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THE MAP OF THE CLAY MINERAL ASSOCIATIONS IN THE CLAY FRACTION BELLOW 2 μm FROM THE SURFACE HORIZON OF THE ROMANIAN SOILS

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Abstract

The map has been prepared on the basis of information supplied by the 400 soil profiles investigated at the colloidal level by X-ray difraction, taking into account not only the field surveys and laboratory results, but available soil and lithological maps also.

The 8 mineralogical classes from the map legend, representative for the certain clay mineral associations, established in the clay fraction of the soil surface horizon have been displayed in an ascending order of the structural mobility, determined by the massive presence of some clay minerals having specific crystalo-chemical characteristics to promote certain processes, which leads to changes of the soil physical and chemical properties.

The map presents information regarding not only the clay mineral association, but the clay mineral contents for each association also, even if this last aspect has semi-quantitative character. Concerning this last aspect it has to highlight the fact that the 25-50% interval considered as a reference system, express a moderate participation of the association components. The other intervals of values under and over this interval, are considered expressing a subordinate and dominant participation, respectively.

INTRODUCTION

The chemical and physical properties of soil are influenced strongly by soil constituents which have high specific surface or highly reactive surface. Since such of surfaces are associated with small particle size, the clay fraction of the soil will be dominant factor influencing interactions between soil components and between those and the other components of the environment.

Clay minerals represent the most active inorganic part of soils, both in terms of their influence on soil properties and functions and of soil response to different natural and/or artificial intervention or stimuls.

The purpose of this paper is to highlight a map which refers to clay minerals distribution in the fraction bellow 2 μm of the surface horizon (A 0-20 cm) in Romanian soils.

MATERIAL AND METHODS

The map has been prepared on the basis of information supplied by the mineralogical studies of the soil clay fraction from Romanian soils carried out in the last 25 years, taking into account not only the field survey and laboratory results, but available soil and lithological maps too. From samples collected from about 400 soil profiles, the results reffering to soil surface horizon (A 0-20 cm) were selected.

The clay fraction was separated by pipette method, after which it was treated with calcium, potasium, chloride and ethylene glycol. The obtained oriented clay preparates below 2 μm were examined by X-ray diffraction.

A method, which use the intensities of the 001 basal reflection of the indentified clay minerals was used for the semi-quantitative evaluation of the mineralogical composition of the clay fraction [3, 4].

RESULTS AND DISCUSSION

In the figure 1, the mineralogical map of the soil clay fraction from surface horizon of the Romanian soils is presented.

The 8 mineralogical classes in the legend represented by certain clay mineral associations found in the soil surface horizon are displayed in the increasing order of structural mobility, determined especially by the massive presence of some clay minerals having specific crystalo-chemical chracteristics, to promote certain processes which lead to changes of the soil physical and chemical properties.

The changes of physical properties which refer especially to the volume of soil (the solid-lacunar space ratio) and those chemical which refer to the exchange properties of the soil, play a substantial role concerning the soil fertility.

The map provides information concerning not only the clay mineral associations but also the content of components of these mineralogical associations, even if this last aspect has a semiquantitative character. A 25-50% share of clay minerals is regarded as the reference, it proving a moderate participation of the components of such association. The other deviations from the values found below and over this range are considered as expressing a subordonate and dominant participation respectively.

Occurance in dominant quantities of the smectite minerals which have contraction-swelling properties, can induce modifications in the soil particle and aggregates settling or packing at the horizon or soil level. Such modifications can also be deppended by some structural characteristics facilitating the water penetration between the structural layers of the crystalline network of these minerals. The high content of smectitic clays provides to the soil a certain behaviour when wet intervals alternate the dry ones.

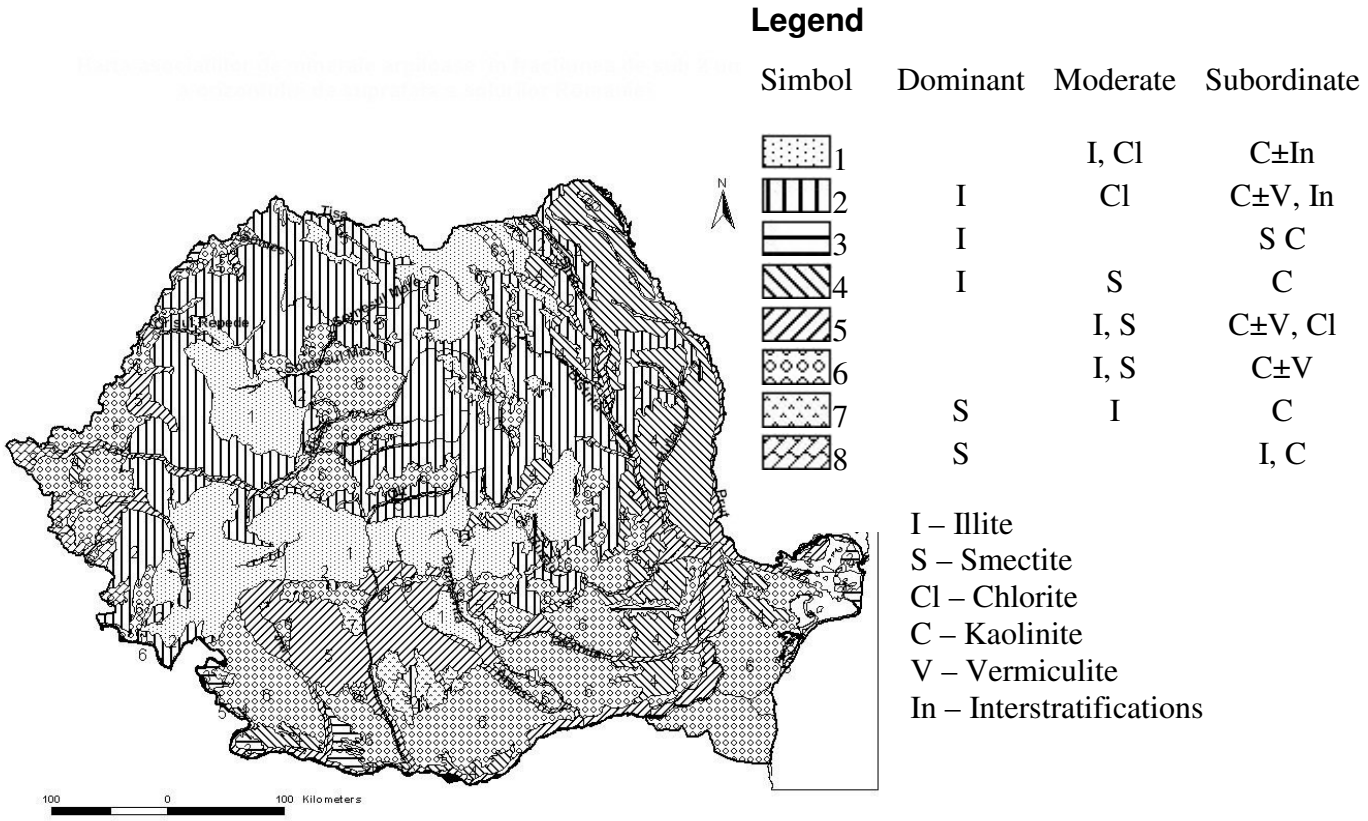

Fig. 1. Mineralogical map of the clay fraction (<2µm) from surface horizon of the Romanian soils

The high cation exchange capacity imparts to the status of smectite minerals a significant role to the nutrients or contaminants occurred in soil as a result of certain human activities.

Potasium fixation has been reported for soils containing smectites [1]. However in comparasion with other clay minerals like vermiculite, weathered illite that can occure in these soils as well, the potasium fixation power of smectite mineral is lower. The high CEC of smectite is available to hold fertilizer cations such K and NH_4, macronutrients such Ca and Mg and micronutrients like Cu and Zn.

In the case of some nutrients the temporary fixation facilitates a slow rate of their availibility for plants. In the case of contaminants (heavy metals, radionuclides, hydrocarbons, pesticides) occurance in large quantities of smectite minerals leads to an increase of soil capacity to retain by absorption these substances a certain period of time. In this way the interaction between these contaminants with the other environmental components (air, water) can be impeded [2].

Unfortunately, smectite in large amounts may produce unfavorable hydraulic conditions and root growth may be restricted.

Unlike the soils with prevailing smectitic association, those with dominant and moderate illitic and chloritic associations indicate a more stable structure because these two clay minerals have a rigid structure in comparision with smectite.

Illite is the principal K reserve at the soil colloidal level. As function of its weathering degree, this clay mineral can become an important K source, but it can become a competitor for the plant concerning the nutrients as K and NH_4 proceeded from fertilizers.

The weathered illite (and vermiculite) have a remarcable fixation power for K or NH_4, which is much superior those of smectite.

Chlorite in soil are largely inherited minerals formed as alteration products from minerals such as horblende, biotite and other ferro-manganian minerals. They have a low frequency in soil due primarly to their low stability.

In the majority of the cases, the chlorite from Romanian soils can be considered as hidroxy interlayered minerals (smectite or vermiculite). These minerals may be described as chlorite-like minerals but the interlayer hidroxide sheet (Al or Fe) of the chlorite structure is incomplete.

The presence of hydroxy interlayers in expandable minerals determins certain changes of the soil properties:

- a decrease of some physical properties (tensile strenght, liquid limit, sweeling);
- an increase of the potential sites for anion adsorption;
- a reduction of the effective cation exchange capacity;
- a decrease of K selectivity and fixation.

The other mineralogical components vermiculite and kaolinite show different behaviours but which draw them near smectite and illite respectively.

Their presence in moderate quantities can influence K and NH_4 fixation (vermiculite) and an increase of anion retention (kaolinite). Their influence on the soil properties is much lower due mainly to their small amounts in soil compared to the other clay minerals.

A short characterisation of these mineralogical associations from the point of view of soil-clay quality relation appears necessary.

Association 1 is characteristic for the mountain areas ocupied generaly by podzols and districc cambisols, representing about 15% from Romanian total area.

Association 2 is frequent in the clay from haplic luvisols, albic luvisols and planosols located in zones of hills and plateau (Transylvania, Moldavia and high areas of the West Plain). This association can be found also in the clay of districc cambisols located into a intramontain depressions (Haţeg, Maramureş, Dornelor). The mineralogical diference at the colloidal level between luvisols and districc cambisols is the fact that this association which occures on the all soil profile in districc cambisols, in the case of luvosols it appears only in the surface and eluvial horizons. About 24% from the country surface is occupied by this association.

Association 3 dominated by illite is common for the arenosoils located especialy in the zones of plains (the Easthern part of Romanian Plain, Oltenia Plain, Carei Plain) and Danube Delta. The spreading of this association is very low (about 1%).

Association 4 is frequent in the clay of kastanozems (N-Dobrogea) and chernozems from plain zones (Transylvania, Moldavia, E-Romanian Plain). The soils which have this type of association at the clay level in the surface horizon ocupy about 10% from the total country area.

The next type of associations (5 and 6) are quite similar from the clay mineralogical composition point of view. The two principal components of the clay illite and smectite occure in moderate quantities, the difference reffering to the order in witch they are presented. This order suggest a weak domination tendency of the respective mineral. These association are frequently met in the areas from South part of Romania occupied by chernozems (Dobrogea, Romanian Plain, Banato-Crisan Plain) and phaezems (the high areas of these mentioned plains and Est part of Transylvania Plain).

The association 5 is also frequent in clay of fluvisols. The area occupied by these two associations togheter is about 40% from total surface area of Romania.

The last two types of minerals associations (7 and 8) have a similar characteristic given by the smectite domination which can be accompanied in moderate quantities (case frequent to gleyosols and sometimes to eutric cambisols) and in subordinate quantities (case frequent to vertisols) by illite.

The mentioned soils occur frequent in Banat Plain, Banat Hills, Moldavia Plain, Romanian Plain between Olt and Arges rivers (vertisols) and in Somes Plain, Timis Plain (gleyosols). The occupied surface by these two associations represent about 10% from total surface of the country.

CONCLUSIONS

1. The map of clay mineral association in the clay fraction (<2 μm) from the surface horizon of the Romanian soils highlight 8 mineralogical classes, ordered ascending by structural mobility determined by the massive presence of some clay minerals having specific crystalo-chemical characteristics to promote certain processes, which leads to changes of the soil physical and chemical properties.
2. The clay minerals which occur in the clay fraction from the surface horizon of the all Romanian soils are illite and kaolinite. In comparison with the illite, which occurs with rare exceptions, in dominant and moderate quantities, the kaolinite occurs with very rare excetions in the subordinate quantities.
3. The two minerals are accompanied by smectite, chlorite and vermiculite. In comparision with smectite which can become a dominant component, the other two clay minerals occur only in moderate or subordinate quantities. In the certain cases the interstratifications can be presented, too.
4. The mineralogical associations dominated by illite occur in the soils which take up a surface which represent about 40% from the total country area, while the associations dominated by smectite, ocupy about 10% from the same area.
5. A surface of 40% from the total country area is occupied by the soils, with clay fraction composed by illite and smectite in moderate quantities.

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