CLAY FRACTION OF STAGNIC LUVISOLS FROM THE PIŞCHIA AREA, TIMIŞ COUNTY

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Abstract. This paper presents a study concerning the mineralogical composition of Stagnic Luvisols clay fraction from the Pişchia area. This area is situated south of the Mureş course in the Vinga Plain. The soil horizons samples were analyzed in the polarizing transmission microscopy, electron transmission microscopy and X-ray diffractometry. The clay minerals identified in the clay fraction of these soils were smectite (montmorillonite), illite and kaolinite. The quantitative variations of the clay minerals (illite, illite/smectite, smectite, illite/chlorite, chlorite/smectite, kaolinite) along the entire profile may have been caused by the initial non-uniformity of the parental material and by pedogenetic processes, as well.

Keywords: clay fraction, Stagnic Luvisol, Pişchia area, Timiş county

Cuvinte cheie: fracţie argiloasă, preluvosol stagnic, zona Pişchia, judeţul Timiş

1. INTRODUCTION

The Stagnic Luvisols, with their particularities imposed by the local conditions from The Vinga Plain, represents the final stage of the weathering of the weathering crust (Radulescu & Anastasiu, 1979). Cracian (2000) specified that the clay fraction of haplic luvisols is mostly made up from illite and smectite, and subordinately by kaolinite. The mineral composition of these soil’s clay fraction is determined by the initial composition of the weathering crust, with the only difference that clay minerals can be transformed during the pedogenetic processes (Uruioc, 2001). This is the reason why the study of mentioned soil’s clay fraction permits on one hand the deciphering of their evolution, and on the other hand, is helpful in the scientific agriculture.

The objective of this study was the identification and estimation of the amount of clay minerals and non-clay minerals which made up the clay fraction of the Stagnic Luvisols from the Pischia area, by scientific methods.
2. MATERIAL AND METHODS

The qualitatively and quantitatively analysis of the clay fraction, was investigated by means of polarizing transmission microscopy, X-ray diffractometry (powder method) and electron transmission microscopy. Three soil profiles was taken into study (Fig.1) considered to be representative for the Stagnic Luvisols, from the studied area. From each horizon, four samples were collected, making an average sample. The 25 soil samples (S23, S24 S25, S26, S27, S28, SA2 - profile 1; S29, S30, S31, S32, S33, S34, S35, S36, SA4 – profile 2; S37, S38, S39, S40, S41, S42, S43, S44, SA7 - profile 3) was collected from each horizon, until the weathering crust (Table 1).

Table 1. Samples from soil horizons and weathering crust
Tabelul 1. Probe din orizonturile solului și din scocărța de alterare

<table>
<thead>
<tr>
<th>Sample</th>
<th>Horizon</th>
<th>Interval (cm)</th>
<th>Sample</th>
<th>Horizon</th>
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<th>Sample</th>
<th>Horizon</th>
<th>Interval (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S24</td>
<td>Am</td>
<td>22-35</td>
<td>S30</td>
<td>Ao</td>
<td>26-37</td>
<td>S38</td>
<td>Ao</td>
<td>30-44</td>
</tr>
<tr>
<td>S25</td>
<td>ABw1</td>
<td>35-53</td>
<td>S31</td>
<td>AB</td>
<td>37-49</td>
<td>S39</td>
<td>ABw1</td>
<td>44-57</td>
</tr>
<tr>
<td>S26</td>
<td>Btw1</td>
<td>53-80</td>
<td>S32</td>
<td>Bt</td>
<td>49-92</td>
<td>S40</td>
<td>Btw1</td>
<td>57-85</td>
</tr>
<tr>
<td>S27</td>
<td>Btw1</td>
<td>80-100</td>
<td>S33</td>
<td>Btw1</td>
<td>92-128</td>
<td>S41</td>
<td>BCw2</td>
<td>85-96</td>
</tr>
<tr>
<td>S28</td>
<td>Cw2</td>
<td>100-145</td>
<td>S34</td>
<td>BCw2</td>
<td>128-147</td>
<td>S42</td>
<td>C1</td>
<td>96-140</td>
</tr>
<tr>
<td>SA2</td>
<td>SCA</td>
<td>145-170</td>
<td>S35</td>
<td>Cw3</td>
<td>147-160</td>
<td>S43</td>
<td>C2</td>
<td>140-185</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>S36</td>
<td>Cca</td>
<td>S44</td>
<td>C3</td>
<td>185-200</td>
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<td></td>
<td></td>
<td>SA4</td>
<td>SCA</td>
<td>SA7</td>
<td>SCA</td>
<td>200-220</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSIONS

3.1. Minerals description

In clay fraction < 2μm from The Stagnic Luvisol’s horizon were identified non-clay minerals: calcite, feldspar, quartz, goethite and colloidal silica; and also clay minerals: kaolinite, smectite, (montmorillonite), illite and interlayerings (illite/montmorillonite, illite/chlorite, chlorite/smectite). The minerals were distinguished by their specific properties.

The study of the specters of the X-ray diffraction, show that the most of the analyzed samples can be grouped in four categories:
In the first group, the diffraction maximums suggests by their position and intensity a mainly smectitic mineral composition. This is the most numerous group of samples S34, S35, S36, from the lower part of the profile P₂ Murani, and profile P₁ Pischia (S40, S41, S42, S43, S44, SA7).

- The second category, in which the diffraction maximums by their intensity suggests a mineral composition in which kaolinite appears in high amounts in some profiles. So, in samples S37 (Fig. 2. b), S38, S39, S40, S41, S42, S43, S44 from profile P₁ Pischia and in samples S24, S25, S27, S28, SA2 from profile P₁ Murani, the amount of kaolinite are 3 to 5 times higher than in samples S29, S30, S31, S32, S33, S34, S35, S36, SA4, from profile P₁ Murani;

- The third group, where appear higher quantities of interlayering like illite/montmorillonite is represented by sample S29 from profile P₂ Murani (Fig. 2.a) and by samples S41, S42, S43, S44, SA7 from profile P₁ Pischia;

- The fourth mainly illitical category is represented by samples S24, S25, S26, S28, SA2 from profile P₁ Murani and samples S29, S30, S31, S32, S33, S34 from profile P₂ Murani.

Non-clay minerals and clay minerals from the clay fraction (kaolinite, illite, montmorillonite, illite/montmorillonite, illite/chlorite, chlorite/smectite) were investigated by electron transmission microscopy. The clay mineral content of $<2\mu m$ fraction is between 46% and 50% in the weathering crust and varies between 47% and 56% in soil horizons. Generally appear higher amounts in Bt horizon, as result of the illuviation processes that led to the enrichment of this horizon with clay minerals. Their vertical quantitative distribution will be presented considering their relative amount expressed in percentage (Fig.3).
Kaolinite is present as lamellar aggregates or parallel growths resulted from the weathering of the feldspars. It can be present in idiomorphic blades with pseudohexagonals contours, or hipididomorphic and xenomorphic crystal fragments. The kaolinite distribution in the horizons is very un-uniform and different from one profile to another. The smallest amounts of kaolinite are in profile P2 Murani, and the largest differences between horizons are in profile P1 Murani. At profile P3 Pischia the kaolinite content is slowly decreasing with depth.

Montmorillonite appears in xenomorphic blades with blurred edges and unequally turned and is present in almost all analyzed profile horizons.

Illite results from the mica illitisation phenomenon and it appears as idiomorphic blades or hipididomorphic blades. With small exceptions, the illites are slightly decreasing from upper horizons to lower ones. Higher quantity values (30-55%) from the first horizons (samples S24, S29, S37, S38) are explained by the transformation of smectites in illites or illite/montmorillonite under the influence of potassium fertilizers.

The illite/montmorillonite with a lot of montmorillonite appears in nebulous shapes, semitransparent or as weakly turned blades at the edge of the micas or of the weathered feldspars. It is quantitative subordinated to illites. The higher values from the first horizons, suggests in this interlayer case, a more intense process of argillisation or the existence of interstratification of the initial parental material with a different clay mineral composition.
The *illite/chlorite*, resulted from the weathering of trioctaedrical minerals, keeps the same differentiated aspects between horizons, due to the same causes, with the mention that at each horizon level, with few exceptions, the quantitatively values are lower.

The *chlorite/smectite* was identified in the west part of the investigated area in the Bt horizon (sample S27), as a transforming product of the biotite, through chlorite. The chlorite/montmorillonite interlayering can be the result of Fe and Mg organization from the chlorite net into a new structure like the dioctaedric smectite. The presence of this interlayering, reflects the argilisation and transport conditions of the profile colloids, through the descendent water currents.

*Non-clay minerals* (quartz, feldspar, calcite, goethite) are present in variable amounts.

*Goethite* is an autigen mineral, which results from the weathering of hematite during the pedogenetic processes (Schwertmann, 1971). It appears in sub-unitary proportions in all the horizons. The goethite together with other minerals does not exceed 1% in every horizon.

*Calcite* appears sporadically in samples S24, S25, S27, S35, S36 in 1-2%.

*Feldspar* are present in all soil horizons and are maintaining between 10-16% and are partially weathered. Much more represented is the quartz (29-37%).

### 3.2. Genetic considerations

The diffraction specters interpretations of the glicolated samples and of the clay mineral imagines obtained by electronic microscopy have permitted some genetically interpretations. In the case of profile P2 Murani from the west of the studied area, quantitative analysis of clay minerals suggests the existence of parental material interlayering which differs mineralogical, concerning the montmorillonite and illite ratio.

In the Cca horizon (sample S36), the ratio montmorillonite/illite is 2.7, in Bt horizon (samples S32, S33) is about 1, and in the surface horizon Ap (sample S29) it reaches 0.6. The values of this ratio suggests a tri-layering of the parental material, which is confirmed by the granulometric analyze.

The values of the Nf/Ng (fine sand/thick sand) are dropping in BC horizon from 46 to 38 in Bt and reach 25 in Ap.

At this profile, the amount of montmorillonite is doubling in Cca horizon and in the weathering crust reported to Ap, and the amount of illite is doubling in Ap reported to the Cca and the weathering crust.

The increase of the montmorillonite amount toward the depth shows the migration of sodium ions toward the base of the profile. The higher percentage value of the illite towards the surface, can be explained by potassium adding from fertilizers.

Profile P3 Pischia presents some mineralogical quantitative differences reported to profile P2 Murani. At the surface, the ratio montmorillonite/illite has a value (0.8) comparable to the one from profile P2 Murani (0.6), but in depth, this value reaches values 3 times higher (Uruioc and Craciun, 2000). Another important difference is given by the kaolinite amount which is 2-3 times higher at this profile, probably due to the geographical position in a higher, colder and moister area, where the soil has evolved to a more acid pH favorable for kaolinite formation.
Clay fractions of stagnic luvisols from the Pişchia area

Profile 1

Profile 2
Fig. 3. Vertical distribution of clay minerals of Stagnic Luvisols.

Profile P3

P3 - profile situated at ESE of Pişchia; SCA – weathering crust; 1. montmorillonite and illite / montmorillonite (with a lot of montmorillonite); 2. illite; 3. kaolinite. P2 - profile situated at S-V of Murani; SCA – weathering crust; 1. montmorillonite and illite/montmorillonite (with a lot of montmorillonite); 2. illite; 3. kaolinite. P7 - profile situated at N-V of Murani; SCA – weathering crust; 1. montmorillonite and interlayerings (illite/ montmorillonite, illite/chlorite, chlorite/smectite); 2. illite; 3. kaolinite.

P3 - profil situat la ESE de Pişchia; SCA – scoarţă de alterare; 1. montmorillonit şi illit / montmorillonit (cu mult montmorillonit); 2. illit; 3. caolinit. P2 - profil situat la S-V de Murani; SCA – scoarţă de alterare; 1. montmorillonit şi illit/montmorillonit (cu mult montmorillonit); 2. illit; 3. caolinit. P7 - profil situat la N-V de Murani; SCA – scoarţă de alterare; 1. montmorillonit şi interstratificaţii (illit/ montmorillonit, illit/chlorit, chlorit/smectit); 2. illit; 3. caolinit.
CONCLUSIONS

Studying the data, we can make the following conclusions:

- Clay minerals from the clay fraction of argillic brown soil are represented by: kaolinite, illite, montmorillonite, illite/montmorillonite, illite/chlorite, chlorite/smectite;
- The amount in clay mineral of <2µm fraction is between 46% and 50% in the weathering crust and varies between 47-56% in soil’s horizons;
- Generally appears higher amounts in Bt horizon, as a result of illuviation processes which led to the enrichment in clay minerals of this horizon;
- Non-clay minerals (quartz, feldspath, calcite, goethite) are present in variable amounts (1-37%);
- Argillic brown soil has formed on a substrate probably richer in clay (montmorillonite);
- The higher values of illites and illite/montmorillonite, from the first horizons, are explained by an intense process of argillisation, the existence of layers of the initial parental material with a different clay mineral composition or by the administration of potassium fertilizers.

BIBLIOGRAPHY