# FORMATION AND CHARACTERISATION OF SOILS INFLUENCED BY GROUNDWATER AND IMPROVEMENT MEASURES

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***Abstract**. Soil formation and evolution is subject to a large number of their properties and numerous specific processes taking place on the surface or in their depth, properties that determine the formation conditions and the characteristics of those soils. The paper presents the formation and characterization of three soil types, respectively gleyic alluvisoil, gley and white alkali in the perimeter of Sanandrei, Timis county, soils formed under the influence of groundwater, ie. soils with different properties and low natural ferility, as well as the amelioration measures that should be taken. By characterizing and describung the soils, we aim at providing an information fund on pedo-climatic resources based on the existing pedologic documentation, as well as that accumulated in time by OSPA Timisoara in order to forecast the land agrochemical potential for its capitalization and future prodiction insurance. The influence groundwater has on the soil in the Sanandrei commune were the topic of several research papers, among which we include: Oprea (1956, 1963, 1964, 1968), Ujvari (1972), Bizere (1973), Ungureanu (1976 1977, 1980, 1985). Of great importance for the soil formation process evolution in the formation of these soils are pedo-hydro-geologic conditions. The groundwater acts as a pedogenetic factor only in the areas where the hydrostatic level is located at depths less than 5 m, just like in the case of the soils in the studied area. The soils under the influence of the pedo-phreatic level are richer in organic matter, with a deeper humus-rich horizon, present a lower differentiation (a weaker leaching and dealkalization). Generally, the hydromorphy degree depends on the depth and oscillations of this pedo-phreatic level. One of the physical properties which is a limiting and representative factor in the formation of these soils, is the texture, usually fine or medium-fine. Also one of the causes of the formation of these soils is the unevenness of the land. These soils are located on flat land or in depression. Measures to improve these soils are drainage and drainage works.*

***Keywords:*** *soil, groundwater, formation, characterization, property, improvement measures*

## INTRODUCTION

The Sanandrei commune, due to its being located mostly on flat or microdepressionary land, due to groundwater flowing very close to the surface, is characterized by a dispersion of specific soils, respectively alluvisoils, gleyic soils and on smaller areas, white alkali soils, which display certain specific properties and which require improvement measures.

The communal territory is fragmented by numerous dales of different shapes and sized. Soils described in the paper occupy the low subsidence plain, which is called "the drained Bega plain", is part of the Timis Plain, and is also one of the youngest plains. In this plain, over the Pleistocene sand and gravel formations, brought by the rivers Mures and Bega, during the lacustrine stage, argils and clays were deposited, which has generated a variety of soil types.

## MATERIALS AND METHODS

The paper is based on observations obtained in the field and studies provided by OSPA Timisoara.

To establish the main physical-chemical characteristics of water and soil we used the following methods:

- Determination of the soil reaction (pH) by means of potentiometric pH-sensitive glass electrode at a ratio soil: water of 1: 2.5;
- Determination of soluble salts in the aqueous extract at a soil:water ratio of 1:5 to 1:20;
- Determination of humus - by oxidizing the soil organic matter with dichromate in sulfuric acid medium K and excess oxidizer salt dosing - Mohr method according to Schollenberger;
- Determination of alkali earth carbonates – gas-volumetric method (method Scheibler);
- Determination of the granulometric composition by treating the solution with hydrochloric acid after the Kacinscki method and separating fractions by sieving and pipetting;
- Determination of the apparent density: with metallic cylinders, the natural structure (DA);
- Determination of the soil density: the pycnometer in distilled water (D);
- Determination of the humidity content: drying in the oven at 105 ° C (EU);
- Determination of the hygroscopicity: according to the Mitscherlich method by achieving a state of equilibrium of soil humidity in the presence of a 10% sulfuric acid solution (CH);
- Determination of the equivalent humidity: a centrifugal force equal to 1,000 times the acceleration of gravity.

By calculation, we also determined: - The total porosity PT = (1 DA / D) x100 (%)

Where: DA = apparent density;

D = density (g / cm3).

- Aeration porosity PA = PT-CCxDA

Where: CC = field capacity;

- Field capacity CC = 19.2 + 0.520xCH

where: H = the hygroscopic coefficient;

- CAU useful water capacity = CC-CO

where: CO = wilting coefficient;

- wilting coefficient CO = CH x 1.5 humus tank capacity (t / ha) = ΣHUMxHxDA

where: HUM = humus content (%);

H horizon thickness (cm);

- Nitrogen index (IN) IN = (HUMxVAh) / 100

where: VAH = degree of saturation calculated hydrolytic acidity;

- Compaction degree Gt = (PTmn-PTE) / PTmn x100

Where: PTmn = minimum total porosity required is determined by the clay content of the soil;

Pte = total effective porosity.

**RESULTS AND DISCUSSIONS**

1. Fluvisoils were formed under regular repetition of the flooding process –alluviation, on sedimentary materils of proluvial, colluvial, river, sea or lacustrine type, identified in the first 50 cm of the surface. Constantly supplied by the river, supplemented by rain and side streams, the underground water is located at shallow depths (1-3 m).

In most cases, the granulometric composition of alluvisoils depends on the parent material. Any textural profile differences identified are due to crossed disordered stratifications. The main properties of alluvisoils are presented in Table 1.

*Table 1.*

Colluvial bati-mezogleyic, epicalcaric alluvisoil, on medium carbonate fluvial deposits, clayey / clayey

| ***Horizon*** | *Ap* | *AC* | *$CAg_2w_◦$* | *$CGo_4w_◦$* | *$IICGo_◦$* | *$IIICGo_◦$* | *$IVCGo_4$* |
|---|---|---|---|---|---|---|---|
| Depths *(cm)* | *0-17* | *17-30* | *30-40* | *40-62* | *62-75* | *75-86* | *86-130* |
| Coarse sand (2.0-0.2 mm)% | 2.0 | 1.1 | 1.7 | 0.2 | 1.4 | 1.8 | 0.3 |
| Fine sand (0.2 - 0.02 mm) % | 53.8 | 44.1 | 47.5 | 55.9 | 53.1 | 52.0 | 40.5 |
| Dust (0.02 - 0.002 mm) % | 15.5 | 24.1 | 22.5 | 16.8 | 16.1 | 16.6 | 24.1 |
| Clay ( < 0.002 mm) % | 28.7 | 30.7 | 28.3 | 27.1 | 29.4 | 29.6 | 35.1 |
| Texture | **LL** | **LL** | **LL** | **LL** | **LL** | **LL** | **TT** |
| DensityD g/cm$^3$ | 2.53 | 2.55 | 2.58 | 2.56 | 2.55 | 2.55 | - |
| Apparent density -DA g/cm$^3$ | 2.16 | 1.20 | 1.17 | 1.24 | 1.28 | 1.28 | - |
| Total porosity(PT%) | 50.2 | 52.9 | 54.6 | 51.5 | 49.8 | 50.2 | - |
| Aeration orosity (PA %) | 15.5 | 20.0 | 22.8 | 17.3 | 14.3 | 15.1 | - |
| Hygroscopicity Coef./ (%) | 6.3 | 6.2 | 6.1 | 6.3 | 6.4 | 6.4 | - |
| Wilting coefficient (CO%) | 9.4 | 9.3 | 9.1 | 9.5 | 9.6 | 9.1 | - |
| Field capacity (CC%) | 27.5 | 27.4 | 27.3 | 27.6 | 27.6 | 27.7 | - |
| Head. Total pt. water (C T%) | 39.8 | 44.1 | 46.7 | 41.6 | 38.9 | 39.4 | - |
| Head. Water output (CU%) | 18.1 | 18.1 | 1.82 | 18.1 | 18.1 | 18.1 | - |
| Conductive. sonar.Kmm/oră) | 5.0 | 7.0 | 8.5 | 8.0 | 4.8 | 4.8 | - |
| pH in $H_2O$ | 8.1 | 8.3 | 8.5 | 8.3 | 8.3 | 8.3 | 8.1 |
| Carbonate ($CaCO_3$ %) | 0.16 | 0.25 | 3.3 | 3.9 | 3.3 | 2.4 | 1.7 |
| Humus (%) | 2.04 | 1.48 | 0.82 | 0.62 | - | - | - |
| Phosphorus (ppm) | 3.9 | 3.2 | 3.0 | 4.1 | - | - | - |
| Mobile potassium (ppm) | 105 | 94 | 75 | 79 | - | - | - |

The structure is present only in the upper horizon. The physical, physical-chemical and hydro-physical properties vary from in the different areals, depending on the soil horizon or parental material granulometric composition with their mineralogical characteristics

Humus content in the upper horizons is 1-1.5% in the upper horizon and extremely low in the next. They contain a very low total reserve of humus (below 30 t / ha). The cation exchange capacity and alkali saturation level show low values in soils evolving in alluvia recently transported from piedmont and mountain areas with acid rocks and average and high values in the same areas, but with material originating from alkali rock alteration.

2. Gleyic soils are heavily affected by pedophreatic water, reduction processes being already visible on the surface through marbled colors of predominantly neutral shades.

In the superior gleyic soils, large or small quantities of organic matter in various humification stages are accumulated. Depending on the humus percentage, material nature soil formation processes maturity, gleyic soils are differentiated on a subtype level, as one can observe from the data presented in table 2.

*Table 2.*

Vertic gleysol on very fine noncalcareous coluvial materials, argillaceous-clayey / argillaceous-clayey

| *Horizons* | Aţel | AoGo | AoGo | $ACGr_5$ | $CGr_3$ | $CGr_6$ | $CGr_6$ |
|---|---|---|---|---|---|---|---|
| Depths *(cm)* | *0-9* | *9-19* | *19-31* | *31-54* | *54-69* | *69-100* | *100-150* |
| Coarse sand (2.0-0.2 mm)% | 3.5 | 3.4 | 4.2 | 2.8 | 3.4 | 3.3 | 3.8 |
| Fine sand (0.2 - 0.02 mm) % | 22.8 | 23.3 | 19.0 | 22.6 | 17.2 | 278.4 | 28.1 |
| Dust (0.02 - 0.002 mm) % | 28.5 | 27.7 | 33.8 | 27.9 | 30.2 | 22.5 | 24.9 |
| Clay ( < 0.002 mm) % | 45.2 | 46.6 | 43.0 | 46.7 | 49.2 | 45.8 | 43.2 |
| Texture | AL | AL | AL | AL | AL | AL | AL |
| DensityD $g/cm^3$ | - | 2.65 | 2.61 | 2.60 | 2.61 | - | - |
| Apparent density -DA $g/cm^3$ | - | 1.36 | 1.42 | 1.38 | 1.38 | - | - |
| Total porosity(PT%) | - | 49 | 46 | 47 | 48 | - | - |
| Eration orosity (PA %) | - | -13.1 | -15.1 | -14.8 | -20.7 | - | - |
| The degree of compaction (%) | - | 7.4 | 10.7 | 8.7 | 9.0 | - | - |
| Hygroscopicity Coef. (CH%) | - | 9.9 | 9.4 | 9.9 | 10.9 | - | - |
| Wilting coefficient (CO%) | - | 14.8 | 14.1 | 14.8 | 16.3 | - | - |
| Field capacityCC%) | - | 45.4 | 43.3 | 45.5 | 49.7 | - | - |
| Hydraulic conductivity (K mm/oră) | - | 0.5 | 0.3 | 0.3 | 0.2 | - | - |
| pH in $H_2O$ | 6.6 | 6.8 | 6.9 | 7.2 | 7.2 | 7.2 | 7.1 |
| Carbonate ($CaCO_3$ %) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Humus (%) | 2.91 | 2.95 | 2.35 | 1.55 | - | - | - |
| Total nitrogen ( (%) | 0.163 | 0.134 | 0.119 | 0.090 | - | - | - |
| Phosphorus (ppm) | 13.6 | 18.3 | 7.2 | 4.2 | - | - | - |
| Mobile potassium (ppm) | 82 | 73 | 70 | 68 | - | - | - |
| Instead bases (SB me la 100 g sol) | 27.76 | 27.96 | 25.60 | - | - | - | - |
| Exchangeable hydrogen (SH me/100 g) | 2.80 | 2.47 | 1.78 | - | - | - | - |
| Head. cation exchange (T me/100 g) | 30.56 | 30.43 | 27.38 | - | - | - | - |
| Degree of alkalic saturation (V%) | 90.83 | 91.88 | 93.49 | - | - | - | - |

Vertic gleyic soils have medium fine and fine granulometric compositions, poor physical and hydro-physical, but favorable chemical properties, large humus and nutrients reserves, high degree alkali saturation and high cation exchange capacity (Table). At the surface of these soils, especially on land occupied by pastures and hayfields, frequent unevenness (hollows) caused by constriction and swelling processes (gilgai relief), unevenness subsequently accentuated by grazing under high humidity conditions.

3. White alkali. The parental material it formed on is of alluvional nature. The vegetation characteristic of this type of soil is represented by the species Festuca pseudovina, Static Gmelin, Hordeum histix, Puccinelia distans. Groundwater is found at a depth of approx. 1.5-2.0 m, and it is currently used as natural pastures.

Physical and chemical properties of this soil type are displayed in Table 3.

Coarse sand varies between 0.40% in the B / C horizon and 3.69% in $Btna_1$ horizon.

Fine sand values range between 11.55% in the C2 horizon and 24.98% in the Gr horizon.

Dust values vary between 31.91% in the $Btna_2$ horizon and 48.84% in the Gr horizon.

Argil is located between 26.87% in the Gr horizon and and 52.76% in the $Btna_2$ horizon.

The apparent density values range from 1.37 $g/cm^3$ in the Ap horizon, where it is low, and 1.67 $g/cm^3$ in the $Btna_3$ horizon, where it is very high.

The total porosity varies between 38% in the $Btna_3$ horizon, very low, and 49% in the Ap horizon, very high.

Aeration porosity values are between 5% in the $Btna_2$ horizon, which is extremely low, and 15% in the Ap horizon, where it is low.

Field capacity values range from 16.5% in the B/C horizon, which is low, and 25.0% in the Ap horizon which represents a medium value.

Useful water capacity values vary between 3.1% in the B/C horizon, very small, and 15.1% in the Ap horizon, which is high.

Wilting coefficient values are between 1.4% for the $C_1$Go horizon, very low value, and 13.4% in the B/C horizon, a high value.

Soil reaction is slightly alkaline in the $C_1$Go horizon with pH values of 8.2, to very strongly alkaline in the Btna1 horizon with pH values of 9.5.

The humus percentage decreases from an average 3.1% in the Ap horizon to horizon Btna to a very low 1.67%.

The calcium carbonate content increases with depth from a medium 10% value in the $Btna_3$ horizon to a very high 27.98% in the $C_1$Go horizon.

The alkali sum ranges between the low value of 15.09 g m.e.100 completely dry soil in the Ap horizon and a high 32.68 g m.e.100 completely dry soil in the $Btna_2$ horizon.

The total cation exchange capacity values range between a low 15.20 g m.e./100 completely dry soil in the Gr horizon and a high 32.68 g m.e./100 completely dry soil in the Btna2 horizon.

The degree of alkali saturation value is 100%, the soil being considered alkaline.

*Table 3.*

Chemical and physical properties of white alkali soils

| Horizon | Ap | $Btna_1$ | $Btna_2$ | $Btna_3$ | B/C | $C_1$Go | $C_2$Gr | Gr |
|---|---|---|---|---|---|---|---|---|
| Depths *(cm)* | 0-2 | -14 | -38 | -61 | -75 | -100 | -150 | 150- |
| Coarse sand (2.0-0.2 mm)% | 2.8 | 3.69 | 1.03 | 0.55 | 0.40 | 0.80 | 0.74 | 2.48 |
| Fine sand (0.2 - 0.02 mm) % | 24.98 | 21.56 | 20.83 | 14.76 | 18.64 | 23.8 | 11.55 | 21.81 |
| Dust (0.02 - 0.002 mm) % | 38.24 | 37.84 | 31.91 | 37.8 | 37.0 | 35.36 | 47.84 | 48.84 |
| Clay ( < 0.002 mm) % | 33.98 | 36.91 | 52.76 | 47.29 | 43.96 | 40.04 | 39.90 | 26.87 |
| Texture | TP | TP | AL | AP | TP | TP | TP | LP |
| Aparent density -DA g/$cm^3$ | 1.37 | 1.60 | 1.63 | 1.67 | 1.64 | 1.62 | 1.57 | 1.50 |
| Total porosity(PT%) | 49.0 | 40.0 | 39.0 | 38 | 39 | 40 | 42 | 44 |
| Aeration orosity (PA %) | 15.0 | 8 | 5 | 9 | 12 | 9 | 9 | 10 |
| Higr coefficient (%) | 6.6 | 7.0 | 7.2 | 8.0 | 8.9 | 7.6 | 7.7 | 8.0 |
| Field capacity (%) | 25.0 | 20.1 | 21.1 | 17.1 | 16.5 | 20.1 | 21.1 | 22.7 |
| Useful water capacity (%) | 15.1 | 9.6 | 10.3 | 5.1 | 3.1 | 8.7 | 9.5 | 10.7 |
| Wilting coefficient (%) | 9.9 | 10.5 | 10.8 | 12.0 | 13.4 | 1.4 | 11.6 | 12.0 |
| pH in $H_2O$ | 8.5 | 9.5 | 9.3 | 8.8 | 8.8 | 8.2 | 8.4 | 8.2 |
| Humus (%) | 3.1 | 2.34 | 1.84 | 1.67 | | | | |
| $CaCO_3$ | | | | 10.00 | 11.8 | 27.98 | 22.00 | 23.4 |
| Degree of alkali saturation (V%) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Cl me/100 g sol | 0.62 | 0.68 | 0.76 | 0.68 | 0.76 | 0.65 | 0.48 | 0.38 |
| $SO_4$ me/100 g sol | 1.23 | 1.04 | 2.06 | 3.35 | 0.80 | 1.04 | 0.98 | 0.62 |
| $HCO_3$ me/100 g sol | 0.44 | 0.28 | 2.41 | 4.52 | 4.33 | 3.64 | 3.15 | 3.00 |
| $Ca^{2+}$ me/100 g sol | 0.50 | 0.50 | 0.50 | 0.60 | 0.50 | 0.60 | 0.60 | 0.60 |
| $Mg^{2+}$ me/100 g sol | 0.49 | 0.49 | 0.49 | 0.49 | 0.90 | 0.66 | 0.49 | 0.66 |
| $Na^+$ me/100 g sol | 0.05 | 0.30 | 0.44 | 0.31 | 0.41 | 0.15 | 0.02 | 0.02 |
| $K^+$ me/100 g sol | 0.99 | 0.99 | 0.99 | 1.09 | 1.40 | 1.26 | 1.09 | 1.26 |

The main measures to improve the soil are:

1. The unevenness of the field - indirect cause of excess humidity; activities necessary for shaping and / or levelling. Levelling farmland helps optimizing the distribution of rainwater

into the soil, creating a favorable ratio of air and water circulation into the soil, prevents excess humidity on depression land or soil erosion on slopes. Mainly, agricultural land levelling interventions fall under land improvement works. However, in less severe cases, farmers can interfere with their own means to achieve a certain rainwater reception and distribution environment in such a way as to prevent prolonged stagnation of rainwater. It is mandatory that the shaping-levelling works avoid the removal of the fertile soil sequence of the soil subjected to improvement. In special cases, stripping, storage and relocation are recommended.

2. Excess groundwater humidity can be permanent, generated by superficially positioned pedophreatic networks, with temporary (seasonal) or constant discharge, especially during spring and early summer, when the water level is abundantly supplied through precipitations, flowing on river units or from underground sources.

Removing excess moisture in the soil can be achieved by setting up a drainage network, ie. a series of channels and auxiliary works aimed at removing excess water from the soil surface or the soil so as to achieve a water and air regime favorable for the development of agricultural plants. The removal of excess water stagnating at the soil surface is carried out by opening channels of varying depths, at well organized intervals and directions.

In-depth drainage works are recommended for lowlands, meadows or some erosion valleys affected by excess humidity supplied by the superficially positioned pedophreatic networks. It is necessary to open channels that should intersect the groundwater level and lead excess water towards natural collectors.

## CONCLUSIONS

The paper presents a characterization of three soil types, namely: gleyic alluviosoil, gleyic and white  alkali soilse formed under the influence of groundwater, soils located within the Sanandrei commune.

In order to improve these soils, it is necessary to take various measures that will improve key attributes and factors that led to their formation so that, after taking these measures, we can talk not only about an improvement, but also about their utility. For the gleyic soil, improvement works are needed to regulate watercourses and drainage is necessary for decreasing and maintaining control of the groundwater. Associated pedoameliorative works improve the aerohydric regime and organic and chemical fertilizing works are carried out periodically.

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