THE WEATHERING AS A MAIN PROCESS MODELLING THE SOIL VITAL ENVIRONMENT

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Abstract
The objectives of the paper had been to evaluate the level at which weathering, as the main process active in the studied soil, proceed to modelling the soil vital environment.
The researches had been performed in Patranjeni area, located in The ApuseniMountains, on an AlosolRodic. The results pointed out that on the general background of an extremely anthropic polluted and acid soil (pH below 4.5), the micromorphological observation (on the oriented thin sections) had been reveal an intense weathered process of the skeleton grains (composed of greenish grey sandstones). Consequently, the soil matrix had been in situ enriched with large amounts of weathered products which kept the soil in a state of youth and gives mainly to the Bt_2horizon the characteristics of a layer known as „alteration bed". The analytical data showed an extremely high level of total Fe, ranging between 14712 ppm and 23759 ppm, whereas the total Mn values are lower and ranged from 176 ppm to 743 ppm. The acidification directly influenced the soil life environment, by increasing: the weathering of the skeleton grains, the soil matrix debazification and the organic matter oxidation. In addition, the soil ecosystem being affected, the soil inhabitants (from macro- to micro-scale) had been also affected. On the other hand, the soil vital environment had been modelled mainly by the weathering that locally buffered the highly acidity and created a vital environment for the soil life.
Key words:weathering, redoximorphic features, pollution, micromorphology.

INTRODUCTION

Although the weathering of rocks is both a mechanical and mainly a chemical process the biological influence is very important; acids produced around the roots of living plants and by the bacterial decomposition of plants interact with rock minerals increasing the chemical alteration of those minerals (Formoso, 2006). Life coatings on rocks (lithobionts) include epiliths that live on the surface, and may be composed of bacteria, cyanobacteria, fungi, algae, and lichens (Dorn, 2007). Few studies have focused their analyses on mineral-weathering bacterial communi-ties in relation to geochemical cycles and soil characteristics (Uroz et al., 2011). Forests which developed on acidic soils are characterized by an important stock of inorganic nutrients entrapped in poorly weatherable soil minerals; the mineral-weathering process is of great importance, since such minerals are not easily accessible to tree roots (Uroz et al., 2011).
The objectives of the paper was to evaluate the level at which weathering, as the main process active in the studied soil, proceed to modeling the soil vital environment.

MATERIALS AND METHODS

The studies had been performed in Patranjeni area, located in ApuseniMountains (The Romanian Western Carpathians), on a slope of AmpoiValley, having a slope ≥ 25%, and facing north. The climate in the area is temperate continental with an average annual temperature of 8.0°C and average annual precipitations of 630 mm.

The soil was AlosolRodic (according to SRTS-2012; and RhodicAlisol – according to WRB-SR-2014) formed in loamy slope deposits (having 3-4 m thickness) rich in sandstone gravels.

The vegetation is a young pine plantation poorly developed (50%) due to the anthropic pollution (the dioxide and trioxide sulphur emissions brought by the winds along the Ampoi Valley (as well as the acid rains) from the nearby industrial area.

Two types of sampled had been collected and analyzed according to RISSA Methodology-1987, from each pedogenetic horizon of the profile: disturbed samples (for the chemical analysis); and undisturbed samples for the micromorphological study.

The undisturbed soil had been air drayed and impregnated with epoxidic resins. After hardening, oriented thin sections (25–30 µm) have been made from each sample and studied by the aim of microscopic tools in plain polarized light (PPL) and cross-polarized light (XPL), using for their description Bullock et al. (1985) terminology.

RESULTS AND DISCUSSIONS

The results pointed out that on the general background of an extremely acid soil with the pH values ranging from 3.92 – 4.62 (the chemical data had been detailed in a previouspaper – Manea et al., 2017), the micromorphological investigation (on the oriented thin sections) showed an intense weathered process of the skeleton grains, with a maximum in the bottom profile, where the pH, the base saturation degree and the cation exchange capacity reached the highest values (Răducu et al., 2019).

Synthesizing the micromorphological investigations on the thin sections of the soil sampled from the main pedogenetic horizons, Ao_2(7 – 25 cm), EB (40 – 62 cm), Bt_2(90 – 112 cm), many aspects resulted, emphasizing the complex characteristics of the weathering process that act in the soil profile.

The soil skeleton grains had been relatively abundant (from 5% in the upper horizons, to 40% in the deeper Bt_2 horizon), and composed of greenish grey sandstones (fig. 1).

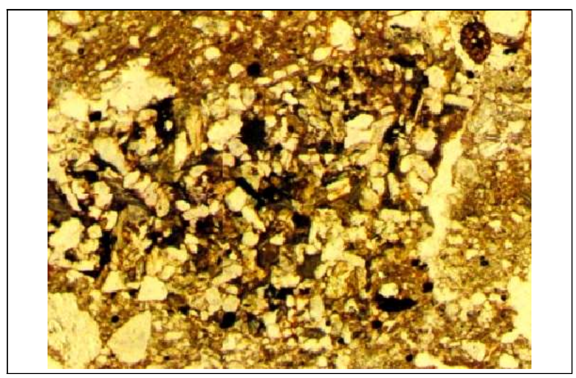

Figure 1. The greenish grey sandstone.

The related distribution pattern in the matrix of the surface Aohorizon is specific to the acidic horizons, with low pH, more precisely with the organic matter resulted from the decomposition of the vegetal remains originated from the acidophilic vegetation (coniferous) and combined with the high quantities of Fe and Al.

On the other hand, in the EB (40 – 62 cm) and Bt_2(90 – 112 cm) horizons the related distribution pattern is specific to the horizons with strongly alteration, in which the constituents resulting from the rock fragments weathering (clay, Fe, etc.) appear: 1) either in the cracks and on the surfaces of the medium weathered skeleton grains; 2) either replacing the totally weathered rock fragments and remains at their place of origin, preserving the initial organization of the rock texture; 3) or mobilized and locally leached, within the matrix and having a fluidal appearance.

In addition, the Bt_2(90 – 112 cm) is a horizon *in situ* enriched with large amounts of weathered clay which gives it the characteristics of a horizon known as „alteration bed‟.

This alteration bed is defined (by Răducu, 2015) as „an underlying mineral layer non-pedogenetic, representing a young deposit with fine texture, located at the soil profile bottom, resulting from the rocks fragments weathering (and in which appear both strongly altered rock fragments and the zones with weathering products that preserved the initial organization of the rocks), very friable, and having also redoximorphic features. It could be mistaken with B (Bv or Bt) horizon‟.

In this respect, the lower part of the Bt horizon is a layer rich in rock fragments (dominated by the presence of the sandstones with ferruginous cement – fig. 2) and being in different degrees of alteration, which represented a source of plasmic material supply that continuously enrich the soil matrix

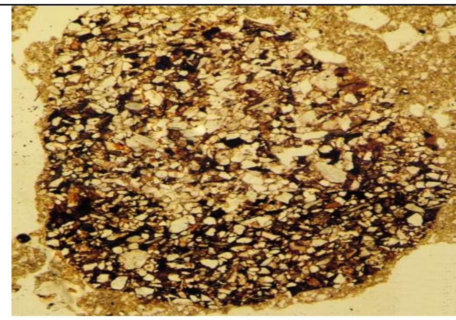

Figure 2. The highly weathered rock fragment

For this reason, the microscopic image of the Bt_2horizon (90 – 112 cm) does not reflect the chemical characteristics of the soil profile (low pH and high amount of Al, and consequently the aggressiveness of the soil solution).

This aspect could only be explained by the weathering intensity which provided continuously plasmic constituents that mask (or buffer) the destruction and/or leaching of the plasma.

Furthermore, as a result of a very weathered skeleton grains, the analytical data showed an extremely high level of total Fe (fig. 3), ranging between 14712 ppm and 23759 ppm.

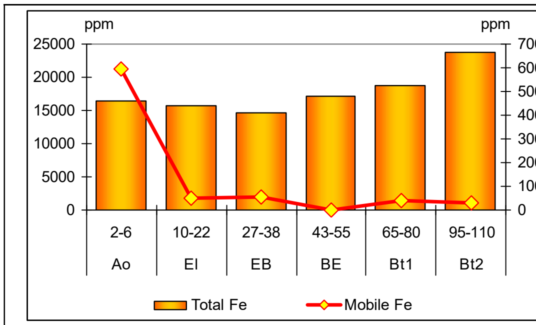

Figure 3. The total and mobile Fe.

The highest value (23759 ppm) had been reached in the deeper Bt_2(90 – 112 cm) sub-horizon, corresponding to the highest level of the alteration.

The lowest value (14712 ppm) had been detected in the EB horizon (27-38 cm), despite of a very active leaching process.

In what concerning the mobile Fe, the values are much lower (fig. 3), ranging between 28.20 ppm and 594.00 ppm.

The distribution of the mobile Fe forms into the soil profile is very different than the total Fe, the highest value being reached into the upper horizon, and the lowest one, into the deeper (Bt_2) horizon.

As an explanation of these different distributions, it could be noted that in the upper horizon it could be also a biological intake of Fe (from the vegetal remains decomposition); while in the deeper horizons, the mobile Fe may be subjected to leaching.

The high content of Fe was also emphasized chromatically, at the morphological level: in BE (40-62 cm) and Bt_1 (62-90 cm) horizon the hue is 7.5YR with the value 4.5 and chroma 4 (fig. 4); while the matrix of the Bt_2 horizon (90-112 cm) had the hue 5YR with the value and chroma 4.

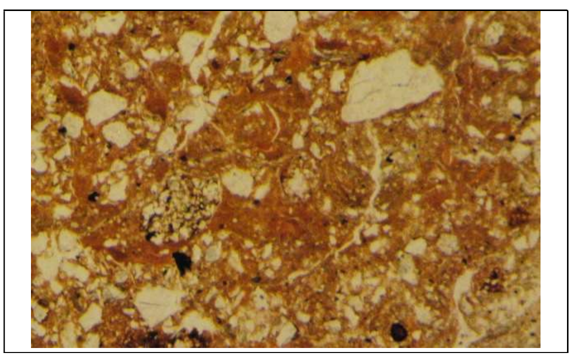

Figure 4. The reddish plasmic material in the soil matrix of Bt_1 horizon (62-90 cm). PPL.

In what concerning the Mn, the analysis results showed lower values (fig. 5), comparing to Fe. The total Mn values ranging from 176 ppm to 743 ppm.

The distribution of the total forms of Mn is similar to that of the total Fe, the lowest value being registered into the upper Ao horizon, while the highest values had been reached into the Bt_2.

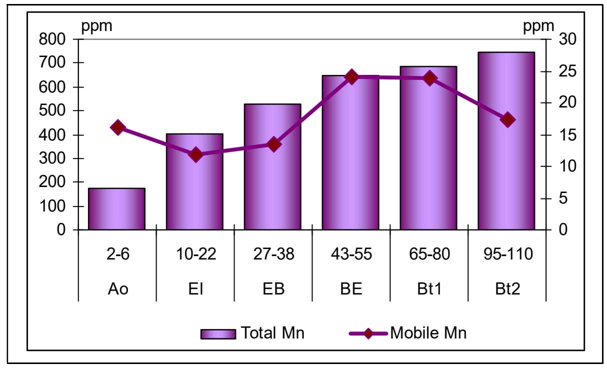

Figure 5. The total and mobile Mn.

The mobile Mn attended a sinuous distribution in the soil profile (fig. 5), therange of values being included in the limits of 11.8 – 24.1 ppm.

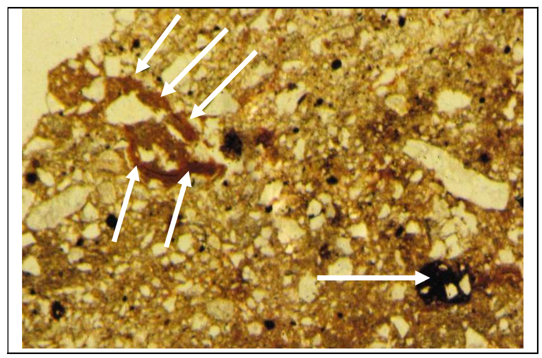

Figure 6. The strongly weathered rock fragments (➲). PPL.

Many rock fragments are highly weathered, being totally replaced by the alteration products.

The weathered products either remains in place (fig. 6), or presented a fluidal morphology (fig. 7) as a result of their mobilization by the soil solution (having both vertically circulation and laterally down the slope, taking into account the position of the soil profile at the middle of the slope).

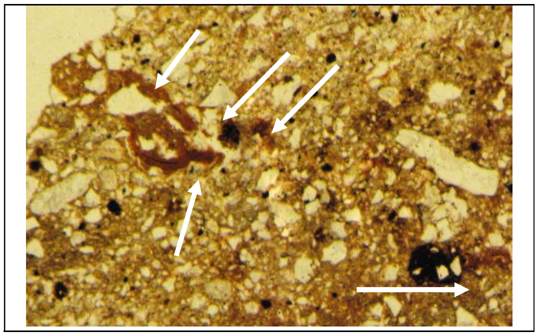

Figure 6. The strongly weathered rock fragments (➲). PPL.

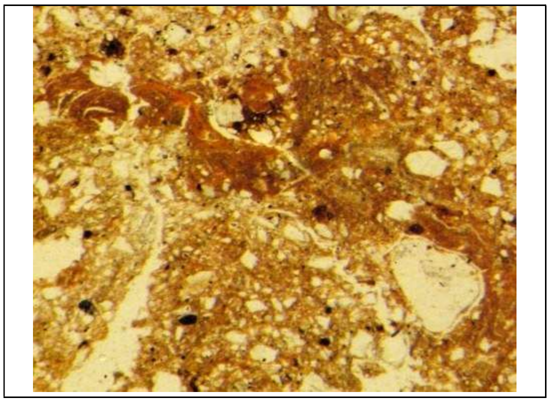

Figure 7. The weathered products with the fluidal morphology.

The hierarchization of thepedogenetic processes (according to their intensity) which modeling the characteristics of this soil profile during its evolution, the weathering (*in situargillization*) could be considered in the foreground and the clay illuviation in the second plan. The weathering is very intense, emphasized by the high degree of the skeleton grains alteration. Clay illuviation is also an active process in the soil profile, due to: a very large amount of clay resulting from weathering; the specific climatic conditions of the area; and the profile position on a slope of 25-30%. Furthermore, the acidification directly influenced the soil life environment, by increasing the weathering of the skeleton grains, soil matrix debazification and organic matter oxidation. The soil vital environment being affected, the soil inhabitants (from macro- to micro-scale) had been also affected. However, the intense weathering had also a positive effect by constantly released the weathering products (clay, cations, etc.) that created many clayey±Fe±Mnpedofeatures and locally buffering the soil, as well as inorganic nutrients. In this respect, the weathering process it self created a vital environment for the microorganisms, while microorganisms initiated and intensified the weathering (biological weathering). Thus, the soil vital environment had been modeled mainly by the weathering that locally buffered the highly acidity and created a vital environment for the soil life.

CONCLUSIONS

The chemical analysis results pointed out the general background of an extremely anthropic polluted and acid soil (with pH below 4.5),

The micromorphological observation (on the oriented thin sections) had been revealed an intense weathered process of the skeleton grains (composed of greenish grey sandstones).

Consequently, the soil matrix had been *in situ* enriched with large amounts of weathered products which kept the soil in a state of youth and gives mainly to the Bt_2horizon the characteristics of a layer known as „alteration bed‟. The analytical data showed an extremely high level of total Fe, ranging between 14712 ppm and 23759 ppm, whereas the total Mn values are lower and ranged from 176 ppm to 743 ppm. The acidification directly influenced the soil life environment, by increasing: the weathering of the skeleton grains, the soil matrix debazification and the organic matter oxidation. In addition, the soil ecosystem being affected, the soil inhabitants (from macro- to micro-scale) had been also affected.The soil vital environment had been modeling mainly by the weathering that locally buffered the highly acidity and releasing inorganic nutrients, creating a vital environment for the soil life.

Funding

Financial support for the publication of this study was jointly provided by the Romanian Ministry of Research, Innovation and Digitization, trough the Project PN 19 34 04 01 (Development of intelligent tools for quantifying the biodiversity of soil micro-organisms as ecosystem services provider to secure natural resource of soil in the context of climate change).

ACKNOWLEDGEMENTS

This work was supported by the Romanian Ministry of Research, Innovation and Digitization, trough the: Project PN 19 34 01 01 (Soil functions contribution to eco-systemic services related to local soil, geologic, and climatic conditions and to the present and historical land use as support for agri-environmental policies); and the Project number 44 PFE/2021, Program 1 – Development of national research-development system, Subprogramme 1.2 – Institutional performance – RDI Excellence Financing Projects.

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