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# DETERMINATION THE SOIL-PARENT MATERIAL UNIFORMITY USING PARTICLE-SIZE AND MINERALOGICAL COMPOSITION IN THE LIPOVA HILLS

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***Abstract.*** *The criterions used to establish the soil profile and parent material uniformity were: sandy and silty fraction distribution; index minerals distribution on the whole soil profile and parent material; ratio of two particle-size distribution (Coarse sand/Fine sand) and of two index minerals. The soil profile and parent material uniformity can be establish using the index minerals obtained by the mineralogical analysis. The appearance on the soil profile of one or two discontinuities express a irregular parent material. Conservation a constant ratio for two index minerals on the soil profile and parent material represents the uniformity. It has been analyzed fragments from parent rocks, skeleton fragments from soil horizon, and on soil texture class. It is necessary to eliminates the film with oxides and clay which cover the fragments, sieves in accordance with the particle-size diameter and prepare thin section in order to identification the minerals with the polarizing microscope. In conclusion, the soil profile Albic-Stagnic Luvisols from Lalasint has forming and evaluated in a stratified parent material, and the limits of the layer are at 28 cm depth and 42 cm depth. Soil profile has distinct morphological, physical, chemical and mineralogical properties inherited from the environmental factors, especially from rocks and parents materials and also as a results during soil forming processes, the largest proportion is confined to the coarse fraction. A morphological, physical particle size distribution, chemical and mineralogical analyses are the condition in order to evaluating the soil profile uniformity and the soil profile development. The soil profile Buzad is younger then Lalasint. The soil profile formula is Ao-El-Btw-C, rich in light and heavy minerals, like muscovite, epidote, amphiboles, pyroxene, and also in index minerals like staurolite. The discontinuity of the soil profile appears at the 29cm depth, with change the quantitative of quartz granules and the form of granules from the rounded to angular, and coveres with silt.*

***Keywords****: sand, silt, index mineral, uniformity soil*

## INTRODUCTION

In order to evaluating soil development must be identify the primary minerals inherited from the parent material and rocks, the secondary minerals, and carbonates and oxides as $Fe_2O_3$, $Al_2O_3$, $SiO_2$, $CaCO_3$ (BARSHAD, 1964)

This will be resulted from the chemical and mineralogical analyses.

It is also necessary to establish the uniformity of the whole soil profile and of parent material on the basis of the particle-size distribution and the nature of heavy minerals and the ratio of the fractions of the particle-size.

The soil chemical composition is dependent of the various sedimentary rock types in which the chemical elements are held (JACKSON M., 1969).

The criterions used to establish the soil profile and parent material uniformity were:

- sandy and silty fraction distribution;
- index minerals distribution on the whole soil profile and parent material
- ratio of two particle-size distribution (coarse sand/fine sand) and of two index minerals.

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It is necessary to totalize: Coarse Sand (CS) + Fine Sand (FS) + Silt I (0.02-0.01 mm) + Silt II (0.01-0.002 mm), and to recalculate each fraction in comparison with this new unit.

The parent material uniformity will be verified by the ratio between the Fine Sand new calculated and the Coarse Sand new calculated (FS/CS). The existence of a discontinuity indicates a parent material irregular, stratified, for a specific depth.

The soil profile and parent material uniformity can be establish using the index minerals obtained by the mineralogical analysis. The appearance on the soil profile of one or two discontinuities express a irregular parent material. The main index minerals are Quarts, Felsppars, Rutile, Zircon and Tourmaline. Conservation a constant ratio for two index minerals on the soil profile and parent material represents the uniformity. (ROGOBETE, 2016)

## MATERIAL AND METHODS

From about 100 soil profiles, effectuated for doctoral study in Lipova Hills, we have selected two soil profiles in order to establish the uniformity of soil profiles and parent materials (ROGOBETE, 1979)

For these soil profiles it has been realized profile description, physical analysis (particle – size distribution), chemical analysis (for ex: humus acids, pH, CECs, BSP, Al, Si, $Fe_2O_3$, $Mn_2O_3$, etc), mineralogical analyse with polarization microscopy for the coarse fraction (sand and silt) and for the clay fraction – some analysis like X-ray diffraction, infrared, thermic differential. All the mentioned analytical methods respect effective standard.

## RESULTS AND DISCUSSIONS

### I Soil profile Lalasinț

The first analyzed soil profile is situated in the northern part of Lipova Hills near the Mures river, on a plateau in forest with oaks (Quercus petraea) at 325 m altitude. The rock and parent material belong to Barremian (Cretaceous period), in which prevails quartzic sand - stones. In this deposite there are also conglomerates and silicolithes.

Profile description

Profile description reveals Ao – Ea - EaBt – Btw – C with Fe and Mn oxide in the Btw horizon, forming by pherolysis phenomena.

The soil type is Luvosol albic stagnic (SRTS) or Stagnic albic Luvisols (WRB)

The profile is located on flat terrain, absolute altitude 325 m, in Quercus petraea forest, its parent rock and material is Cretaceous flysch, predominantly composed of conglomerates and silicolites.

Ao 0-19 cm yellowish brown gray, 10YR5/3 and 10YR6/4 dry, loamy, friable grainy

Ea 19-37 cm light brown gray, 10YR6/3 and 10YR7/3 dry, loamy-sandy, poorly structured, yellowish rust spots

EaBt(w) 37-40 cm yellowish gray, 10YR6/6, loamy, large angular polyhedral, moderately compact, rust spots, ferrimanganese concretions

$Bt_1$(w) 48-67 cm yellowish brown, 10YR5/8, loamy-clayey, prismatic, compact, ferrimanganese spots and concretions

$Bt_2$(w) 67-120 cm rusty brown, 7.5YR5/6, loamy, prismatic, compact, ferrimanganese concretions large and numerous

BtC 120-134 cm reddish brown, 7.5YR5/8, clay with whitish skeletal fragments with silicolites

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*Table 1*

Analytical data - Lalasint

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 2-19 | 19-37 | 37-48 | 67-101 | 106-120 |
| Horizon | Ao | Ea | EaBtw3 | $Bt_1w4$ | $Bt_2w4$ |
| Coarse sand | 2.0 | 2.0 | 3.0 | 7.0 | 25.0 |
| Fine sand | 37.2 | 35.2 | 34.6 | 30.6 | 16.2 |
| Silt I | 15.0 | 18.7 | 16.4 | 10.0 | 3.5 |
| Silt II | 16.8 | 16.4 | 16.8 | 8.3 | 2.9 |
| Clay, | 29.0 | 27.7 | 29.2 | 44.1 | 52.4 |
| pH $H_2O$ | 4.90 | 4.55 | 5.20 | 5.45 | 5.35 |
| Humus % | 2.12 | 0.85 | 0.46 | 0.62 | - |
| Huminic acids | 0.20 | 0.20 | 0.16 | 0.21 | - |
| Fulvic acids | 0.77 | 0.25 | 0.16 | 0.29 | - |
| CECs, me | 22.42 | 24.47 | 22.76 | 37.05 | 36.19 |
| BSP, % | 43.0 | 32.8 | 64.8 | 77.4 | 77.4 |

The pH is strong acid (4.55 in Ea horizon) and the Al content is very high (11.61 me in Ea horizon), and the ratio Fulvic acids/Huminic Acids is favorable for fulvic acids.

Mineralogical analysis for sandy fraction from soil and parent material

It has been analyzed fragments from parent rocks, skeleton fragments from soil horizon, and on soil texture class. It is necessary to eliminates the film with oxides and clay which cover the fragments, sieves in accordance with the particle-size diameter and prepare thin section in order to identification the minerals with the polarizing microscope. The soil and parent material minerals can be light or heavy minerals and another classified is in index minerals (resistant on weathering) and nonresistent on weathering. The next move is to calculating the amounts of index mineral, nonclay fraction, and clay fraction at each horizon.

In the soil profile Lalasinț there are many skeleton fragments of quartzite covered with argillite cutan (figure 1)

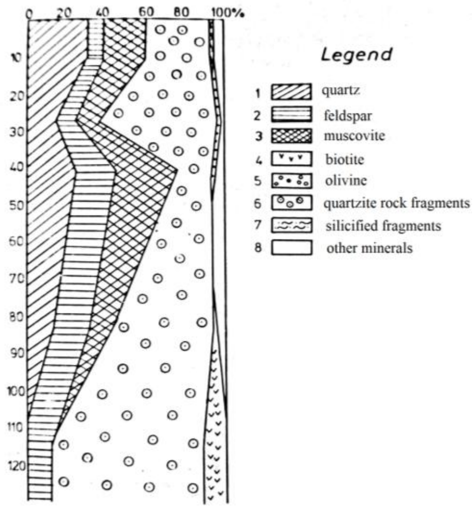


Figure 1. Mineralogical composition Lalasinț

These fragments are accumulated (78%) in the lower part of soil profile, the minimum values (17%) or at 45 cm depth (table 2).

*Table 2*

Mineralogical composition (%)

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 2-19 | 19-37 | 37-48 | 67-101 | 106-120 |
| quartz | 31.62 | 15.35 | 25.27 | 13.92 | - |
| feldspars | 7.41 | 9.55 | 20.74 | 18.78 | 12.44 |
| nuscovite | 21.41 | 11.55 | 30.06 | 10.72 | 0.49 |
| garnets | 1.31 | - | 0.68 | 0.83 | - |
| biotite | 1.00 | - | - | 1.27 | 11.47 |
| olivine | 1.14 | 1.47 | 1.78 | - | - |
| staurolite | 0.63 | - | 0.66 | 0.72 | - |
| zircon | - | - | 0.80 | 0.98 | - |
| hornblende | - | - | 1.13 | - | - |
| epidote | - | - | 0.59 | - | - |
| brookite | - | - | - | 0.87 | - |
| fragments | 33.72 | 60.85 | 18.25 | | 75.58 |
| quartzite fragments | - | 1.20 | - | 1.77 | - |

These fragments are originated from the parent rocks respectively silicolites from the cretacic base.

The Quartz mineral disappears completely under 98 cm depth. Granate, olivine hornblende is getting from the vicinity basalte zone. Quartz grains are rounded up to 28 cm and angular under 28 cm

Mineralogical analysis for clay fraction

The determination of mineralogical composition for clay fraction (<2μ) imposes to eliminate the other components which cover the colloidal particles, like humus, silica, Fe, Mn oxides, using acetate acid-perhydrol- filtration-peptization with NaOH – percolation with distillate water and finally saturation with ethylene glycol, K and Ca (as chloride). Obtained separates has been analyzed by X-red, infrared and thermic quantitative analytical Xray

*Table 3*

Clay mineralogical composition, Lalasint (%)

| Horizon | Depth, cm | Expandable minerals, % | Chlorite % | Illite % | Kaolinite % |
|---|---|---|---|---|---|
| Ao | 2-19 | - | 30 | 62 | 8 |
| Ea | 19-37 | - | 42 | 49 | 9 |
| Btw | 67-101 | 52 | | 40 | 8 |

In the upper part of soil profile (2-19 cm) are minerals of the types chlorites and kaolinites, as accessories minerals for illites, whereas in the lower part of the soil profile prevails expandable minerals accompanied by the illite and kaolinite.

The main cause for that significant difference is the existence of a parent material stratification. But it is necessary to remark that in the eluvial horizon El the forming process of chlorite minerals is very active.

Degree of soil profile uniformity of Lalasint

The results obtained at particle – size distribution sand fraction mineralogical analysis and clay fraction mineralogical analysis, have been used to establish the soil profile and parent material uniformity.

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The constancy of Coarse sand / Fine sand ratio and Quartz/Feldspars ratio along the soil profile reflected the uniformity for soil profile and parent material. In contrary a strong variation of a certain depth represents a stratification for this level.

*Table 4*

Degree of soil profile uniformity of Lalasint

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 2-19 | 19-37 | 37-48 | 67-101 | 106-120 |
| Cs+Fs+Silt=100 | 2.8 | 2.7 | 4.2 | 10.5 | 32.0 |
| Cs | 48.6 | 52.3 | 48.8 | 54.1 | 20.8 |
| S I | 25.8 | 21.1 | 23.1 | 17.1 | 44.5 |
| S II | 22.6 | 23.6 | 23.7 | 14.8 | 3.7 |
| Fs/Cs | 18.0 | 18.6 | 11.6 | 5.2 | 0.6 |
| Quartz | 31.62 | 15.35 | 25.27 | 13.92 | - |
| Feldspars | 7.41 | 9.55 | 20.74 | 18.78 | 12.44 |
| Q/Fs | 4.27 | 1.61 | 1.22 | 0.74 | 0 |
| Zircon | - | - | 0.80 | 0.98 | - |

- the ratio Fine sand / Coarse sand change abruptly at 37-48 cm depth and at about 100 cm
- the quartz content has a discontinuity at 19-37 cm
- the feldspars content has at 37-48 cm an evidently modification
- the Quartz/Feldspars ratio varies from 4.27 at the level 2-19 cm, to 0.74 at the level 67-100 cm
- from the 37-48 cm depth appears zircon minerals.

In the interval 28-42 cm there are also great variations for rocks fragments and muscovite.

In conclusion, the soil profile Albic-Stagnic Luvisols from Lalasint has forming and evaluated in a stratified parent material, and the limits of the layer are at 28 cm depth and 42 cm depth.

**II Soil profile Buzad**

The soil profile is located in the north-western part of Lipova Hills near the village Buzad, in a forest (Quercus robur), on a slope (5-6$^{o}$).

The parent rock is from Pliocene age, and consist of sand which covered marl and gravel stratum. The parent material is a Pleistocene, deposit, with a sandy stratum, covered by clay stratum.

The soil profile has the following formula:

Profile description

0 – 19 cm, Ao, 10YR5/2, loamy, granular structure

19- 29 cm, El, 10YR5/3, loamy, angular blocky structure

29- 37 cm, $ElBtw_2$, 10YR6/4, sandy clay loam, columnar structure

37- 78 cm, $Btw_3$, 10YR7/6, clayloam, prismatic structure, iron-manganese concretions

79- 86 cm, BtC, 10YR8/6, sandy loam Stagnic-Luvisols

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*Table 5*

Analytical data - Buzad

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 19-29 | 29-37 | 40-60 | 78-86 | 86-120 |
| Horizon | El | $ElBtw_2$ | $Btw_3$ | BC | C |
| Coarse sand, % | 0.20 | 0.25 | 0.2 | 0.2 | 0.2 |
| Fine sand, % | 50.2 | 49.75 | 47.7 | 53.4 | 63.4 |
| Silt I, % | 10.6 | 10.0 | 11.1 | 13.6 | 11.7 |
| Silt II, % | 8.5 | 5.0 | 13.4 | 10.4 | 13.7 |
| Clay, % | 30.5 | 35.0 | 27.6 | 22.2 | 11.0 |
| pH $H_2O$ | 5.35 | 5.47 | 5.80 | 6.12 | 6.45 |
| Al, me | 10.06 | 1.02 | 0.65 | 0.18 | 0.09 |
| Humus % | 1.37 | 0.90 | 0.47 | 0.42 | - |
| Huminic acids, % | 0.21 | 0.18 | 0.18 | 0.16 | - |
| Fulvic acids, % | 0.41 | 0.33 | 0.14 | 0.11 | - |
| CECs, me | 30.74 | 24.49 | 32.92 | 34.94 | 30.55 |
| BSP, % | 66.1 | 70.8 | 82.2 | 91.2 | 87.2 |

The greatest clay (<2µ) content is in the ElBtw horizon (35.0%), the lowest pH is in Elhorizon (5.35) and also the Al content (10 me/100g)

Mineralogical analysis for sandy fraction soil and parent material

In this soil profile, it can be remark the net predominance of the light minerals (<2.95 g/cm$^3$) and meagre participation of the heavy minerals (>2.95 g/cm$^3$)

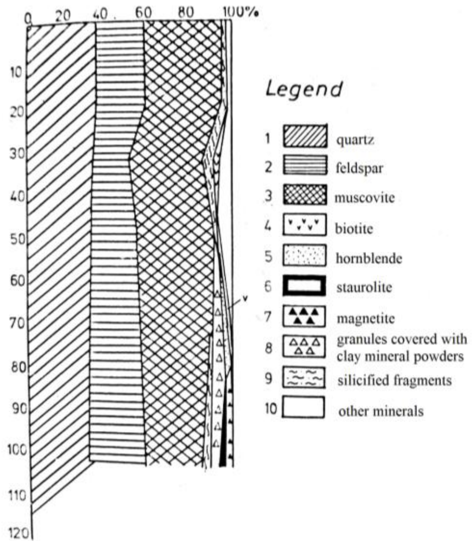


Figure 2. Mineralogical composition of Buzad soil profile

Along the soil profile, the muscovite, quartz and feldspars are dominantly and relative constant, on the decrease of 100 cm depth (table 6), where the most part of feldspars becomes due to weathering sericite.

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*Table 6*

Mineralogical composition (granule %) Buzad

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 10-29 | 29-37 | 40-60 | 78-86 | 86-120 |
| quartz | 35.15 | 33.70 | 32.34 | 29.82 | 29.84 |
| feldspars | 24.35 | 17.56 | 23.70 | 25.63 | 27.48 |
| nuscovite | 37.15 | 36.63 | 37.41 | 32.41 | 27.59 |
| biotite | - | 1.67 | - | 1.08 | 0.48 |
| garnets | 0.69 | 0.73 | 0.42 | - | 0.63 |
| hornblende | 0.57 | 0.60 | 0.35 | - | |
| epidote | - | 0.63 | 0.73 | 1.85 | 1.10 |
| tourmaline | - | 0.59 | - | - | |
| pirite | - | 0.94 | 0.54 | - | |
| magnetite | - | 0.99 | 0.57 | - | 2.59 |
| staurolite | - | 0.70 | 1.64 | - | 1.85 |
| fragments of quartz | 1.47 | 5.20 | - | - | 1.81 |
| silicifiate fragments | - | - | 0.83 | 0.93 | 2.10 |
| silicates concretions | - | - | - | 0.46 | |
| covered granules | - | - | 0.66 | 7.77 | 4.47 |

The macroscopic aspect of the quartz granules knows a suddenly modification at the depth 29 cm, where the round forme becomes an angular forme.

This means a detritical contributions, the water transported materials from the other zones.

Under the level from 29 cm depth, the transport was very rapidly and the granules remains angular and similarly are the situation with muscovite and feldspars. Also, about the 29 cm level perceives a change of the sericite and muscovite granules, respectively a quantitative decrease and that indicates a metamorphic origin (the presence of minerals like zircon, tourmaline, epidote – at the bottom of soil profile.

These granules are covered with silt and this is a sign for the provenience from a wet environment, also a warm climate.

Mineralogical analysis for clay fraction from soil and parent material

The X-ray diagrams emphasize the expandable minerals preponderantly

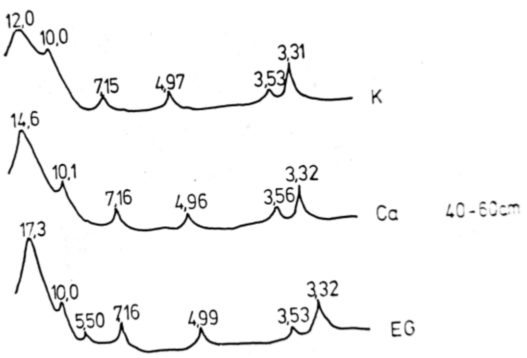


Figure 2. X-ray diagrams, Buzad

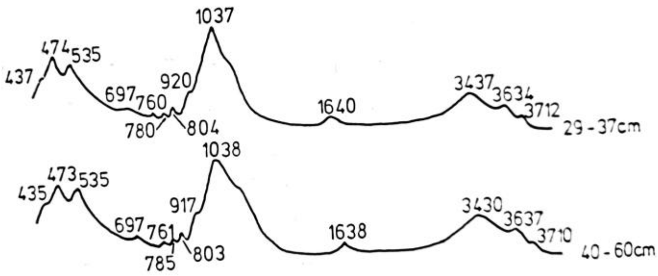


Figure 3. Infrared absorbtion spectrum, Buzad

Diffraction X-ray lines (001 and 002) reveals the presence of illite minerals. The values 7.10kx certifies the presence of kaolinite.

The basal parameters 14.6 – 15.2kx, with $Ca^{2+}$ saturation indicates expandavle minerals in the clay soil fraction.

*Table 7*

Mineralogical composition of clay fraction at Buzad soil profiles

| Horizon | Depth, cm | Expandable minerals, % | Illite % | Kaolinite % |
|---|---|---|---|---|
| Ao | 10-19 | 60 | 37 | 3 |
| El | 29-37 | 65 | 32 | 3 |
| Bt | 40-60 | 76 | 21 | 3 |

The expandable minerals re predominantly in the soil profile, with a maximum quantities in the Bt horizon (76%), as a result of the weathering during soil - forming process. The quantitative variations are the results of the parent material variations.

Degree of soil profile uniformity of Buzad

The considerations which secedes from the table 8 are the next:

*Table 8*

Degree of soil uniformity at Buzad

| | Depth, cm | | | | |
|---|---|---|---|---|---|
| | 10-29 | 29-37 | 40-60 | 78-86 | 86-120 |
| Cs | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 |
| Fs | 72.2 | 76.5 | 66 | 68.6 | 71.2 |
| S I | 15.2 | 15.4 | 15.3 | 17.7 | 13.1 |
| S II | 1.2 | 7.7 | 18.5 | 13.5 | 15.3 |
| Fs/Cs | 240 | 255 | 220 | 343 | 356 |
| Quartz | 35.15 | 23.7 | 32.34 | 29.82 | 29.84 |
| Feldspars | 23.35 | 17.56 | 23.7 | 25.63 | 27.48 |
| Q/Fs | 1.44 | 1.92 | 1.36 | 1.16 | 1.08 |
| Staurolite | - | 0.70 | 1.64 | - | 1.85 |

- the FS/CS ratio is irregular for the first 60 cm from the soil profile and constantly under 60 cm
- the quartz content is maximum in the first 29 cm and decreases under this depth
- the quartz/feldspars ratio has an evidently discontinuity in the 29-37 cm interval
- at the depth 29-37 cm appears an indec mineral, respectively staurolite

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- the quartz granules are round until 29 cm and became angular after that depth
- the expandable minerals increase quantitative under the 29-37 cm depth

All these findings impose the conclusion that the soil profile from Buzad has been formed on a bistratified parent material, and the discontinuity level is at 29 cm.

## CONCLUSIONS

Soil profile has distinct morphological, physical, chemical and mineralogical properties inherited from the environmental factors, especially from rocks and parent materials and also as a result during soil forming processes, the largest proportion is confined to the coarse fraction (diameter larger than 2µ).

A morphological, physical particle size distribution, chemical and mineralogical analyses are the condition in order to evaluating the soil profile uniformity and the soil profile development.

Soil profile from Lalasint – Albic – Stagnic Luvisols, with old sandstones, conglomerates and silicolithes as parent rocks, which have intense weathering, is strong acidifies, soil profile formula and rich in fulvic acids is Ao – Ea – Btw -C

The soil profile contents many fragments, the quartz disappears until 98 cm depth.

The aspect of quartz granules is rounded until 28 cm and becames angular under 28 cm depth.

In the first 28 cm the clay fraction contains predominantly chlorites and kaolinites, and in the Bt horizon illites and expandable minerals (smectites)

The ratio Fine Sand/Coarse Sand and Qurtz/Feldspars varies abruptly at 19 cm and 48 cm depth.

So, the Albic – stagnic Luvisols Lalasint has evaluated in a stratified soil, possible tritratification layer.

The soil profile Buzad is younger then Lalasint. The soil profile formula is Ao-El-Btw-C, rich in light and heavy minerals, like muscovite, epidote, amphiboles, pyroxene, and also in index minerals like staurolite. The discontinuity of the soil profile appears at the 29cm depth, with change the quantitative of quartz granules and the form of granules from the rounded to angular, and coveres with silt.

In the superior part of soil profile dominantly are illite and kaolinite and in the Bt horizon expandable minerals.

The most important discontinuity at Buzad soil profile is at 29 – 37 cm depth.

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