

3 Investigation area

To perform the purpose of this investigation, soils has been chosen in South Bulgaria according to following criteria:

- Soils to be situated in impacted areas where pollution by heavy metals could be expected, other soil profiles to be situated in unpolluted territories.
- The soils and their parent material should be representative for Bulgaria.

Following these requirements the following profiles has been chosen: two profiles (Profile 1 and Profile 2) in the impact zone of the Cu-smelter near Pirdop town; one profile (Profile 3) in the neighbourhood of Pb–Zn–smelter near Plovdiv, and two profiles (Profile 4 and Profile 5) in the region of National Park “Rogen” – which can be accepted as a background territory. Location of studied sites is shown on Figure 2.1 and in Figure A4 (appendix) are present pictures of profiles.



Fig. 3.1: Map of Bulgaria showing areas where the study was carried out (1-Zlatiza; 2-Pirdop; 3-Plovdiv; 4-National park “Rogen”; 5-“Haidushki polyany”)

3.1 Geographical position and geology of investigated territories

3.1.1 Pirdop - Zlatitza valley

AREA DESCRIPTION

Soil profiles 1 and 2 are situated in Zlatitza–Pirdop valley, which is part of big Sredna Gora region in South Bulgaria, called Kraishte (GEOGRAPHY OF BULGARIA 1989). The area of Pirdop geographically occupies the Pirdop-Zlatitza valley, located 85 km to the east of Sofia. The valley is situated between the mountains Stara Planina (to the North), Sredna Gora (to the South), Koznitza (to the East) and Gulabetz (to the West). The total area of the valley is about 120 km². Besides this territory the surrounding hills with the mining sites among them should be also added as well as a part of the river basin of Topolnitza (the main river which drains the valley).

GEOLOGY, SOIL TYPES AND CLIMATE

Alluvial deposits of the river Topolnitza and other rivers in the region containing gravels, sands, loamy sands and other unconsolidated alluvial sediments occupied the plane part of the district of Pirdop. Different unconsolidated delluvial materials occupy the foots of the surrounding hills. The significant part of the territory is covered by metamorphic rocks presented by sandstones, some limestone (rich in clay) and different mixture materials. The cristalline rocks in the region are presented by granite and granite-diorite containing Cu-ores, also by gneiss and other rocks.

The soil cover is made up by three main soils: Shallow Cinnamonic Soils, occupying 5574.6 ha (35% of the territory); Brown Forest Soils, occupying 2 178.5 ha (15.3% of the territory) and Alluvial and Delluvial Soils, occupying 5 635.3 ha (39.5% of the territory). The rocks and the other non-soil sites in the region are about 86 ha (6.2%). Most of the soils in the region are developed on non-calcareous parent materials having coarse texture and rock fragments. The soils usually have shallow profiles, coarse texture, pH under 6 and quite a small amount of organic matter. Most of the soils can be assessed as marginal for cultivation. The relief favours the increasing of soil erosion and soil degradation.

The region of Pirdop-Zlatitza valley belongs to European–continental area and transitional-continental region (DIMITROV 1979). The climatic conditions are: mean annual temperature 8,8°C and mean annual precipitation of 670 mm. As a whole, the climatic conditions are favourable for agricultural processing but the coarse texture as well as the acid and shallow soils restricts the development of effective agriculture. The north–west winds are predominant in the region of Pirdop town.

SAMPLE DESCRIPTION

Profile 1: It is determined as Orthic Luvisol. The profile is located in a distance of 1.5km southernly from Zlartiza town into an arable land. The topography of the region can be described as low mountainous.

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|----------------|----------|--|
| Ap | 0-23 cm | Strong brown [7.5YR 5/6], dry, moderately compacted, non-structural, clay loam, roots, with visible transition, non react after treating with 10%HCl. |
| B ₁ | 23-44 cm | Brown [7.5YR 4/4], dry, compacted, angular blocky structure, clay loam, small gravel occur, the transition is gradually, non react after treating with 10%HCl. |
| B ₂ | 44-60 cm | Brown [7.5 YR 4/6], dry, compacted, angular-prismatic structure, clay loam, with visible transition, non-react after treating with 10%HCl. |
| C ₁ | 60-75 cm | Strong brown [7.5 YR 5/8], dry, slightly compacted, angular structure, sandy loam, mottled Fe-Mn spots, non-react after treating with 10%HCl. |

Soil characteristics are listed in Table 3.1. The profile has texture differentiation, characterised with $T_k=1.73$. Throughout the profile there are not carbonates, the soil reaction is slightly acid, with pH between 6.85 and 5.35. The humus content in depth is gradually decreasing.

Tab. 3.1: Main soil characteristics of Orthic Luvisol (Profile 1) in Zlatitza

Horizons	Depth, cm	pH (H ₂ O)	Soil moisture, %	OM, %	Particle size particles mm, %			
					2-0.2	0.2-0.02	0.02-0.002	<0.002
Ap	0-23	5.35	5.69	2.71	27.56	28.06	31.32	13.06
B ₁	23-44	6.35	8.42	1.51	23.06	21.24	33.07	22.63
B ₂	44-60	6.70	5.03	0.86	n. d.	n. d.	n. d.	n. d.
C ₁	60-75	6.85	2.60	0.26	n. d.	n. d.	n. d.	n. d.

Profile 2: It is Eutric Fluvisol. Investigated profile is situated in a distance of 2.5 km eastern from Pirdop, in the impacted area of Pirdop Cu-smelter. The topography in vicinity of the profile 2 is plate with a slope approximately 2° to the north-east.

- Ap 0-29 cm Light grey [10YR 7/2], fresh, friable, single grain, loamy, gravel occur with d=1-2cm and roots, the transition is clear, non-react after treating with 10%HCl.
- A^{II} 29-52 cm Light grey [10YR 7/2], slightly moist, slightly compacted, blocky structure, loamy, small gravel occur with size approximately d=1cm and single roots, the transition is gradually, non-react after treating with 10%HCl.
- A^{III} 52-72 cm Light brownish grey [10YR 6/2], moist, slightly compacted, angular blocky structure, loamy, small angular gravel occur, the transition is gradually, non-react after treating with 10%HCl.
- AC 72-95 cm Brown [10YR 5/3], moist, slightly compacted, small blocky angular structure, small-sized gravel occur, the transition is gradually, non-react after treating with 10%HCl.
- AC₂ 95-118 cm Light brownish grey [10YR 6/2], moist, slightly compacted, loamy, small angular stones with diameter up to 1cm, non-react after treating with 10%HCl.

Table 3.2 represents soil characteristics. The texture does not show variety, and is determined as loamy. Here again the tendency towards humus decreases in depth. pH decrease in depth from acid (4.15) in surface horizon to slightly acid (6.35) in deeper horizon.

Tab. 3.2: Main soil characteristics of Eutric Fluvisol (Profile 2) in Pirdop

Horizons	Depth, cm	pH (H ₂ O)	Soil moisture, %	OM, %	Particle size particles mm, %			
					2-0.2	0.2-0.02	0.02-0.002	<0.002
A _p	0-29	4.15	2.96	4.05	27.75	27.93	33.32	10.00
A ^{II}	29-52	4.30	3.01	3.47	23.28	23.30	41.70	11.82
A ^{III}	52-72	5.90	2.32	1.49	32.31	26.76	32.45	8.48
AC	72-95	5.95	2.51	0.74	33.40	27.39	29.08	10.13
AC ₂	95-118	6.35	0.63	0.63	33.34	22.96	29.29	9.41

3.1.2 Plovdiv region

AREA DESCRIPTION

The investigated area is situated in the Plovdiv-Pazardjik plain of the Upper Thracian lowlands. It represents a huge plain, sharply outlined by the northern mountain slopes of The Rhodopi Mountain and the southern slopes of the Sredna Gora mountain (GALABOV et al. 1977). The line with the biggest lowering of the relief is parallel with The Maritza River. Average about sea level of the studied region is 180–200 m. The Chepelarska River runs through the region, which has precipitated a mighty layer of gravel and sands mixed with carbonate materials and in some places mixed with clay. They form the largest mantled cone in the Plovdiv field (CHOLAKOV et al. 1975) where the Pb–Zn smelter is. In the front part of the cone there are springs in the place Ortahan, place Bashkaynak, in villages Krumovo, Yagodovo, Katunica and others. Little rivers flowing in the region which derive from the north Rhodopa slope also form mantled cones, situated between villages Kuklen and Parvenets (GALABOV et al. 1970).

GEOLOGY, SOIL TYPES AND CLIMATE

With regard to the geological variety a small part of the area is at the foot of the northern slopes of the Rhodopi Mountain. It is composed mainly of Paleogenic and Triassic limestone, andesites, crystalline schists, granites, etc.

The existing conditions enable the overlapping of young Pliocene accumulative surface by quaternary alluvial depositions. Eutric Fluvisols covers almost the entire land. They have been formed in zone of the overflown terraces of the rivers with a height of 1-2 to 3-4 meters. In some places often connected with older quaternary river terraces and delluvial

cones as well as with a manifestation of a rise and a submergence of the terrain resulting from eparogenic tectonic contemporary processes, there are also some generally older and clay-rich soils – Chromic Luvisols, Vertisols (KOINOV 1986). As a whole in the sub area there is a predominance of slightly loamy alluvial meadow soils, with a moderately deep humus horizon and relatively low organic matter content. In depth the last one turns into alluvial gravel or sandy parent materials. The soil profile is non-differentiated with a crumbly structure, a large water and air permeability, a presence of carbonates in its entire depth and a light alkaline soil reaction (pH in water ≥ 7.0).

The Plovdiv plain is in the western part of the East - Mid Bulgaria climatic region. The continental character of the climate is significantly moderated. Winter is relatively mild and the summer is hot with a well-expressed drought particularly during August and September, which are the driest months of the year. The average annual temperature is 12°C, while for January it is 1.7°C, and for July it is 22.5°C. The rainfall regime has a continental character. The total annual precipitation ranges from 550 to 570 mm, 270 mm occur during autumn to winter and about 260 mm during the vegetation period. Maximum precipitation occurs in May and June, the minimum in September. This temperature regime results in significant evaporation. The humidity insurance of the region is one of the lowest in the country. Most of the winds during the year come from northwest and north-north-west (DIMITROV 1979).

SAMPLE DESCRIPTION

Profile 3: Is determined as Calcic Fluvisol. The profile is situated in a distance approximately 800m to the southeast from the smelter. The parent rocks are calcareous materials. The topography surrounding territory is plate.

Ap	0-28 cm	Light brownish grey [10YR 6/2], dry, friable, granular structure, clay loamy, root of grasses occur, the transition is clear, react after treatment with 10% HCl.
A	28-44 cm	Light brownish grey [10YR 6/2], dry, compacted, blocky structure, clay loam, single grass roots, the transition is visible, react after treatment with 10% HCl.
aC	44-67 cm	Light grey [10YR 7/1], dry, slightly compacted, single grain, loamy, the transition is graduated, react after treatment with 10% HCl.
C ₁	67-100 cm	Light grey [10YR 7/2], dry, slightly compacted, single grain, sandy loam, the transition is clear, react after treatment with 10% HCl.
C ₂	100- ↓ cm	alluvial deposits in a form of gravel mixed with clays containing CaCO ₃ .

Data for the soil characteristics are presented in Table 3.3. The data characterises a deep humus horizon with organic matter content from 1.35% (in the Ap-horizon) to 0.54% in the C₂-horizon. Carbonates are found throughout the entire profile and their content increases in depth to 30.87% in C₂-horizon. The soil reaction is slightly alkaline. The particle size analyse were not made of soil profile 3, because of high carbonate content in whole profile. For characterisation was used the data of analysing neighbouring profile (ANGELOVA 1993). According this data the texture is clay loamy in the top horizons getting lighter in depth.

Tab. 3.3: Main soil characteristics of Calcic Fluvisol (Profile 3) in Plovdiv

Horizons	Depth, cm	pH (H ₂ O)	Soil moisture, %	CaCO ₃ %	OM, %
Ap	0-28	7.05	1.78	16.32	1.35
A	28-44	7.40	2.18	17.21	0.82
aC	44-67	7.65	1.34	29.17	0.34
C ₁	67-100	7.70	1.13	30.17	0.69
C ₂	100-↓	7.40	0.50	30.87	0.54

3.1.3 National park “Rogen”

AREA DESCRIPTION

Soil profiles 4 and 5 are falling into the Mid-Rhodopi part, which is part of Rilo-Rhodopian region, according to Bulgarian physic-geographical dividing into districts. This district is situated in the south part of Bulgaria and includes the main body of the whole mountain chain. The Mid-Rhodopi region includes part of the territory of the Rhodopi mountain massif, which is restricted from west by the deep meridian valley of The Vucha River, from North by the foot of the mountain from Novi Krichim town to Topolovo village, from East-by the high parts of the waterbed between The Borovitza River and The Sushitsa River and the ridge parts of the Prespanian hill, and from South-west through Smolian town to the Bulgarian-Greek frontier which also borders the Southern limits of the region.

GEOLOGY, SOIL TYPES AND CLIMATE

Mid-Rhodopian region is characterised with deep erosion base that reaches the maximum values for the whole Rhodopian massif. The parent rock of the two soil profiles is characterized with big variety and it includes different types of gneiss, amphibolithe, schists, granites, and paleogenic sediments and volcanic rocks with different chemical composition.

In the territory of National Astronomical Observatory the soil cover is markedly unvaried predominantly spread are the Cambisols (BOYADGIEV 1997).

This region belongs to transitional–continental region and to the mountainous climate area. Winter is relatively cold and the summer is mild. The average annual temperature is 7.3°C, and precipitation rate is 970 mm, with maximum in June and minimum in September. The parameter defining distribution of the pollutants in this region appears to be the wind with its speed and direction. The basic regularity consists of that, that as the speed of the wind is high the bigger is the turbulence and the diffusion of technogenic emissions becomes faster and more complete. The predominant winds in the region are north–western. From wind rose and location of some sources of pollution can be assume probability of pollutants transfer in Rogen region mainly form Plovdiv (DIMITROV 1979).

An average annual duration of *solar radiation* in Bulgaria is about 3 107 hrs, while the maximal in June is (410 hrs) and minimal in December is (100 hrs). The solar radiation is most intensive in the summer (1 166 hrs) and the shortest it is the winter (358 hrs). The energy and character of the solar radiation in industrial centres differ essentially from those in the pure natural regions. The macroclimatic special features in the technogenic regions and specially the pollution of the air with dust and aerosols from the emissions lead to loss from the initial solar radiation and to decreasing of photosynthetical active radiation.

SAMPLE DESCRIPTION

Profile 4 is situated in territory of the National Park “Rogen”. The topography is mountainous with slope to the southeast. The natural vegetation is grass.

- Ah 0-10 cm Dark brown [7.5YR 3/4], fresh, granular structure, small quartz grains occur with a d=2-5cm, loamy, roots of grasses, the transition is gradually, non-react after treatment with 10% HCl.
- A 10-25 cm Very dark brown [10YR 2/2], fresh, slightly compacted, granular structure, single quartz grains and stony fragments with a size 5-8cm, clay loamy, a tiny roots occur, the transition is gradually non-react after treating with 10%HCl.
- AB 25-55 cm Brown [7.5YR 4/4] with dark yellowish brown [10YR 4/6] spots, moist, moderately compacted, granular structure, single stony fragments containing quartz, feldspar and shale, clay loamy, the transition is graduated, non-react after treating with 10%HCl.
- BC 55-70 cm Strong brown [7.5 YR 5/6] with semi-weathered reddish yellow spots [7.5 YR 5/8 and 6/8] of rock fragments, fresh, slightly compacted, small granular structure, loamy, the transition is graduated, non-react after treating with 10%HCl.
- C 70-↓ cm Yellowish red [5 YR 5/6], moist, friable, non-structured, sandy loam, weathered rock fragments up to d=15 cm, non-react after treating with 10%HCl.

The soil is characterised with dark brown humus horizon with high organic matter content. Table 3.4 shows some of its main characteristics. According to these data the soil texture varies from loamy to sandy loam in deeper soil horizon. The pH values do not show variety, and soil reaction is slightly acid.

Tab. 3.4: Main soil characteristics of Cambisols (Profile 4) in National Park “Rogen”

Horizons	Depth, cm	pH (H ₂ O)	Soil moisture, %	OM, %	Particle size particles mm, %			
					2-0.2	0.2-0.02	0.02-0.002	<0.002
Ah	0-10	5.10	5.47	8.15	34.79	35.12	22.19	7.90
A	10-25	4.95	4.91	6.36	33.64	34.52	23.90	7.94
AB	25-55	5.20	3.73	1.93	32.86	33.17	22.32	11.65
BC	55-70	5.25	3.73	1.79	35.10	32.66	21.91	10.33
C	70-↓	5.05	2.84	0.76	n. d.	n. d.	n. d.	n. d.

Profile 5: Situated approximately 2000 m to the west from profile 4. The pit is located in a mountainous meadow. The attitude is 1700m, and the topography is mountainous plato. Miscellenious grasses with predomination of *Graminae* present the vegetation.

- Ah 0-8 cm Very dark brown [10 YR 2/2], moist, slightly compacted, granular structure, single quarts grains, clay loam, roots, the transition is gradually, non-react after treating with 10%HCl.
- A 8-30 cm Black [10YR 2/1], moist, non-compacted, middle granular structure, single quarts grains with diameter up to 10cm, sandy loam, non-react after treating with 10%HCl.
- AB 30-60 cm Strong brown [7.5 YR 5/6] with dark brown [7.5 YR 4/4] spots, moist, non-compacted, small granular structure, single quarts grains and rock fragments with size up to 20 cm, clay loam, the transition is graduated, non-react after treating with 10%HCl.
- C 60-↓ cm weathered rock fragments

Profile 5 is characterised with dark brown humus horizon, rich of organic matter. In Table 3.5 are presented main characteristics of profile 5. Soil texture varies from clay loam in upper horizon to sandy loam. Content of organic matter sharply decrease in depth. Soil reaction is similar like profile 4 and is determined as slightly acid.

Tab. 3.5: Main soil characteristics of Cambisoils (Profile 5) in “Haidushki polyany”

Horizons	Depth, cm	pH (H ₂ O)	Soil moisture, %	OM, %	Particle size particles mm, %			
					2-0.2	0.2-0.02	0.02-0.002	<0.002
Ah	0-8	4.80	6.57	11.10	44.45	33.65	17.40	4.50
A	8-30	5.05	6.62	6.79	51.83	29.65	15.04	3.48
AB	30-60	5.20	4.16	1.97	40.41	35.10	18.76	5.73
C	60-↓	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.