Comparative characteristics of Ferric Leptosols

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Abstract

The present study aims to establish the genetic-diagnostic characteristic of Ferric Leptosols and Nudilithic Ferric Leptosols which are formed on rocks with high iron content. Thise soils are spread over hard red sandstones, quartzites and granite gneisses of the ridge parts and the upper (eluvium) parts of the slopes in the hilly part of the northeastern Sofia filed.

The performed diagnostic assessment and characteristics give grounds to include the studied soils in the Bulgarian National Soil Classification at subtype taxonomic level as Ferric Lithozems and Ferric Rankers, and in WRB as Nudilithic Ferric Leptosols and Ferric Leptosols.

Keywords

Ferric Leptosols, Nudilithic Ferric Leptosols, soil diagnostics, soil classifications

Introduction

Modern research in soil science provides an opportunity to improve soil diagnostics and improve the national classification of soils. Objectively, this becomes a fact when defining soil formation processes with certain features and characteristics.

In soil science, the main principle for characterization and evaluation of soils is the genetic-diagnostic approach, which combines the morphology, the structure of the soil profile, the chemical, physico-chemical, physical and other indicators and properties.

On this basis, there were changes in the names of soils in the new bulgarian soil classification (Teoharov et al., 2019) and based on the diagnostic characteristics of WRB (IUSS working group, 2015) new soil units were included. It was found that there are primitive and underdeveloped soils in the country, which have not been studied enough.

The present study aims to establish the genetic-diagnostic characteristic of Nudilithic Ferric Leptosols and Ferric Leptosols formed on rocks with high iron content.

Materials and Methods

In soil-geographical zoning, the group of primitive and underdeveloped soils, in this case Ferric Leptosols and Nudilithic Ferric Leptosols in the Sofia region, is formed in hilly, semi-mountainous areas.

According to the large-scale soil studies of Dishovski (1970) and Yanakiev (1989) in the highest part of the region is located north of the village of Sarantsi with 812.9 m above sea level, occupied by highly eroded Cinnamon forest soils and rocks, shallow, underdeveloped, stony, clayey-sandy, which are incorrectly referred to the zonal type. It is not possible for a soil to be cinnamon (zonal) and at the same time to be defined as underdeveloped (azonal). Geomorphologically, the territory of the studied terrain belongs to the Vitosha mountain-valley part (Galabov, 1982). Soil-forming rock formations are very often complexes of rock individuals of different origins and different lithological varieties. These two features of the formations are especially important for identifying their chemistry and for explaining the chemical features of soils.

Hilly-ridge part - covers the higher part of the hills around the Gorno-Malinska valley and the foot of Stara Planina with a wide distribution of red sandstones, coarse-grained quartzites and their deposited products as deluvial deposits. In this part of the Sofia region the studied soils have the widest distribution.

Field studies were performed on the basis of the profile-genetic approach and the catena method (Mordkovich et al., 1985). According to this methology, the western direction defines as catena any arbitrary part of the slope. The Russian concept allows to consider as catena any micro slope on which there is only one eluvial and one accumulative landscape with transit between them. If the slope has a complex relief, a first-order catenary and several second-order catenaries can be divided on it, each of which must have its own eluvial and accumulative part. Based on these methodological requirements, several second-order rocks were selected, which have inhomogeneous soil-forming rocks and relief in the flat and hilly part, respectively, but are separately characterized by the same soil-forming conditions.

These rocks allow to establish the redistributive functions of relief forms on the conditions and factors of soil formation and their influence on soil formation at different exposures and parent rocks. For the purpose of the development, characteristic areas of soil formation in different ecosystems (pastures and forest ecosystems) are covered. Geomorphology and soil morphology have been studied and described according to the Guidelines for soil description (Jhan et al., 2006). In order to fulfill the objectives of the development, field studies were carried out in the land of the municipality of Gorna Malina, Elin Pelin and it allows them to be differentiated and classified at a lower taxonomic level or defined at the type level.

After an in-depth reconnaissance study and a thorough survey of the terrain, the locations of 3 profiles were selected. The profiles are laid by the method of catena in the northeastern part of the Sofia region, in the land of Gorna Malina.

Profile N. 1 Nudilithic Ferric Leptosols, Profile No: 2 Feric Leptosol, Profile No: 3 Feric Leptosol.

To characterize the type and composition of the soil-forming rocks, data and studies of the Institute of Geology - BAS, and the Sofia University “St. Kliment Ohridski ”

The analysis of soil samples was performed according to the following criteria and methods:

- Mechanical Composition (Kachynski, 1958);
- Soil Color (according to Munsell's Color Scale, Color charts, 1994);

- C: N by calculation (Penkov et al., 1981).
- Composition of humus according to Kononova-Belchikova (Kononova, 1963; Filcheva & Tsadilis, 2002).
- Carbonates by the method of Scheibler (Penkov et al., 1981).
- pH in H_2O and in KCl - potentiometrically with glass electrode.

Results and Discussion

Diagnostic characteristics of the studied soils.

Profile 1 (Nudilithic Ferric Leptosols) with coordinates 42 ° 42.237′N and 023 ° 42.610′ E, with an altitude of 660m in the land of the village of Gorna Malina, Sofia region, in the lower part of a sloping ridge. The soil-forming rock is sandstone, with around bare rock sections and fragments. The vegetation is represented by sparse, most often xerophytic grass formations with a predominance of fescue (Festuca ovina), meadow fescue (Festuca pratensis), jaundice (Genista L.), wild carnation (Dianthus campestris), wild vetch (Vicia sepium L.).), red clover (Trifolium L.), sadina (Andropogon L.), yarrow (Achillea millefolium), windmill (Eryngium campestre L.) and hawthorn (Crataegus monogina L.).

Fig. 1. *Profile 1*

Morphological description:

AC 0-17 cm. Color slightly red 2,5YR 4/2 (dry) and dark reddish brown 2,5YR 3/4 (wet), slightly compacted, unhealthy fine-grained powdery to large structure with aggregate size 1-2 mm (fine up to 60%), with a size of 5-10 mm (large up to 30%) and aggregates> 10 mm (very large 10%), very fine roots 0.5-1 mm in diameter, single fragments of the main scale with rounded sides with a size of 1- 2 cm), signs of high biological activity of insects of various origins, porous, abrupt transition;

CR 17-40 cm. Color slightly red 2,5YR 4/2 (dry) and dark reddish brown 2,5YR 3/4 (wet), semi-weathered rock with an abundance of mica inclusions, massive plate structure with the presence of quartz grains.

Profile № 2 (Ferric Leptosols - Rankers) with coordinates 42 ° 43.082′ N and 023 ° 42.648′ E, with an altitude of 598 m, in the land of the village of Gorna Malina, in the upper part of a ridge with a slope of 6 °. Soil-forming rock is Red Sandstone. The vegetation is represented by xerophytic grass associations with a predominance of sadina (Andropogon L.), thyme (Thymus L.), fescue (Festuca ovina), and less common are Teucrium L., mulberry (Verbascum L.) , puppy (Antirrhium L.), hawthorn (Crataegus L.), dog rose (Rosa canina L.), pubic (Laserpitium L.), oregano (Origanum majorana L.), windmill (Eryngium campestre L.). There are in some places single white pine (Pinus silvestris L.), dogwood (Cornus L.), wild pear (Pirus achras).

Fig. 2. *Profile 2*

Ah 0-25 cm. Color reddish gray 5YR 5/2 (dry) and brown 7,5YR 4/2 (wet), plenty of pebbles with pointed surfaces 0.5-3 cm in size, fine earth is unstructured, in the dry state strongly dusty, the presence of single larger roots with a diameter of 1-3 mm, a sharp transition;

R 25cm - hard rock.

Profile № 3 (Ferric Leptosols - Rankers)

with coordinates 42 ° 42.269′ N and 23 ° 42.602′ E, with an altitude of 652 m in the land of the village of Gorna Malina, the relief of the area is dissected hilly, the profile is set in the upper part of a slope with 5 ° slope to the north. Soil-forming rock is semi-weathered

sandstone. The vegetation is represented by xerophytic grass associations with a predominance of fescue (Festuca ovina), and less common are Teucrium L., wild strawberry (Fragaria vesca L.), thyme (Thymus L.), sorrel (Malus silvestris).), meadow (Poa L.), windmill (Eryngium campestre L.), plantain (Plantago major L.). In the immediate vicinity the terrain is afforested with pine (Pinus silvestris L.) about 30 years old.

Fig. 3. *Profile 3*

Ah 0-20 cm. Color reddish brown 2,5YR 5/4 (dry) and dark red 2,5YR 3/2 (wet), up to 70% is dominated by highly dusty, unhealthy medium three-shaped, lumpy structure of aggregates with size <5 mm (very fine up to 20 %) and with a diameter of 5-10 mm (fine 10%), single fine roots, the presence of quartz grains, a sharp transition;

CR 20-40 cm. Color light reddish brown 2,5YR 6/4 (dry) and dark reddish brown 2,5YR 3/4 (wet), dense, unhealthy powdery structure up to 50% individual grains, unhealthy chubby structure aggregates <5 mm (very fine) up to 20%) and with a diameter of 5-10 mm (fine up to 30%), individual aggregates are 20-50 mm in size and are highly porous, single fine roots, an abundance of quartz grains.

The morphological description shows that the studied soils are characterized by red chromium in different shades (2,5YR, 4/2, 5/4, 6/4, 5YR 5/2), low power (10-25-30cm), unhealthy structure (powdered), high content of quartz grains, irregularly shaped rock fragments and high porosity. The surface diagnostic horizon is formed on hard or semi-weathered rocks. It is weak, covered with the grass root system and covered with decomposed and semi-decomposed organic residues and with high biological activity. Due to the sloping terrain and the drainage of the soil moisture, the clay formation processes are weak, individual. Annual deposition of organic matter increases the humus content without affecting the pronounced red color of the soil. In general, the soils have an underdeveloped, shallow,

skeletal, non-clayey profile, formed on very specific, red-colored soil-forming rocks, which largely determine the lithogenic origin of Fe and iron compounds and their influence on the red color of the clay (mineral) part of the soil. According to Stoykova (2021), this is evidence of the presence of the non-clayey mineral - hematite and the course of rubeification processes, characteristic for the southern Mediterranean type of soil formation. The clay minerals dominate from the illite group. characteristic of the southern Mediterranean type of soil formation. The clay minerals dominate from the illite group. characteristic of the southern Mediterranean type of soil formation. The clay minerals dominate from the illite group.

Fig. 4. *Gorna Malina- Open modern red sandstones with shallow weak developed humus-silicate soils (Ferric Leptosol - Rankers) and acid grass formations.*

Table 1. *Diagnostic indicators and characteristics of the studied soils (%).*

Soil Properties	Profile 1		Profile 2		Profile 3	
	AC	CR	Ah	R	Ah	CR
Muncell color	2,5YR 4/2	2,5YR 4/2	5YR 5/2	-	2,5YR 5/4	2,5YR 6/4
Physical clay <0.01 %	14	5.89	21.82	0	15.3	14.6
Clay % <0.001	8.83	2.49	5.62	0	4.8	2.4
SOM (humus) %	3.1	0.67	5.9	0	4.8	1.9
Total Fe %	1.71	1.57	2.87	0	1.32	1.22
pH in H_2O	6.3	6.8	5.1	0	4.9	4.8
Total carbonates in %	0.38	0.52	0.23	0	0	0
Main Clay. Mineralogy	illite		illite		illite	
Additional clay mineralogical identification	montmonilo-rit-illit	-	illite	-	illite -	-
Primary minerals	quartz, plagioclase, mica	quartz, plagioclase, mica	quartz, mica	- -	-	-
Ratio C / N	12	10	11	0	11	10

The soil texture of the soil reflects the relative content of the different sized partical elements of the fine earth of the soil. This is an important diagnostic indicator for studying the genesis and properties of soils. The clay fraction is a major part of the mechanical composition of all soils, which actively binds organic grains, cations, anions and water molecules in soil aggregates. In table 1 presents the main diagnostic indicators that determine the diagnostic characteristics of soils.

The soil texture usually could be clayey-sandy and sandy-clayey, with a lower content of clay in the Nudilithic Feric Leptosols (up to 14%). The sludge fraction does not exceed 10%. The humus content is about 3% for Leptosols and 5-6% for Rankers (Ferric Leptosols). The content of clay and humus is evidence of the different degree and speed of soil formation processes in different types and their definition as primitive and undeveloped soil. However, the initial initial processes of clay formation (soil formation) determine the low values of the metabolic forms of iron. The steppe nature of the vegetation definitely influences the low values of the C/N ratio and the presence of the type "mull" humus and the porcess of decomposition of the organic matter. According to the pH values and the total carbonate content, these soils are acidic and non-carbonate. Only the soil-forming scale of Profile 1 has a neutral reaction. The increased content of carbonates in AC horizon can be considered as "contamination" of the fragments, but not the presence of carbonates in the clay.

An important diagnostic indicator is the total iron content, which can be defined as high, especially in Rankers (Ferric Leptosols). Apparently its inheritance from the rock and the relatively increased content of silt and clay affects the higher in the surface horizons.

Conclusion

The Ferric Leptosols and Nudilithic Ferric Leptosols are formed on hard red sandstones, quartzites and granite gneisses of the ridge parts and the upper (eluvial) parts of the slopes in the hilly part of the northeastern Sofia valley.

The processes of humus formation (soil formation) mainly involve dilute xerophytic grass communities of degree type, ephemeral species, shrubs, semi-shrubs and single group forest plants, whose organic residues form a "mull" type of humus.

According to the diagnostic characteristic, the studied soils have a primitive (A-CR) or poorly developed AR profile, with shallow, rudimentary, initial, or incompletely developed (weakly deep) surface horizons with thickness 10-25 to 30-40 cm, clay content up to 14 -22%, medium to low humus content.

Iron-weathering soil-forming rocks, high iron content (1.20-2.90%), the formation of red clay and non-clay minerals are evidence of the active processes of ferritization and rubification and the formation of non-clay minerals from the hematite group.

The performed diagnostic assessment and characteristics give grounds to include the studied soils in the Bulgarian soil classification at subtype taxonomic level as Ferric leptosols and Ferric Rankers, and in WRB as Nudilithic Ferric Leptosols and Ferric Leptosols.

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