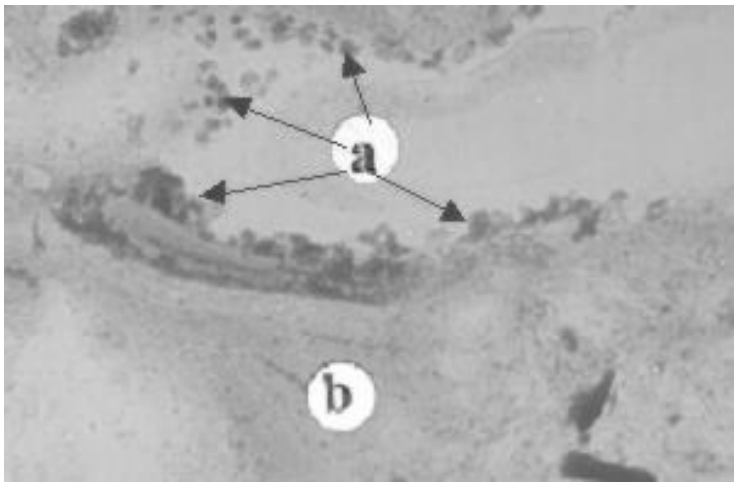

Fig. 2. ***Impure clay coatings with microorganisms (P1); 184 X, N II***

Fig. 3. M*icroorganisms on clay coatings (P4); SEM, 2000X*

CONCLUSIONS

1. Many types of illuvial coatings were observed in the studied Phaeozems: from the *impure clay coatings* containing abundant organic-mineral impurities to the *limped clay coatings* with sporadically or no impurities.
2. The optical microscopes and SEM observations showed: that impure clay coatings are colonized by the microorganisms that consume, in time, the organic constituents (impurities).
3. The microorganism activity has two important results: 1) gives to the coatings a layered appearance; 2) induce the evolution of the impure clay coatings throughout limpid clay coatings.
4. As a result of the microorganism activity, many types of illuvial coatings (with different quantities of impurities) are present in each studied Phaeozem.
5. The microorganisms are more than simple soil habitants, they built the soils according to their needs and, together with the others pedogenetic factors, induce specific characteristics of the textural pedofeatures (clay coatings) and influence their evolution.

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