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Agrogeological and mineralogical characteristics of the soil from experimental fields of the Institute of Agriculture-Kyustendil, Bulgaria

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Abstract

Four main and two secondary feeding provinces with minerals and soil forming material are determined: Bistritsa River feeding province, Struma River feeding province, Struma Diorite Formation feeding province and Neogene Conglomerate Sandstone feeding province.

Montmorillonite from the clay minerals, quartz, magnetite, and chlorite shales are determined as the most important agricultural minerals for the studied soils. Quartz has property of creating electrical energy under the influence of external factors such as pressure, shock, heat, friction, chemical reactions, etc. make it a prime suspect as a source of energy and electrical impulses in soil, which are very important for cation exchange between soil and plant roots and for converting some substances into others, incl. of inorganic chemical compounds in organic. Quartz determines the basic granular composition of the soil and determines the moisture absorption, plasticity, moisture performance, etc. It helps maintain constant temperature and acidity of the soils. Magnetite associates with carbonates and quartz and by this way marks secondary mineralization due to adsorption processes in the soil and speaks of the participation of magnetite in cation exchange processes in the soil. The mineral magnetite is also related to the microbial composition of the soil. Chlorite shale as well as Montmorillonite can, under certain conditions, release chlorine and thus, together with the released sodium described above, NaCl salt is formed, which is the mineral halite or otherwise table salt, which salinized the soil and leads to damage to agricultural production, worsens the quality and storage life of the fruit and finally leads to the death of the plants and economic loses. In these cases it is needed to use gypsum agricultural mineral fertilizer for neutralization of the salt and its drainage.

Key words: agrogeology, minerals, feeding, soil, fertility, agriculture

Introduction

Location

The Institute of Agriculture and its experimental fields are located 3 km North-eastern from the town of Kyustendil. Town of Kyustendil is located in South-West Bulgaria, situated in the valley with the same name, on both banks of the Banshtitsa River and at the foot of the hill “Hisarlaka”, which is the Northeastern hill of the mountain “Osogovo” (fig. 1). The town is located in the central part of the Balkan Peninsula on the border between Bulgaria, Serbia and North Macedonia. Its altitude is 512 m. The climate of the town of Kyustendil is transitional continental to Mediterranean. Rainfall in Kyustendil is not heavy. Their average annual amount is about to 589 mm. There is a tendency to alternate dry with wet years or periods. By seasons they are distributed fairly evenly. Snowfall is usually from November to March, with snow cover up to 30 cm thick and lasting for up to 15 days. However, the water wealth of Kyustendil and its surroundings is not small. There are many rivers, springs, dams, mineral and ground waters Ivanchev (1996). The largest river in the region is the Struma River as Bistritsa River is the biggest tributary of Struma River on the territory of the municipality of Kyustendil. The Bistritsa River is one possible source for irrigation of the experimental fields of the Institute of Agriculture, town Kyustendil (Sotirov, 2023). It is 51 km long and borders directly to the studied experimental fields. It rises at 2182 m above sea level in Osogovo Mountain, northeast of Mount Ruen. Bistritsa flows on the right into the Struma River at 462 m above sea level, southwest of the village of Konyavo (BAS, 1988).

Soils

At the vicinity of the valley of Kyustendil can be indicated four main soil types – Arenic Fluvisols, Haplic Chernozems-Vertisols, Chromic Luvisols, and Cambisols World reference base for soil resources (Teoharov et al., 2009). All of them are distributed only in the form of small spots in the Northwestern part of the Kyustendil valley. Cambisols covers the belt from 800 m to 1900 m above sea level, and Chromic Luvisols occupy the peripheral parts of the valley and slopes up to 800 m altitude. The most common are the Arenic Fluvisols, which occupy the bottom of the Kyustendil valley and the floodplain and overflow terraces of the rivers – Struma, Dragovishtitsa, Bistritsa and Banshtitsa (Ivanchev, 1996).

The soil on the territory of the experimental fields of the Institute of Agriculture in Kyustendil is defined as leached Chromic Luvisols (FAO-ISRIC-IUSS, 2006), as the soil pH varies from 5.0 to a depth of 0-10 cm and reaches 5.4 at a depth of 100 cm, and the humus is 0.98% at the surface and decreases to 0.40 at 100 cm, according to Zdravkova (2012). In the experimental field are grown mainly different varieties of apples, cherries and plums, which are typical for Kyustendil valley. Fewer areas are planted with other species such as pears, quinces, sour cherries, grapes and vegetables – cabbage, carrots, cauliflower and broccoli.

Geology

The main drainage artery of the region is the Struma River with two main right tributaries Dragovishtitsa River and Bistritsa River and their inflows.

The geological structure of the area is complex due to its diverse stratigraphy and intensive multiple deformation. A wide range of igneous, sedimentary and metamorphous rocks with Late Proterozoic, Paleozoic, Triassic, Jurassic-Early Cretaceous, Paleogene and Neogene-Quaternary ages are revealed in the area. The area has been known since ancient times as rich in indigenous and scattered deposits of gold (around the villages of Sovolyano, Dragovishtitsa, Skrino, Zlogosh). A primary gold deposition is exploited around the village of Gorno Uyno. Of interest are also the Tertiary sediments, which have been the subject of prospecting and exploration for coal, such as were established and exploited in the Nikolychevtsi mine, immediately around of the studied area. Practical are also the building materials – the Paleogene clays at Dragovishtitsa, the quarries for crushed stone in the Triassic carbonate sediments at Zemen, Garbino, Zlogosh, the quartz sands in the Quaternary alluvial sediments, etc. The area is characterized by a dissected relief, the result of intense neo-tectonic movements. This fact should be kept in mind, despite the low according to statistical data degree of seismic activity. Steep rock slopes pose a potential danger for the development of collapse processes (Zagorchev, 1993).

Neo-Proterozoic rocks. River Dragovishtitsa passes through the Lisetsky diorites. Their age is Neo-Proterozoic and they are part of the Lisetsky orthometamorphic complex (fig. 2 and 3). They are dark green in colour, strong and heavy, medium-grained rocks. Their texture is massive and coarse-skinned. Their mineral composition includes relic plagioclase, quartz, epidote, cyosite, chlorite, biotite, muscovite, calcite and accessory minerals – apatite, scheelite (?), ore minerals. The metamorphic change is less pronounced.

Quaternary overlays. In the area of the Kyustendil valley to its confluence with the Struma River, the valley rivers pass mainly through Quaternary deposits, as there it emerges from the mountainous relief around and enters a flat downslope of the Struma River in the Kyustendil valley. Quaternary overlays have considerable diversity, attached to certain morphological forms. They are localized around the valley of the Struma River and its tributaries, as well as at the foot of the mountains. They are lying on Neogene, Paleogene and before Paleogene rocks. With the widest development are alluvial overlays.

Alluvial deposits are attached to the rived beds, floodplain and overflow terraces of the Struma River and its tributaries. They are distinguished by a large degree of transport processing. The pieces are of limestone, sandstone, quartz, quartzites, diorites, gneisses, lydites, shales, granites.

Pleistocene alluvial deposits were found on the left valley slopes of the Struma and Dragovishtitsa rivers as well as in the valley of the Uinestitsa River. They are represented by clayey, medium- to coarse-grained sands and gravels of diverse size and smoothness. They have polymict composition and small areas and thicknesses.

In tectonic terms, the area falls entirely within the Kraishtidi tectonic zone. The most significant tectonic event that forms the fold-and-water process of the region is related to the Austrian phase, the early Aplian (Austrian) structural plan. Large fragments of the Struma and Moravian units of the Kraishtidi zone also fall into the area.

There are landslides west of the village of Dolno Uino, in the right bank of the Dragovishtitsa River a deep, conditionally stabilized landslide has been found, developed in the metamorphites of the Liska Complex (Zagorchev, 1993). There was a great flood on July 9, 1940, on March 7, 1962 near the village of Goranovtsi.

According to the Water Framework Directive (WFD) (Directive 2000/60/EU of the European Parliament And The Council, 2000), the studied region falls in Ecoregion 7, covering East Balkans, including Southern Bulgaria, parts of Northern Greece, the European part of Turkey, FYROM and Serbia, including rivers Maritsa, Mesta and Struma (Cheshmedzhiev & Marinov, 2008).

Tectonic conditions

Zagorchev (1993), when examining the prealpine construction in Southwestern Bulgaria and the role of the water tectonics in the alpine construction of the Kraishtids, separated and introduced two structural units or zones: western – Penkyov-Eleshnishka, called Moravikum and eastern–Tran-Vlahinska, called Strumicum. The author's research is an indisputable contribution to the hypotheses for the pre-alpine and alpine development of the Kraishtids and in particular the Kyustendil valley and its fence frame.

Most important role in the formation of the Kyustendil valley and its fence frame was played by the late alpine and neo-tectonics activity. In the area, these tectonics are manifested by fault-block character, developing mainly the faults with north-northwest – south-southeast direction of the Struma (Kraishtide) system, as well as some west-eastern and west-southwest – east-northeast faults from the Kyustendil fault zone, according to Zagorchev & Ruseva (1991) and Berov (2018).

Hydrogeology

According to the Hydrogeological Zoning of Bulgaria, the northern sections of the studied region fall within the Kraishte Region. The region

Fig. 1. Location of the studied area

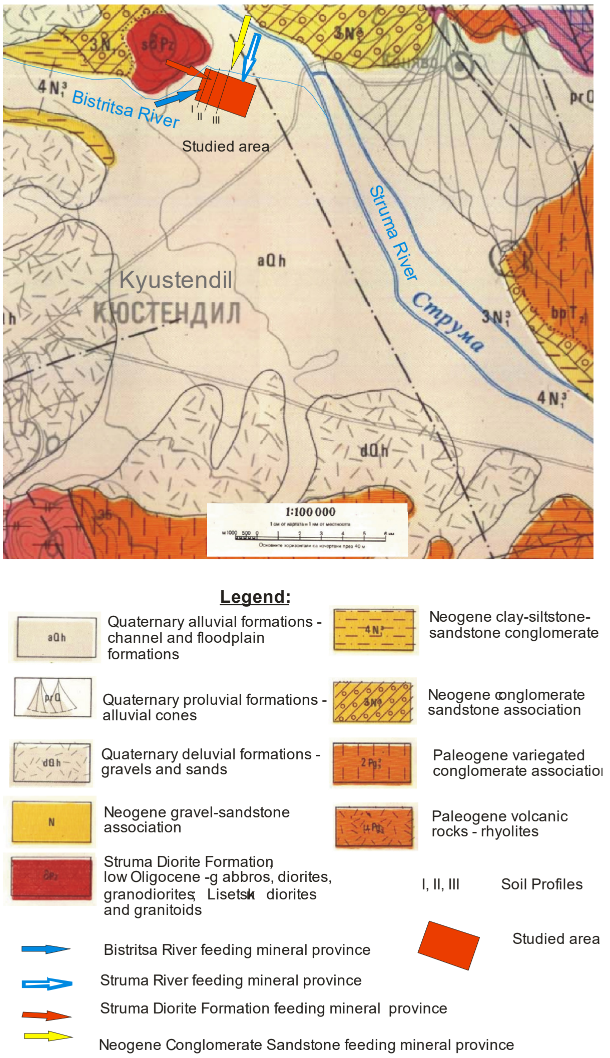

Fig. 2. Geological map of Kyustendil valley and studied area (Zagorchev & Ruseva, 1991), M1:100000

of Kraishte can be characterized as highly water-intensive, but it is poorly studied in hydrogeological terms. The groundwater supply is mainly from rainfall and, in some low parts, from the river network. In the high parts are formed cracked – karst waters, which are mostly non-pressure in nature. It is possible that a large part of the underground flow is drained hidden in the Struma River. The complex tectonic and colourful geological structure have created very specific hydrogeological conditions. The area of the Kyustendil valley and its fence mountains is diverse and different types of water are formed in their genesis, depth of bed, dynamics and chemical composition. According to the West Aegean River Basin Directorate, the research area reveals waters, which are divided into 4 underground water bodies. The waters that are formed in the study area are divided as follows: pore waters, karstic and karst-cracked waters and cracked waters – with deep circulation and shallow circulation (Berov, 2018).

Cracked waters – they are found in many places and occupy the largest area in the studied terrain. They can be divided into two types - cold and thermal. In the experimental fields of the Institute of Agriculture - Kyustendil circulate cold cracked waters – these are waters with shallow circulation, mainly in the zone of natural cracking, developed along not deep cracks. Feeding is at the expense of rainfall and snowmelt, as the

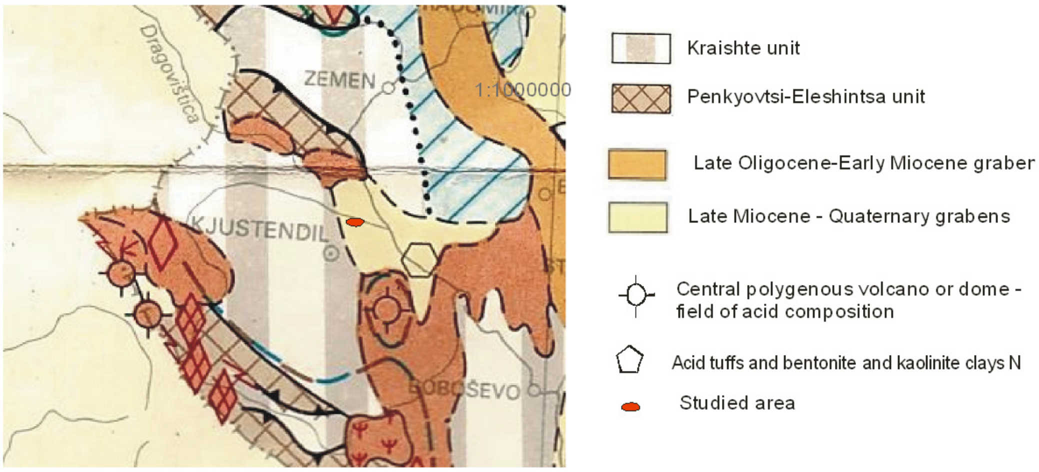

Fig. 3. Map of the alpine Magmatism at the studied area (Dabovski et al., 1989), M1:1000000

waters are drained mainly by descending springs with a small flow rate. Lithological are attached mainly to gneisses, amphibolite and granite of Paleozoic age. In the eastern sections in the study area, this type of water is also found in Paleogene sediments, mainly sandstones and tuffs. According to „Vodokanalproekt" Ltd., for the chemical composition of 39 water samples, the waters are defined as hydrocarbonate-calcium and less often as hydrocarbonate-magnesium. The total mineralization of the waters varies from 0.2 to 0.8 mg/l. The temperature of the waters is about 12–18° C.

The waters from the river Bistritsa River, Drenov dol Reservoir and Industrial Drillhole, intended for irrigation of the experimental agricultural fields of Institute of Agriculture, Kyustendil, Bulgaria were determined as Very good - Blue, according to classification of Cheshmedzhiev & Marinov (2008). All three types of waters actually are the same water of the Bistritsa River, type P3-Mountain. The waters correspond to the type of soils low-acid and they are appropriate for irrigation of the existed cultivated plants apple, cherry and plum trees as also some other fruit and vegetable plant (Sotirov, 2023).

Materials and methods

Mineral study was done in laboratory as the measurements were done by using binocular reflective microscope Carl Zeiss Jena and a digital microscope with a computer program Micro Viewer ver. 2.2.d. with reflective white light.

The uppermost soil horizon for ploughing with depth up to 70 cm was sampled in 3 profiles (fig. 2). A total of 49 samples were analyzed in 3 profiles. They were analyzed, according to the methods, described by Swanson (1998). Between 50 and 100 points in each sample were counted on a Zeiss Jena binocular microscope using reflected white light under 50x/0.85 and 100x/0.25 objectives. The used method is described by Taylor et al. (1998). Reference data was used for some of the mineral content, determined by Debye-Scherer X-ray Method of the studied area presented by Sotirov (2004) and Vitov & Sotirov (2014). Mineral sizes were determined using a microscopic scale.

Results and discussion

The soil on the territory of the experimental fields of the Institute of Agriculture in Kyustendil is defined as leached Cinnamon Forest (Chromic Luvisols) (FAO-ISRIC-IUSS, 2006), with soil pH ranging from 5.0 to a depth of 0-10 cm and reaching 5.4 at a depth of 100 cm, and humus is 0.98% at the surface and decreases to 0.40 to 100 cm, according to Zdravkova (2012). Experimental field consists of agricultural areas about 300 acres where are grown mainly different varieties of apples, cherries and plums, which are typical for Kyustendil valley. Fewer areas are planted with other species such as pears, quinces, sour cherries, grapes and vegetables – cabbage, carrots, cauliflower and broccoli. Apples and pears develop best in a weakly acidic to neutral soil reaction, while cherry and cherry on a rootstock tolerate acidic soils, although they prefer an alkaline reaction. The soil is poor in humus, so the fruit trees rely on good soil structure and drainage properties, and also on the mineral composition as an adsorbent. Soils are defined as weak- to medium-acidic soils, by Zdravkova (2012).

Krumov (2014) presents data for the mechanical analysis of the soil and defines it as highly leached, medium sandy-loam (about 40.6% content of physical clay), weak to medium stony (10-11% content of stones and gravel in the surface soil layer) cinnamon forest soil (Chromic Luvisols).

For comparison, the soil in the study areas contained 27.0% physical clay. On horizons, the mechanical composition shows that the soil in the 0-80 cm layer is medium sandy-loam, and in the 80-100 cm layer it is heavy sandy loam (table 1), but the clay content is approximately the same. The content of fraction il is lowest in the 0-40 cm horizon, then increases. The soil layer 80-120 cm is characterized by the highest clay and il content and the highest on mechanical fraction above 1 mm Krumov, (2014).

Percentage of the hygroscopic humidity is lowest for the 0-20 cm layer (1.69 and 1.85%), increasing gradually to the layer 100-120 cm to 2.62 cm in the 1st profile and up to 3.05% in the 60-80 cm horizon in the 2nd profile. The hygroscopic humidity rises gradually in the layers below the active soil layer due to the relatively high content of fractions with water retention capacity.

The bulk density is high in the two surface layers, decreasing with increasing depth of the active soil volume from 1.90 to 1.55 g/cm^3. The relative density of the soil varies from 2.52 to 2.71 g/cm^3. The total porosity of the soil profile is low, compared to the optimal 55-65%. The porosity is lowest in the most compacted surface layer 0-10 cm, reaching a value of 25.20% (table 2).

The soil response at both profiles is slightly acidic to neutral, being within the range of 5.4 to 6.1 pH for different soil layers (table 3)

The humus content is highest in the 0-20 cm (1.52-1.48) layer, with increasing depth of the profiles a decrease is observed. In the 80-120 cm layer the humic content ranged from 1.1% to 0.96%.

The content of absorbable nitrogen in the soil is weak. The largest amount is in the 0-20 cm and 20-40 cm layers from 23.91 to 37.58 mg/1000 g, and the smallest in the 8-120 cm layer, between 14.52 and 25.62 ng/1000 g soil.

The stocking of the soil with phosphorus in the 0-20 cm layer is average, and at other depths weak. The greatest amount of phosphorus in both profiles is contained in the soil layer 0-20 cm (4.1-5.3 ng/100 g), lowering for the layer 80-120 cm approximately twice (1.8-2.1 mg/100 g).

The potassium content of both profiles is the highest in the 0-20 cm layer (18-20 mg/100 g) and the smallest in the layer 100-120 cm (11-13 mg/100 g) (Krumov, 2014; Krumov & Hristov, 2011; Hristov & Krumov, 2015).

Data from (Teoharov et al., 2009) given in tables 4 to 6 were used for comparison (control).

The studied soils can hardly be divided into horizons due to the fact that almost 100 years are part of the experimental fields of the Institute of Agriculture - Kyustendil, and before that they were part of nurseries and agricultural lands. For centuries, this soil has been processed, leveled and cleaned of stones, thorns, roots and others to be easier to process. The following mechanized land treatments are applied: tillage, milling, dismantling, and cultivation. So there is only one horizon, which we can call the ploughing horizon and it is usually processed to a depth of 40 cm in deep plowing and up to 70 cm in dignitary for new plantations. The area is about 300 acres of agricultural experimental fields with fruit trees and fewer vineyards and vegetable gardens, divided into 21 plots. Soil formation continues at the moment, which can be seen everywhere by the powdery decay of rock fragments, mainly of shale. There are also coalificated plant remains,

Table 1. Mechanical composition of the soils in the experimental field, % (Krumov, 2014)

Depth, cm	Hygro-scopic moisture	Sum >1	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	Sum <0.01
					Profile 1				
0-20	1.69	0.0	20.3	21.4	21.3	16.2	3.2	37.00	37.0
20-40	1.79	1.2	20.3	18.6	23.8	11.7	7.9	36.20	36.2
40-60	2.55	3.5	28.5	11.6	17.9	7.7	5.3	38.50	38.5
60-80	2.22	1.2	33.0	14.2	16.0	7.5	4.5	35.60	35.6
80-100	2.55	0.0	16.1	8.8	22.0	17.1	7.2	53.10	53.1
100-120	2.62	4.1	21.3	13.3	18.1	7.2	4.5	43.20	43.2
					Profile 2				
0-20	1.85	0.0	16.3	21.9	22.2	9.5	8.2	39.60	39.6
20-40	1.87	0.0	16.8	21.6	22.4	8.7	8.7	39.20	39.2
40-60	2.55	0.0	15.7	17.1	23.1	10.2	5.9	44.10	44.1
60-80	3.05	0.6	16.2	17.8	17.9	8.6	6.7	47.50	47.5
80-100	2.77	0.6	18.6	18.5	16.4	10.9	5.1	45.90	45.9
100-120	2.83	1.6	21.2	16.6	17.6	6.9	5.6	43.00	43.0

Table 2. Physical properties of the soil in the experimental fields (Krumov, 2014)

Depth, cm	Vol. density, g/cm	Rel. density, g/cm^3	Total porosity, %
0-10	1.90	2.54	25.20
10-20	1.79	2.71	33.95
20-30	1.67	2.75	39.27
30-40	1.59	2.52	36.90
40-50	1.59	2.54	37.40
50-60	1.55	2.67	41.95
60-70	1.67	2.63	36.50
70-80	1.55	2.61	40.61
80-90	1.58	2.53	37.55
90-100	1.53	2.52	39.29
0-60	1.68	2.62	35.78
0-100	1.64	2.60	36.82

Table 5. General chemical properties of an average profile of leached Chromic Luvisols (Teoharov et al., 2009)

General chemical properties	Humus, %	Total Nitrogen N, %	C:N	$CaCO_3$	pH (H_2O)	pH (KCl)
Average,%	0.90	0.99	7.25	12.76	5.83	2.98

Table 3. Chemical characteristics of the soils in the experimental field, % (Krumov, 2014)

Depth, cm	pH/KCl	N, mg 1000 g	P_2O_5 mg/100 g	K_2O, mg 100 g	Humus, %
			Profile 1		
0-20	6.1	35.87	4.1	20	1.52
20-40	6.1	37.58	3.0	15	1.48
40-60	6.0	30.74	2.6	11	1.45
60-80	5.8	27.32	2.2	8	1.37
80-100	5.8	25.62	2.1	15	1.10
100-120	5.5	14.52	1.8	11	0.96
			Profile 2		
0-20	5.7	34.16	5.3	18	1.48
20-40	5.6	23.91	3.1	13	1.37
40-60	5.5	25.62	3.0	14	1.45
60-80	5.7	20.50	3.4	14	1.22
80-100	5.8	22.20	2.1	13	1.11
100-120	5.4	17.08	2.0	13	1.04

Table 4. Mechanical composition of an average profile of leached Chromic Luvisols (Teoharov et al., 2009)

Grain size	>1	1.00-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Average,%	1.94	16.53	14.92	9.89	5.18	5.26	30.67	41.48

Table 6. Physico-chemical properties of an average profile of leached Chromic Luvisols (Teoharov et al., 2009)

Physico-chemical properties	$T_{8,2}$ meq/100t soil	$H_{8,2}$ meq/100t soil	Al meq/100t soil	Ca meq/100t soil	Mg meq/100t soil	$H_{8,2\,\%}$ of $T_{8,2}$	Al	Ca	Mg	Degree of base saturation, V (%)
Average,%	29.70	2.50	0.00	21.90	7.6	7.1	0	65.6	14.5	77.7

Table 7. Average mechanical composition (microscopically determined) of the soils in the experimental field, Vol. %

Depth, cm	>2 mm	1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.005 mm
0-70 cm, summarized sample, %	1.0	18.2	20.1	18.6	21.3	4.6	16.2

Table 8. Mineral composition of the investigated soils by fraction >2<0.05 mm

Fraction	Mineral composition	Roundness	Sphericity	Surface
>2 mm-<0.05 mm	Quartz – Q; Magnetite -Mt, Calcite – Cc; Gneisses – G; Feldspar – Fs; Muscovite – Ms; Biotite – Bi, limestone, feldspar, limonite, hematite, calcite, apatite, olivine, gneiss (with muscovite, biotite and pyrite) and Cl-slate lithites	0.1; 9.3; 0.5; 0.7 very angular, semi-angular, angular – to semi-rounded	0.3; 0.5; 0.7; 0.9 from high-to low	hatching, dullness, clarity, scraps, strokes

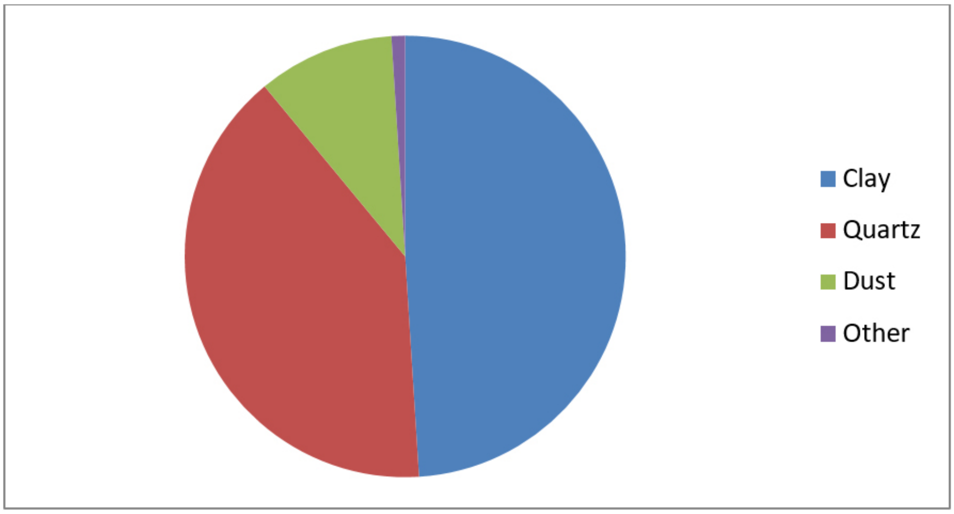

Fig. 4. Profile of the soil composition

which are of two types – mostly humodurain-dull, and humoclaren-bright. Humovitren, lipten and xylene were not observed. This shows the good sealing capacity of clays and the complete lack of oxygen, as well as an increase in soil temperature primarily by chemical processes. The organic macrolithotype fuzen, resulting from natural fires or human fire, is also not observed. Stone pieces around and above 10 cm collected by humans are localized on certain spots. They are mostly quartz and less often chlorite slates and gneisses from the surrounding rocks. Soil formation also involves small amounts of mollusc shells, especially from the common garden snail Helix pomatia.

The soil is poor in humus and is composed for the most part of clay minerals of cinnamon colour (fig. 4) (tables 7 and 8), defined macroscopically as montmorillonite, due to its peculiarity of touching to resemble soap, i.e. smectite group. It is not very plastic, it has a granular appearance of larger or smaller granules, due to the fact that the soil has a high content of minerals, mainly quartz in all its varieties from water clear, crystal clear to yellow, red, green, black, gray, milky white, etc.

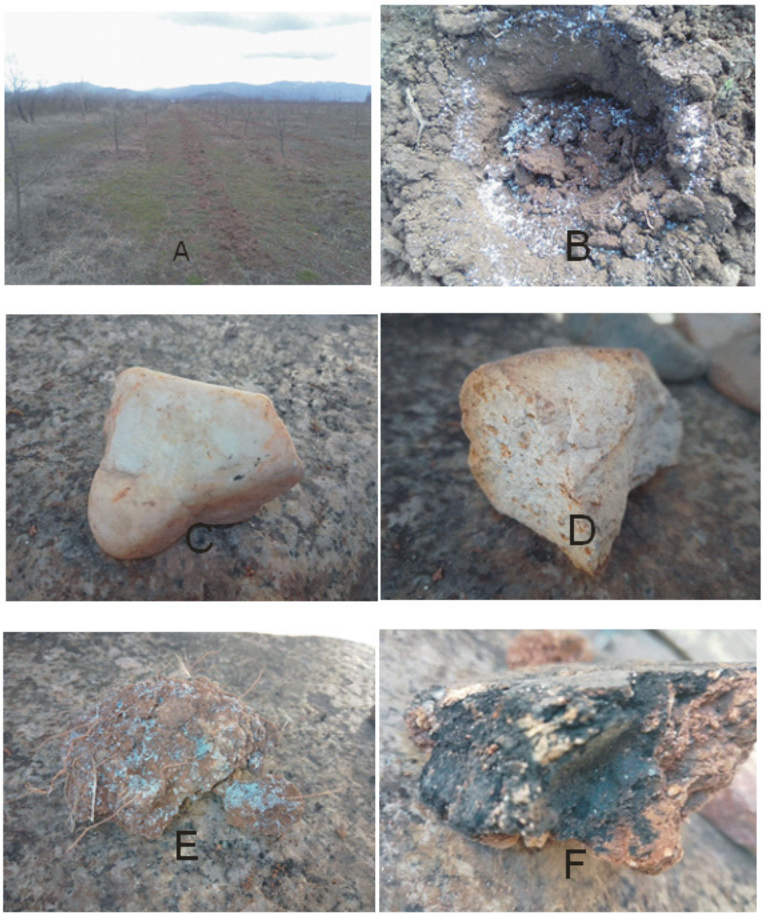

Fig. 5. Landscape view and macroscopic vision of the terrain, soil and soil forming materials.
A) Apple experimental field; B) Hole for planting of trees with N fertilizer; C) White quartz- the main soil forming mineral of the terrain; D) Volcanic material – tuff from closest poligenous vulcano; E) Soil with relics of roots with mushroom mycelium and salt – halite; F) Soil with coalified organic plant relics.

It has a variety of roundness and sphericity – high sphericity to low sphericity and from very angular, semi-angular, angular – to semi-rounded by Powers (1953). All types of sphericity are observed by Pettijohn (1975) – 0.3, 0.5, 0.7, and 0.9, while their roundness is 0.1; 9.3, 0.5 and 0.7, approximately equally distributed by type of minerals and fractions (fig. 5 and 6). It should also be noted that the fractions are also not very diverse in contents, although after washing the soil until only the mineral grains remain, grains of different sizes are observed, but under a microscope almost equal amounts of all fractions are found, is most likely due to the constant mixing of the soil over time during human agrotechnical activities. Anthropogenic detritus and microdetritus are also observed – mostly old red ceramics, few glasses, microplastics, but again it should be summarized that we are talking about quantities of much less than 1%.

Studied soil of might be determined as Alfisols. It is characterized by brown-grey surfacehorizon and an argillic horizont, an a high base saturation, they tend to occur under forests in humid regions of mid-latitudes. Their organic content is low, and may have calcic horizon Luvisols. Field description of the soil, according to Bell (1998) is fine soils with over 35% silt and clay

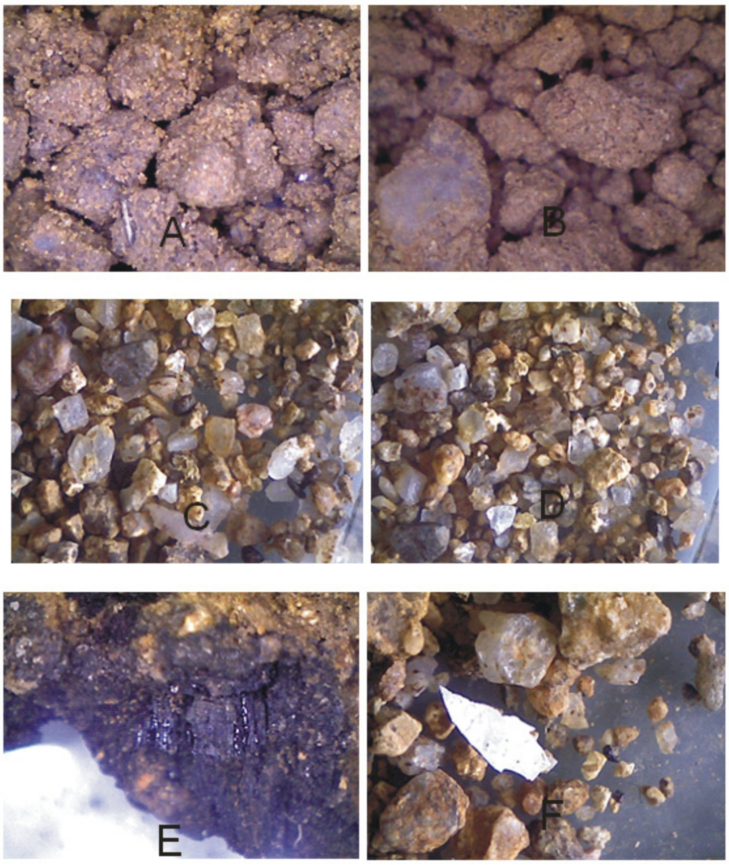

Fig. 6. Microscopic view of the soil and soil minerals (air, reflective white light, x200, digital microscopy); A, B) Mineral grains - mainly quartz <1 mm, covered with clay minerals, mainly montmorillonite and dust fraction <0,001 in different ratios (carbonate CaCO3); C,D) Mineral content of the studied soils - prevailing fraction smaller than 1mm – water, milk, yellow, pink, black quartz, some magetite (magnetic fraction) , limestone, feldspar, limonite, hematite, kaolinite, calcite, apatite, olivine, gneiss (with muscovite, biotite and pyrite) and slate lythites; E) Coalification of organic matter in the soils – macro-lithotypes Clarain-bright and Durain-dull; F) Anthropogenic microdetritus in the soil.

sizes of minarelas - mixed sandy-silt basic soil type, probably because of the human threatment of the soil with particle size sands from 2-0,06 mm, rough smooth polished, visible to naked eye and silts from 0,06-0,002 mm, non-plastic or law plasticity

Minerals with high influence on agricultural properties of the studied soil.

Montmorillonite. In the rich mobilized bases nautral to slightly alkaline montmorillonite dominates, in acid soils kaolinite a dominant clay mineral emerges. Despite the didactic differentiation of physical, chemical and physico-chemical adsorption in soil, the three species occur interrelatedly, with previous agrochemical experience showing that in the complex combination of different chemical and adsorbing processes in the soil, cation exchange is of dominant importance. Under specific geochemical, geological, geomorphological, climatic conditions, e.g. an excessive amount of rain, sodium carbonate is formed (sodium is one of the last elements to dissolve, i.e. a large amount of water is needed) that enters the soil solution. In addition to the large amount of water, the time factor is also needed, i.e. the terrain must have poor drainage properties and the water must remain in the terrain. Then the substitution of adsorbed acal-earth cations by sodium immediately leads to chemical precipitation of the alkaline earth carbonates on

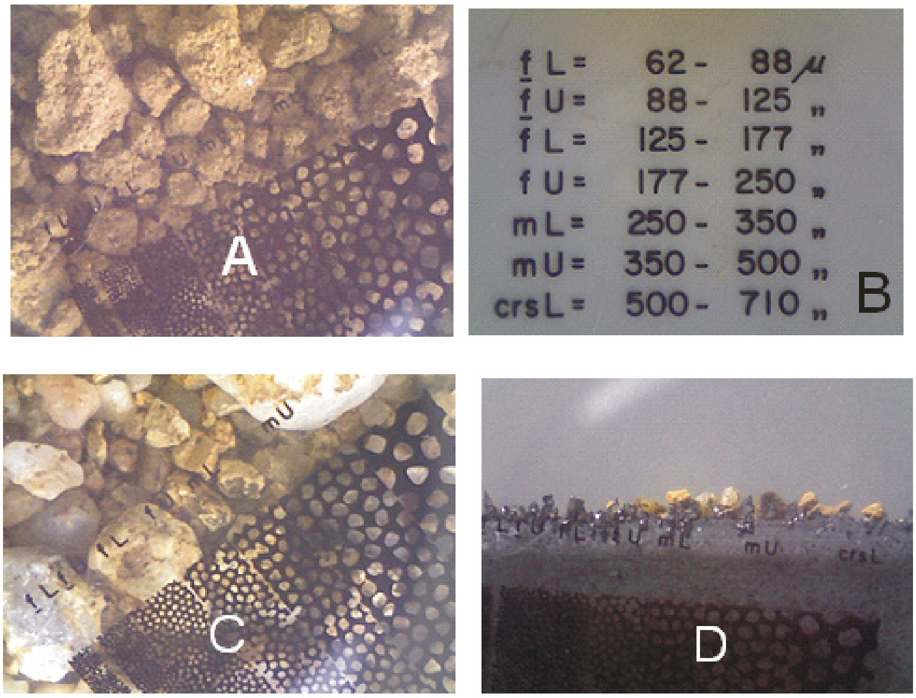

Fig. 7. Microscopic view of the soil and soil minerals (air, reflective white light, x200, digital microscopy) A-microscopic view of the soil, B-scale of mineral grains size, C-microscopic view of the mineral grains, D-magnetic fraction of the mineral content along regular magnet – black particles are magnetite, white particles are association quartz-carbonate with magnetite.

the colloidal surfaces. In turn, physico-chemical ion exchange adsorption can be influenced by preceeding chemisorption processes. For example, the partial hydroxide precipitation of aluminum cations in the soil creates a positively charged hydroskialuminum polymer, which binds to the negative charges on the colloidal surfaces and thus blocks cation exchange positions of the soil adsorbent. In allophane soils (formed on volcanic materials, as they are the subject of this paper) this blockage can reach extreme values (Ganev, 1990).

Quartz-all type of quartz might be observed. The importance of quartz is still very underestimated for its role in the creation of life and for the fertility of the soil. Quartz in all its forms represents an energy resource. Its property of creating electrical energy under the influence of external factors such as pressure, shock, heat, friction, chemical reactions, etc. make it a prime suspect as a source of energy and electrical impulses in soil, which are very important for cation exchange between soil and plant roots and for converting some substances into others, incl. of inorganic chemical compounds in organic. Quartz determines the basic granular composition of the soil and determines the moisture absorption, plasticity, moisture performance, etc. It helps maintain a constant temperature and acidity of the soils. Its role for agrarian science needs to be significantly enhanced.

Magnetite is the main mineral of the magnetic fraction. As seen in figure 7 occurs also alone in the smallest powder fraction silt so in the fine-grained sand fraction. Half of the magnetite is found in association with quartz and calcium carbonate again in the smallest fractions. The present study shows a carbonate content of 33% in the soil, which speaks of a large amount of carbonates, but they are mainly in the dust fraction. This particular adhesion of magnetite with carbonates marks secondary mineralization due to adsorption processes in the soil and speaks of the participation of magnetite in cation exchange processes in the soil. The mineral magnetite is also related to the microbial composition of the soil (Sotirov et al., 2020).

Chlorite shale as well as montmorillonite can, under certain conditions, release chlorine and thus, together with the released sodium described above, NaCl salt is formed, which is the mineral halite or otherwise table salt, which salinized the soil and leads to damage to agricultural production, worsens the quality and storage life of the fruit and finally leads to the death of the plants and economic loses. In these cases it is needed to use gypsum agricultural mineral fertilizer for neutralization of the salt and its drainage.

Conclusion

Four main and two secondary feeding provinces with minerals and soil forming material are determined: Bistritsa River feeding province, Struma River feeding province, Struma Diorite Formation feeding province and Neogene Conglomerate Sandstone feeding province. River's provinces supplied with river sediments along the river length, material is much more threated, second provinces supplied with slope material through temporary water flow, erosion and landslides. This material is clear, angle-shaped with preserved shape of the crystals with low roundness. Clay minerals are generated mostly in situ, but there is other soil forming aeolian materials with high annual volume – dust from Sahara Desert. The size of the clastic grains increases near the rivers and decreases at the opposite direction, where the deep zone of the lake developed.

Montmorillonite from the clay minerals, quartz, magnetite, and chlorite shales are determined as the most important agricultural minerals for the studied soils. Its property of creating electrical energy under the influence of external factors such as pressure, shock, heat, friction, chemical reactions, etc. make it a prime suspect as a source of energy and electrical impulses in soil, which are very important for cation exchange between soil and plant roots and for converting some substances into others, incl. of inorganic chemical compounds in organic. Quartz determines the basic granular composition of the soil and determines the moisture absorption, plasticity, moisture performance, etc. It helps maintain a constant temperature and acidity of the soils.

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