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SOILS OF THE CHARNOKHORA MTS. (UKRAINE)

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Soil cover of the Charnokhora Mts. can be characterised by shallow soil profile containing a lot of unweathered sandstone crumbs and by the specific character of organic matter. This is a result of very hard bedrock (especially sandstones), intense morfogenetic processes and very humid and cold climate. Under beech and spruce forests Dystric Cambisols and Cambic Leptosols prevail. In subalpine and alpine areas Umbric Leptosols, Lithic Leptosols and Dystric Regosols occur. The Pulmonario-Alnetum vegetation occurs on Hapli-Eutric Gleysols enriched by waters from within rocks.
Keywords: flysch, Cambisols, Leptosols, weathering, Charnokhora Mts.

Introduction. Charnokhora Mts. is the highest mountain range in the Ukrainian Eastern Carpathians. It is built of gravelstones, sandstones and shales, where interstratified sandbanks form carpathian flysch. Charnokhora Mts. are 40km long and the main mountain ridge, from Pietros in the north-west to Pop Iwan in the south-east, is about 25km long. The highest peak of Charnokhora Mts. is Howerla, reaching the altitude of 2061m. Altitude determines geoecological zones.

Soil cover of the Charnokhora Mts. is determined by very hard parent material, considerably varied relief and intense geomorphological processes as well as varied climate conditions and vegetation [Skiba, 1998; Skiba, Drewnik, 2003; Skiba, 2005].

Although soil cover of the Charnokhora Mts. has been the subject of environmental studies for almost 90 years, there are still not many scientific papers concerning the subject. Walery Swederski was the pioneer of such studies and he was a manager of the scientific station on Pożyżewska Peak between 1929-1935 [Swederski, 1931a, Swederski, 1933a]. After the Second World War the state borders were moved and the soil cover of these region was investigated by soil scientist from the University of Lviv [Gogolev, 1962] and from the Institute of Ecology of Carpathians of the Ukrainian Academy of Sciences [Maryskevych, 2003; Maryskevych et all., 2002]. The last decade brought more and more studies of the soil cover of the Charnokhora Mts. by soil scientists from Poland and Ukraine [Skiba, Szmuc, 1998; Skiba et all., 2005].

Aims and methods. The aim of this paper is the description of the characteristic soil cover of the Charnokhora Mts. on the basis of studies carried out in 2001-2004 and in 2007. This research covered the area between Gadżyna and Pop Iwan in the south and the transect from Zaroślak to Pożyżewska (Fig. 1.). During those studies samples from the forest area, subalpine and alpine areas and also from under small patches of the Pulmonario-Alnetum vegetation were collected. The samples were taken from each genetic horizon from every outcrop. Texture, reaction, content of organic carbon and organic matter, distribution of amorphous iron oxides and aluminium oxides and mineral composition were determined in laboratory.

Results and discussion. Soil cover of the Charnokhora Mts. Can be characterised by typical properties of the mountain regions soils. Very hard bedrock and very intense geomorphological processes determine a shallow soil profile and a lot of crumbs in the soil mass. A very specific circulation of water is connected to variable relief and very steep and high slopes. Rain water infiltrates the soil profile and it also moves laterally in accordance with the slope inside waste. It is known as lateral movement of soil solutions. It causes the occurrence of many leaks and exudations of water on deflections of the slopes.

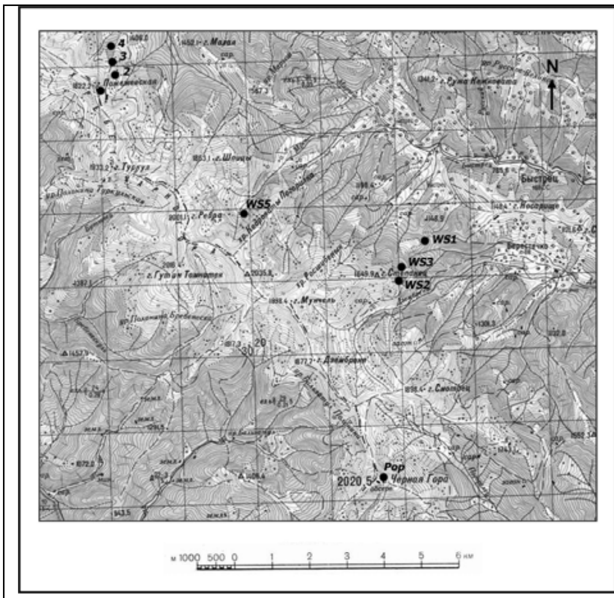

Fig. 1. Localization of the investigated soils

This water, circulating into rocks, becomes rich in various ions and therefore it has very strong influence on the chemistry of the soil cover. Specific character of organic matter is a distinguishing feature too. Tangel/mor or alpine moder are very common types of organic matter. The altitude increases the thickness of organic litter. Cold and humid climate is the reason of very slow rate of the organic matter decomposition [Drewnik, 1999; Drewnik, 2006; Maryskevych, 2003].

In the structure of the soil cover Dystric Cambisols prevail. Dystric Cambisols occur under forest vegetation and under meadows. In subalpine area, under Pinus mugho and Vaccinium mystillus vegetations Umbric Leptosols and Cambic Leptosols are very common. If the texture of the parent material is sandy loam, Skeletic Podzols occur. Eutric Gleysols and Mollic Gleysols can be found in small patches where exudations or leaks occur. In humid areas Histosols prevail. In peak parts and on outcropping bed Lithic Leptosols are very common. On stone rubbles that occur on many slopes, Regosols were formed [Skiba et al., 2005].

In the forest area Dystric Cambisols prevail. Their genesis is connected to carbonateless parent material and very acidic organic matter. Weathered Carpathian flysch transitioning into loamy waste determines brunification processes. In some cases, under humus horizon, lenses of a light soil material can be observed. Most of them occur under spruce forest (Vaccinio-Piceetalia vegetation) and they are connected to slightly decomposed organic matter with reduction capacity. Weak permeability of loamy parent material results in podzolisation process. In these soils spodic horizon does not exist but cambic horizon is well developed [Skiba et al., 2005]. Texture of all investigated Dystric Cambisols is loam, silty loam or silty clay loam. Very high content of sandstone crumbs constituting 30-70% of the soil mass is a characteristic property of Dystric Cambisols. Reaction of the Dystric Cambisols is acidic and it increases up the soil profile. pH value of the humus horizons is 3,5-4,5 and cambic horizons are between 4,5-5,0 (Table 1.). Content of organic matter is from 5,0 to 14% in humus horizons.

1. Reaction of the investigated soils

Profile WS1 Dystric Cambisol				**Profile WS5 Skeletic Podzol**			
Horizon	Depth	pH (H_2O)	pH (KCl)	Horizon	Depth	pH (H_2O)	KCl
A	5-20 cm	4.5	3.6	Ol	0-4 cm	3.8	2.8
ABbr	20-45 cm	4.8	3.8	Ofh	4-12 cm	4.2	3.0
Bbr	45-75 cm	4.8	3.8	AEes	12-25 cm	3.9	3.1
BbrC	75-110 cm	4.8	3.8	Bhfe	25-45 cm	4.5	3.8
C	110-120 cm	4.9	3.8	BsC	45-55 cm	4.6	4.0
Profile WS3 Eutric Gleysol				**Profile Pop Iwan Skeletic Podzol**			
Horizon	Depth	pH (H_2O)	pH (KCl)	Horizon	Depth	pH (H_2O)	pH (KCl)
A	3-15 cm	5.3	4.7	A	2-10 cm	4.4	3.2
AG	15-30 cm	5.6	4.3	AEes	10-25 cm	4.3	3.4
G	30-50 cm	5.8	4.4	Bhfe	25-40 cm	4.8	4.1
CG	50-60 cm	5.9	4.4	BsC	40-65 cm	4.9	4.1
				C	65-80 cm	4.9	4.1

In subalpine areas, under Pinus mugho vegetation, Umbric Leptosols and Cambic Leptosols prevail. These soils show shallow and rocky gravel profile. In the surface area very thick organic horizon occurs (15-30cm). Considerable thickness of the organic horizon is connected to the cold and very humid climate and to very slow rate of the organic matter decomposition. Texture of fine earth is loamy and the reaction is acidic or strongly acidic.

Organic horizons have pH values 3,5-4,0 and the content of organic matter varies between 20 and 90%. In peak parts of Charnokhora Mts., under Vaccinium myrtillus and alpine meadows Cambic Leptosols occur. Very slightly developed cambic horizon was observed with sandy clay loam or loam texture of fine earth. Such soils are very common on steep slopes and they are transitional forms between Leptosols and Cambisols. Skeletic Podzols are shallow, very gravelly soils deriving from sandy loam parent material. Skeletic Podzols occur in subalpine (for example Gadżyna) and alpine areas (for example Pop Iwan). Very advanced podzolisation process was observed, leading to the formation of spodic horizon. Morphology of such soils is as follows: Ol-Ofh-AEes-Bhfe-BsC-C. Sometimes albic horizon was not observed. Reaction of Skeletic Podzols is acidic or very acidic (pH is 4,0-5,0). Content of organic matter ranges between 3-4% in spodic horizon and 20% in organic horizon (Table 2.).

2. Content of organic carbon and organic matter

Profile WS1 Dystric Cambisol				Profile Pop Iwan Skeletic Podzol			
Horizon	Depth	C_{org} [%]	Org. mat [%]	Horizon	Depth	C_{org} [%]	Org. mat [%]
A	5-20 cm	3.1	5.3	A	2-10 cm	7.2	12.4
ABbr	20-45 cm	1.2	2.0	AEes	10-25 cm	4.1	7.0
Bbr	45-75 cm	0.9	1.5	Bhfe	25-40 cm	1.9	3.4
BbrC	75-110 cm	0.6	1.1	BsC	40-65 cm	0.6	1.1
C	110-120 cm	0.7	1.2	C	65-80 cm	0.5	0.8
Profile WS3 Eutric Gleysol				**Profile WS5 Skeletic Podzol**			
Horizon	Depth	C_{org} [%]	Org. mat [%]	Horizon	Depth	C_{org} [%]	Org. mat [%]
A	3-15 cm	6.0	10.4	Ol	0-4 cm		68.7
AG	15-30 cm	1.6	2.7	Ofh	4-12 cm	11.4	19.6
G	30-50 cm	1.0	1.6	AEes	12-25 cm	3.4	5.9
CG	50-60 cm	0.6	1.1	Bhfe	25-45 cm	1.9	3.3
				BsC	45-55 cm	2.2	3.7

In spodic horizon, content of amorphous iron oxides and aluminium oxides is several times higher than in albic horizon, thus spodic horizon meet diagnostic criterion (Table 3.).

Lithic Leptosols and Regosols are very common in the alpine area. Lithic Leptosols occur on outcropping beds. They have a very shallow profile, which consist of very thin organic horizon (5-10cm) lying on unweathered or cracked bedrock. Reaction of organic horizon (Ofh) is 3,0-4,0 and the content of organic matter is very high (30-90%). Lithic Leptosols provide excellent conditions for Asplenietea rupestria and Potentillo-Festucetum airoides vegetations. Regosols are built of stone rubbles partly filled by organic matter and/or fine earth. These soils are slightly deeper than Lithic Leptosols and they are covered by Vaccinium myrtilli or Pinetum mughi vegetations. Most of them are acidic (pH 3,5-4,5) but some Regosols are enriched in alkaline ions through lateral movement of the solutions (Eutric Regosols).

3. Content of amorphous iron oxides and aluminium oxides

Profile Pop Skeletic Podzol			
Horizon	Depth	Fe_{ox}	Al_{ox}
A	2-10 cm	0.15	0.20
AEes	10-25 cm	0.31	0.22
Bhfe	25-40 cm	1.40	0.78
Bs	40-65 cm	0.34	0.25
C	65-80 cm	0.16	0.28
Profile WS5 Skeletic Podzol			
Horizon	Depth	Fe_{ox}	Al_{ox}
Ol	0-4 cm	x	x
Ofh	4-12 cm	0.24	0.19
AEes	12-25 cm	0.10	0.09
Bhfe	25-45 cm	1.24	1.07
BsC	45-55 cm	0.89	1.11

In places, where water circulating within rocks flows out on the surface, Eutric Gleysols and Mollic Gleysols occur. Such soils provide environment for small patches of Pulmonario-Alnetum vegetation. Eutric Gleysols and Mollic Gleysols have slightly acidic or even neutral reaction (5,5-7,0). Mollic Gleysols are characterised by humus horizon, which is 30-40cm deep and it does not show gleyic properties. Texture of such soils is loamy and the content of organic matter is 5-10% in humus horizon and it rapidly decreases down the soil profile. In the lower part of the soil profile clear gleyic properties were observed, expressed by blue or greenish colour of the soil material.

Histosols are very common on flat parts of slopes where outflow of water is limited. This limited outflow forms swamps very common near overgrown glacial lakes.

Mineral composition all of the investigated soils is very uniform. Primary minerals forming soil mass are: quartz, plagioclases (mainly resistant to weathering albite), K- feldspars (such as orthoclase) and micas (especially muscovite). Secondary clay minerals are represented by: chlorite, illite, kaolinite and randomly interstratified illite/smectite (Fig. 2, 3.).

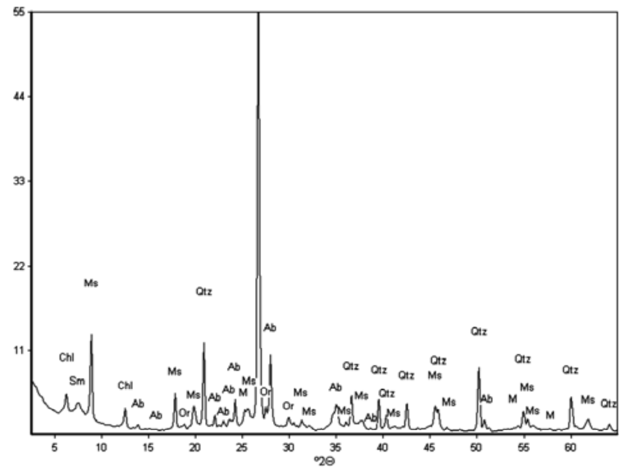

Fig.2. Mineral composition of gleyic horizon from Eutric Gleysol

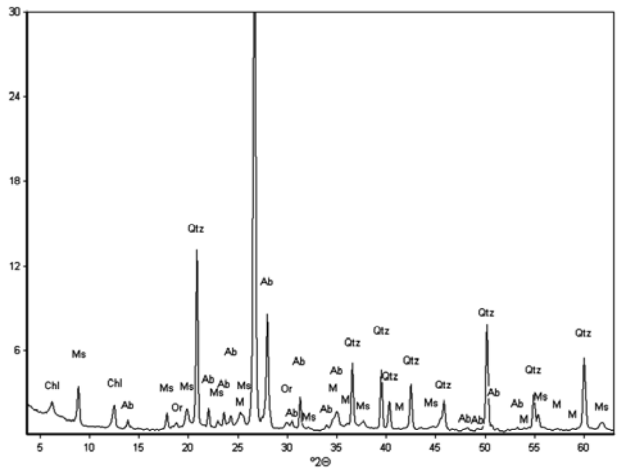

Fig.3. Mineral composition of parent material from Skeletic Podzol

Conclusions.

1. Soil cover of the Charnokhora Mts. can be characterised by very shallow soil profile, containing a lot of sandstone crumbs and specific character of organic matter (tangel/mor or alpine moder).
2. In the soil cover of the Charnokhora Mts. Dystric Cambisols prevail because of carbonateless and loamy parent material. Dystric Cambisols occur under forest area and also under meadow vegetation. Umbric Leptosols are very common in subalpine area and they have a very thick organic horizon (15-30cm). Skeletic Podzols are formed of sandy loam parent material. In peak parts, on stone rubbles Regosols are formed and on outcropping beds Lithic Leptosols occur.
3. The occurrence of exudations and leaks of water on deflections of slopes leads to the formation of small patches of Eutric Gleysols and Mollic Gleysols. Such soils are still enriched with alkaline ions by water migrating from within rocks and they provide good conditions for Pulmonario-Alnetum vegetation.

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ҐРУНТИ ЧОРНОГОРИ (УКРАЇНА)

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Ґрунтовий покрив Чорногір'я характеризується малопотужним профілем, який містить багато невивітрених залишків піщанику та має специфічний характер органічної речовини. Він утворився під впливом дуже твердої породи (переважно піщаника), інтенсивних процесів морфогенезу і дуже вологого та холодного клімату. Під буковими і ялиновими лісами переважають Dystric Cambisols та Cambic Leptosols. В субальпійських і альпійських областях розташовані Umbric Leptosols, Lithic Leptosols та Dystric Regosols.
Ключові слова: фліш, Cambisols, Leptosols, вивітрювання, Чорногора.