

**EUROSOIL 2008 - EXCURSION 2SVK-post-congress**  
**“SOILS WITH EXTREME TEXTURE AT ZAHORSKA LOWLAND”**

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## **1 GENERAL INTRODUCTION**

### **1.1 Aim of the excursion**

The aim of the excursion is to present unusual soilscape of Zahorska Lowland developed on parent materials of extreme texture. The excursion will involve three topics. The first one will be the visit of alluvial plane with hydromorphic soils of varying texture (heavy and light). Fluvisols and Gleysols of Zahorska Lowland are very different from hydromorphic soils of Danube Lowland also because they are non-calcareous. The second topic will be the soils developed on eolian sands. These soils are very light in texture and are affected mainly by weathering resulting in formation of Cambic horizons, but in some areas also by clay illuviation or podzolization. The third topic will be Vertisols developed on heavy Neogene deposits with high content of swelling clays.

### **1.2 Route**

*Itinerary:*

Vienna – Bratislava – Rohoznik – Gbely – Bratislava - Vienna

*Stops:*

Stop 1. Rohoznik, Soil profile 1 – Albic Podzol

Stop 2. Gbely, Soil profile 2 – Gleyic Fluvisol Eutric

Stop 3. Gbely, Soil profile 3 – Gleyic Mollic Fluvisol Eutric

Stop 4. Gbely, Soil profile 4 - Lamellic Luvisol

Stop 5. Gbely, Soil profile 5 - Mollic Grumic Vertisol Pellic

### 1.3 Climate

Slovakia is situated approximately in the middle of the temperate macroclimatic zone. According to Koppen climatic classification the Danube Lowland belongs to *Cfb* climatic class (*C* – temperate climate, mean temperature of warmest month is over 10 °C and mean temperature of coldest month is between -3 and 18 °C, *f* – significant precipitations is distributed among all seasons, *b* – mean temperature of warmest month is below 22 °C) (PETROVIC, 1972).

*The basic climatic data:*

Mean annual temperature: 9 °C,

Mean monthly temperature of July: 18 – 20 °C,

Mean monthly temperature of January: -1 – -3 °C,

Mean annual sum of precipitation: 450 – 600 mm.

### 1.4 Topography

The basic structures of present relief of Slovakia were formed by Alpine orogene. In Paleogene the originally slightly undulated plateau was disintegrated by network of faults to large blocks. The tectonic movements were active selectively in several phases during Neogene starting in Burdigalian and they were most intensive in Pontian. The Carpathians were uplifted to more than 2000 m and the basins south of Carpathians were sunken more than 4000 m (MAZUR & KVITKOVIC, 1980). The sunken basins were filled by marine and lacustrine deposits and the flat or slightly undulated accumulation relief originated.

The Zahorska Lowland comprise of three major geomorphological units:

- 1) The alluvial plain formed by Morava, the only large river passing through Zahorska Lowland. It is only few km wide. Its elevation is decreasing from 154 m above sea level at its northern end to 138 m above sea level at its southern end.
- 2) The central hilly land with elevation of 140-257 m involves the belt of river terraces of Morava and the neogene hills covered by eolian sands.
- 3) The piemont tectonic furrow between the central hilly land and Carpathians bordering Zahorska Lowland from east.

The microrelief of the whole Zahorska Lowland was influenced by wind activity. The relief of wind dunes is dominant in most of central hilly land and thin wind deposits cover also large parts of Morava alluvial plane and terraces.

### 1.5 Geology

The Zahorska Lowland belongs geologically to *Vienna Basin*. It is a sunken unit of Alpine - Himalayan orogenic zone. It separates the Carpathians from Alps. The basement of northern parts of this basin is built by Carpathian structural units, mainly the Carpathian Flysch and Klippen

Belts and partially by Krizna and Choc Nappes. The Vienna Basin is filled by thick marine Neogene fillings composed of Burdigalian and Helvetian sands, conglomerates and clays and Tortonian and Sarmatian gravels, sands, sandstones and clays. On the top there are lacustrine Pannonian, Pontian and Levantian clays and gravels (FUSAN, 1972).

The Neogene fillings are covered by relatively thin Quaternary deposits. The western parts of the Zahorska Lowland are covered by fluvial gravels and sands of Morava river. The central part is covered by wind-blown sands. Their thickness varies from 1 up to 80 meters near Malina Brook (VASKOVSKY, 1977). In the most elevated part of Zahorska Lowland the Quaternary deposits are missing and the Neogene sands and clays are outcropping. The eastern periphery of Zahorska Lowland bordered by Carpathians is filled by coarse proluvial deposits.

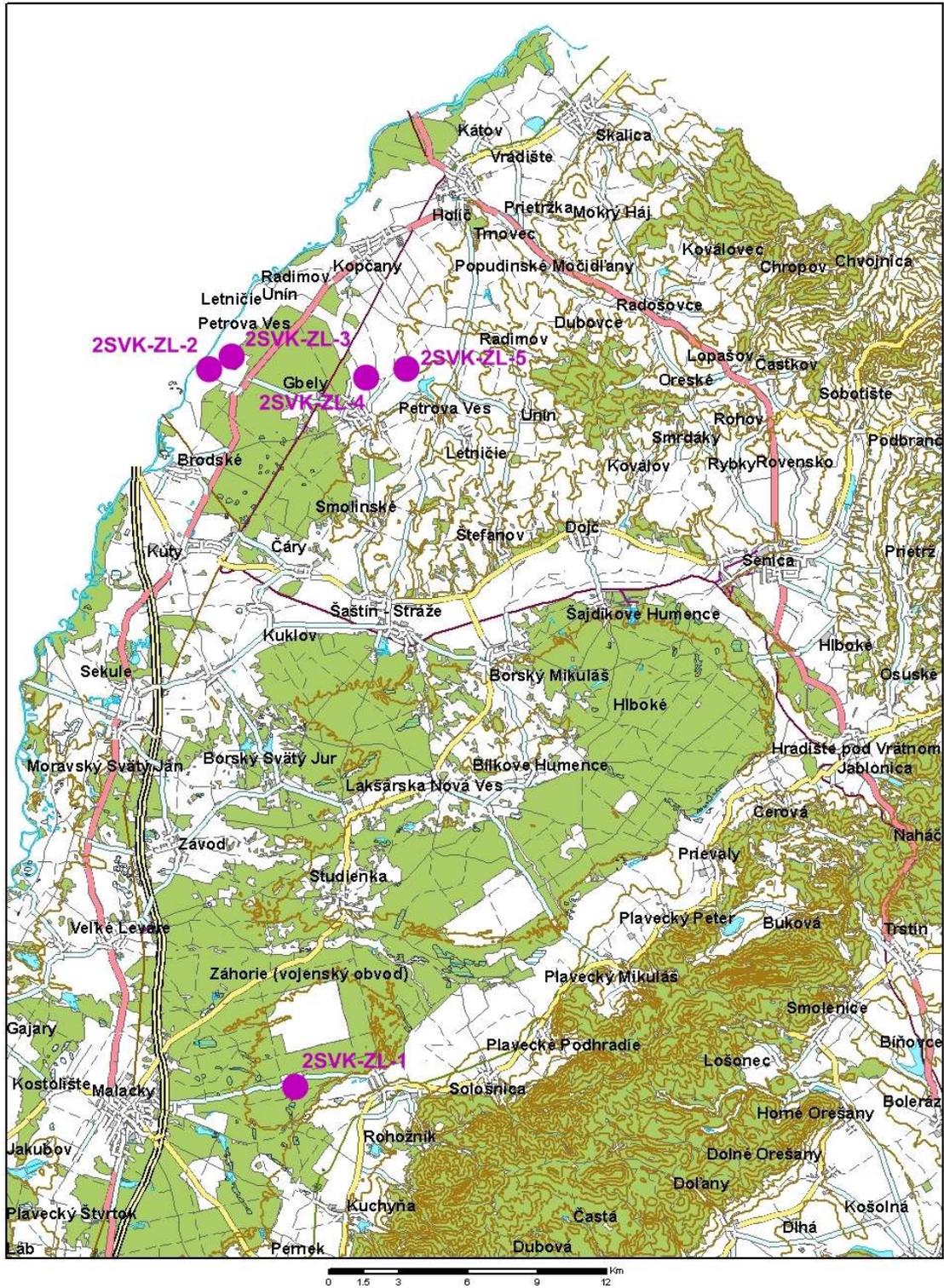
### **1.6 Land use**

The natural vegetation of alluvial plain was represented by the poplar-willow forest occupying the areas with intensive seasonal flooding and ash-elm forests growing in areas free of flooding but affected by ground water. The hilly land was overgrown by acidophilous oak-hornbeam-pine forests. In the depressions between the dunes and between the proluvial cones in the piedmont tectonic furrow the alder forests and peatlands developed.

Large part of Zahorska Lowland is not suitable for cultivation due to poor parent material of soils and it remains still under the forest. It is the largest lowland forest complex in Slovakia. However the original oak-hornbeam-pine forests were replaced by secondary pine forests. Intensive timber harvesting affected not only on the vegetation of the forests but also the soils.

In those areas which are cultivated the major crops are maize (both grain and forage), winter wheat, spring barley, rye, triticale, sunflower and oil rape.

### **1.7 Map of the route (next pages)**



## 2 METHODS

### 2.1 Soil physical analyses

Soil physical parameters were analysed using traditional analytical methods used in Slovakia which are based on treating the soil ring samples. All these methods are described in the soil analytical handbook assembled by FIALA et al. (1999).

- Particle size distribution: Pipette-Method after Novak (FIALA et al., 1999).
- Dry bulk density: determination from ring samples after FIALA et al. (1999).
- Soil particle density: Pycnometer Method after FIALA et al. (1999).
- Total porosity: calculated from bulk density and particle density.
- Hydrolimits (Vol.% water at pF 2.0; 2.5; 4.2):
- Pore size distribution (non-capillary, semi-capillary and capillary porosity) and available field capacity: determination from ring samples after FIALA et al. (1999).
- Saturated water conductivity: determination from ring samples after VELEBNY (1982).

### 2.2 Soil chemical analyses

Most of chemical parameters (except for available Phosphorus and available Potassium) are analysed using international standardised methods (ISO Standards).

- pH(CaCl<sub>2</sub>): ISO 10 390
- CaCO<sub>3</sub>: volumetric method, STN ISO 10 693
- Electric Conductivity: STN ISO 11 265
- C<sub>org</sub>: Walkey-Black Method, ISO 14 235
- N<sub>tot</sub>: modified Kjeldahl method, STN ISO 11 261
- „Plant available“ P: Egner method (FIALA et al., 1999)
- „Plant available“ K: Schachtschabel method (FIALA et al., 1999)
- Exchangeable cations, CEC<sub>eff</sub>, base saturation: STN ISO 13 536
- Total contents in Aqua Regia-extract of the elements (P, Ca, Mg, K, Na, Fe, Al, Mn): STN ISO 11 466, STN ISO 11 047

### 2.3 Soil classification

- Classification system used: WRB 2006.

### 3 EXCURSION POINTS

#### 3.1 Excursion point 1: Soil profile Rohoznik, Zahorska Lowland: Albic Podzol from eolian sand

##### Location

Central hilly land of Zahorska Lowland covered by sand dunes, (48° 27.466' northern latitude, 17° 07.371' eastern longitude, 224 m above sea)

##### Climate

Climate type: Cfb (Koppen)

**Table 1:** Basic climatic characteristics of Rohoznik site.

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-1.9	0.3	4.4	9.2	14.3	17.4	19.1	18.4	14.7	9.7	4.2	0.0	9.2
R [mm]	38	43	38	49	68	83	67	64	50	44	60	47	651

##### Relief

Flat position at eolian wind cover

##### Landuse/vegetation

Arable land (major crops: grain maize, winter wheat, spring barley, sunflower).

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, winter rye, winter triticale, oil rape).

##### Soil profile description: **Albic Podzol, Rohoznik**

- Oi (0 – 0/1 cm): no decomposed litter of pine needles
- Oe (0/1 – 1/4 cm): partially decomposed (fermented) litter
- A (1/4 – 3/12 cm): sand, 2.5Y/3.5/2.5 (dry), 5Y/2/1 (moist), moist, loose, fine granular, abundant roots, clear wavy boundary.
- AE (3/12 – 8/18 cm): sand, 2.5Y/4/3 (dry), 5B/7/1 (moist), moist, loose, massive, abundant roots, clear irregular boundary.
- Bw (8/18 – 65/70 cm): sand, 2.5Y/4/4 (dry), 10YR/4/2-2.5Y/5/4 (moist), contrast colours, moist, friable, massive, abundant roots, diffuse wavy boundary.

BC (65/70 – 80 cm): sand, 2.5Y/4/6 (dry), 2.5Y/6/4 (moist), moist, friable, massive, few roots, diffuse wavy boundary.

C (80 – 110 cm): sand, 2.5Y/5.5/6 (dry), 2.5Y/7/4 (moist), moist, friable, massive, few roots.

**Table 2:** Soil texture of Soil profile 1, Rohoznik.

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
	[cm]	<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
A	1-4	4.2	0.3	1.2	3.0	25.1	63.1	3.1
AE	7-12	1.5	0.1	0.0	1.6	19.5	71.0	6.2
Bw	25-30	7.4	0.9	2.0	0.5	18.0	65.1	6.2
Bw	45-50	6.3	1.0	0.7	0.4	20.5	65.0	6.0
BC	65-70	2.2	0.3	0.2	0.4	26.0	66.2	4.6
C	120-125	1.8	0.1	0.1	0.4	22.6	69.5	5.6

**Table 3:** Soil physical parameters of Soil profile 1, Rohoznik.

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2,5	pF 4,2	k <sub>r</sub>
	[cm]	[g/cm <sup>3</sup> ]	[vol.%]							[cm. min <sup>-1</sup> ]
A	2-7	1.16	53.4	18.6	9.1	25.7	23.4	18.3	10.6	2.7236
AE	7-12	1.05	59.3	7.9	0.9	50.5	8.3	6.6	4.2	0.6014
Bw	25-30	1.43	46.1	11.9	6.1	28.1	14.2	10.5	5.0	0.5787
Bw	45-50	1.52	42.8	12.3	5.0	25.5	14.2	11.2	6.7	1.0056
BC	65-70	1.57	40.4	13.5	13.1	13.8	18.8	17.3	15.2	1.5982
C	120-125	1.63	38.3	14.7	8.9	14.7	17.6	15.8	13.1	1.1917

**Table 4:** Soil chemical parameters of Soil profile 1, Rohoznik.

Horizon	Sample	pH <sub>CaCl2</sub>	CaCO <sub>3</sub>	EC	C <sub>org</sub>	N <sub>tot</sub>	C/N ratio	P <sub>avail</sub>	K <sub>avail</sub>	K <sub>exch</sub>	N <sub>exch</sub>	Ca <sub>exch</sub>	Mg <sub>exch</sub>	CEC	Base sat.
	[cm]		[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]				[%]	
A	1-4	4.7	<0.05	0.08	9.0	3388	26.7	<20	104	0.2	0.0	8.5	0.9	12.8	75
AE	7-12	4.7	0.1	0.05	2.8	1958	14.5	<20	29	0.0	0.0	4.3	0.2	9.9	46
Bw	25-30	4.9	0.1	0.02	0.6	340	18.8	20	21	0.0	0.0	1.5	0.1	5.5	29
Bw	45-50	4.9	0.1	0.02	0.2	511	-	39	34	0.0	0.0	1.0	<0.02	4.0	24
BC	65-70	5.0	<0.05	0.02	0.2	463	-	120	25	<0.01	0.0	1.0	0.1	1.2	97
C	120-125	5.3	0.1	0.02	0.0	251	-	54	30	<0.01	0.0	0.7	0.1	0.7	100

**Table 5:** Total analyses of Soil profile 1, Rohoznik.

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
	[cm]	[mg/kg]							
A	1-4	261	1216	511	909	47	5030	5754	359
AE	7-12	252	988	880	851	54	5375	6525	429
Bw	25-30	158	663	362	796	48	6037	7054	474
Bw	45-50	157	495	296	677	35	4989	6348	300
BC	65-70	204	456	257	564	32	4504	4956	168
C	120-125	91	434	233	486	24	3577	3240	146



**Figure 1:** Soil profile 1, Rohoznik.

### 3.2 Excursion point 2: Soil profile Gbely (a), Zahorska Lowland: Gleyic Fluvisol Eutric from alluvial deposits

#### Location

Alluvial plain of Morava, (48° 44.027' northern latitude, 17° 01.400' eastern longitude, 159 m above sea)

#### Climate

Climate type: Cfb (Koppen)

**Table 6:** Basic climatic characteristics of Gbely site.

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-2.2	0.1	4.3	9.5	14.4	17.3	18.9	18.6	14.8	9.7	3.9	-0.4	9.1
R [mm]	26	27	26	36	56	65	57	53	37	33	43	37	498

These climatic data are representative for all sites situated in surroundings of Gbely.

#### Relief

Flat alluvial plain.

#### Landuse/vegetation

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, winter rye, winter triticale, oil rape).

#### Soil profile description: Gleyic Fluvisol Eutric, Gbely (a),

- Ap (0 – 30 cm): clay, 2.5Y/5/3 (dry), 10YR/4/2 (moist), wet, plastic, fine subangular blocky, rusty mottles, abundant roots, diffuse smooth boundary.
- AC (30 – 60 cm): silty clay, 2.5Y/4/4 (dry), 7.5YR4/6-10SR6/1.5 (moist), moist, firm, strongly developed fine to medium angular blocky with pressure faces, few roots, diffuse smooth boundary.
- Ab (60 – 70 cm): clay, 2.5Y/4/2 (dry), 2.5YR/4/1-7.5YR3/4 (moist), moist, firm, medium angular blocky with pressure faces, abundant rusty mottles, clear smooth boundary.
- Cl (70 – 115 cm): sandy clay loam, 2.5Y/4/3 (dry), 10YR/2/1.5-7.5YR3/4 (moist), contrast colours, moist, firm, massive, rusty mottles (30% of soil volume), smooth gradual boundary.

Cr (115 – 130 cm): sandy clay loam, 5% of fine gravel (5-15 mm) 2.5Y/3/3 (dry), 7.5YR/3.5/4-10YR2/2 (moist), wet, firm, massive, ground water table at 130 cm.

**Table 7:** Soil texture of Soil profile 2, Gbely (a)

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
[cm]		<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
A	0-20	51.8	15.4	17.6	6.1	1.4	5.5	2.3
AC	35-45	57.9	18.4	17.4	5.0	0.4	0.6	0.2
Ab	60-70	72.9	14.1	3.7	1.0	1.5	5.7	1.1
Cl	90-110	25.1	3.0	2.4	1.8	7.9	46.0	13.8
Cr	120-130	26.2	2.1	3.6	2.0	10.4	43.8	11.9

**Table 8:** Soil physical parameters of Soil profile 2, Gbely (a).

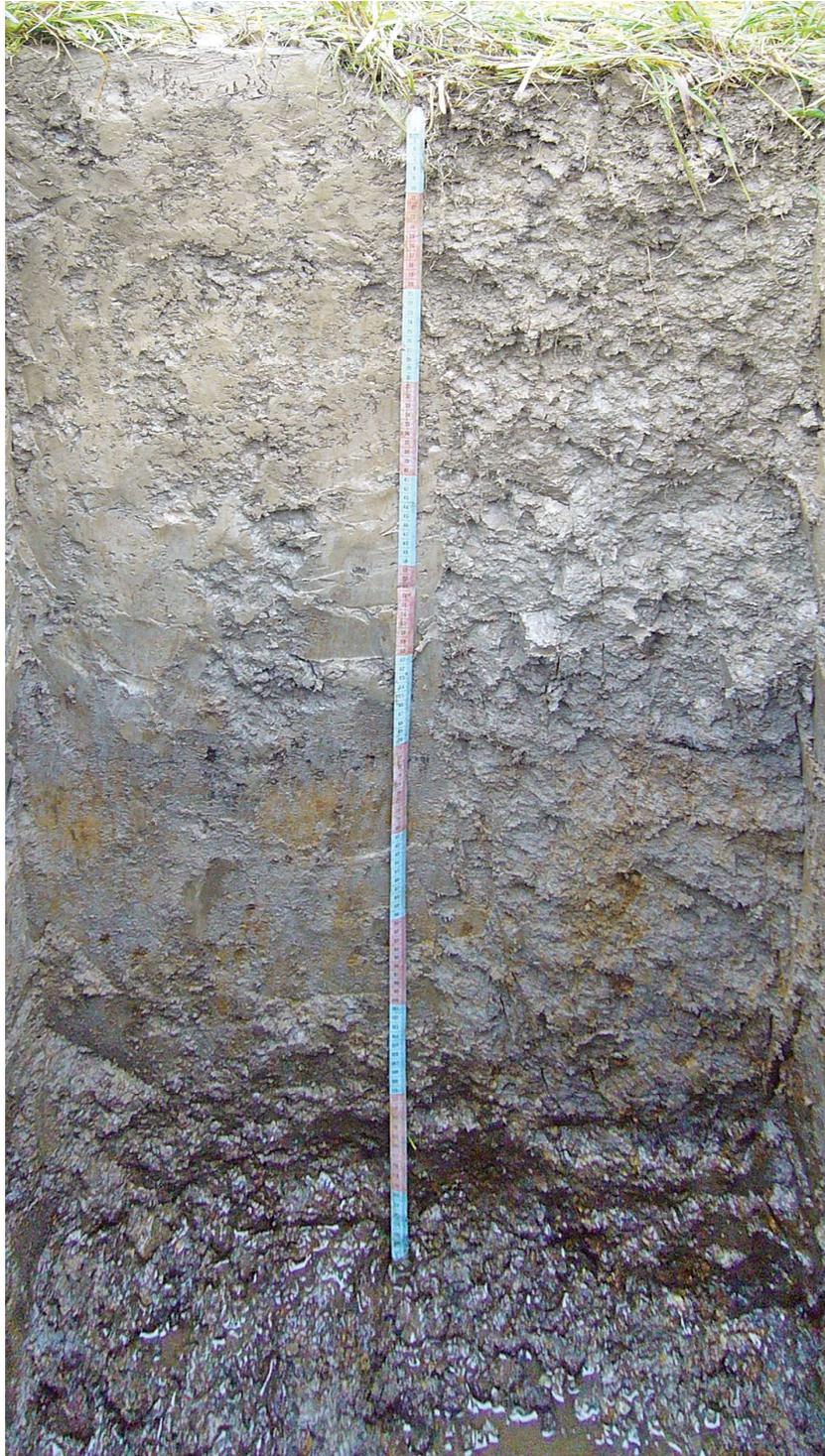
Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2,5	pF 4,2	k <sub>r</sub>
[cm]		[g/cm <sup>3</sup> ]	[vol.%]							[cm. min <sup>-1</sup> ]
A	10-15	1.4	47.3	41.5	1.5	4.3	42.4	34.9	23.7	0.2878
AC	35-45	1.4	49.7	42.1	1.3	6.3	42.6	36.3	26.8	0.0288
Ab	65-70	1.6	40.1	35.7	0.7	3.7	36.0	35.4	34.4	0.0363
Cl	95-100	1.8	33.6	29.7	1.3	2.6	32.1	24.5	13.3	0.0785
Cr	120-130	0.8	18.7	17.0	0.8	0.9	17.6	13.1	6.4	-

**Table 9:** Soil chemical parameters of Soil profile 2, Gbely (a).

Horizon	Sample	pH <sub>CaCl2</sub>	CaCO <sub>3</sub>	EC	C <sub>org</sub>	N <sub>tot</sub>	C/N ratio	P <sub>avail</sub>	K <sub>avail</sub>	K <sub>exch</sub>	Na <sub>exch</sub>	Ca <sub>exch</sub>	Mg <sub>exch</sub>	CEC	Base sat.	
[cm]			[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]	[cmol+/kg]							[%]
A	0-20	5.8	0.1	0.06	2.1	2746	7.8	47	198	0.5	0.1	24.9	4.7	38.7	78	
AC	35-45	6.4	0.1	0.06	1.3	1059	12.1	22	169	0.4	0.2	27.9	5.4	41.3	82	
Ab	60-70	6.7	0.1	0.09	1.2	1518	7.6	26	192	0.3	0.3	35.8	7.0	46.4	94	
Cl	90-100	7.0	0.1	0.09	0.3	377	7.2	20	102	0.1	0.2	13.2	2.4	21.3	75	
Cr	120-130	7.0	0.3	0.09	0.1	373	-	14	73	0.1	0.2	13.5	2.2	21.3	76	

**Table 10:** Total analyses of Soil profile 2, Gbely (a).

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
[cm]		[mg/kg]							
A	0-20	945	2319	8146	14703	243	42376	48184	722
AC	35-45	611	2523	8800	14308	257	45624	48999	858
Ab	60-70	613	2942	9390	14963	341	47776	63574	985
Cl	90-100	354	1980	4328	4831	135	35176	27707	918
Cr	120-130	332	2331	3958	4352	141	40963	21326	6849



**Figure 2:** Soil profile 2, Gbely (a).

### **3.3 Excursion point 3: Soil profile Gbely (b), Zahorska Lowland: Gleyic Mollic Fluvisol Eutric from alluvial deposits**

#### Location

Alluvial plain of Morava, (48° 43.931' northern latitude, 17° 02.116' eastern longitude, 159 m above sea)

#### Climate

Climate type: Cfb (Koppen). Basic characteristics are in tab. 6.

#### Relief

Flat alluvial plain.

#### Land use/vegetation

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, winter rye, winter triticale, oil rape).

#### Soil profile description: **Gleyic Mollic Fluvisol Eutric, Gbely (b)**,

- Ap (0 – 28 cm): sandy loam, 2.5Y/3/2 (dry), 10YR/2.5/2 (moist), moist, loose, weakly developed fine to medium granular in upper part of the horizon, weakly developed medium to large subangular blocky in lower part of the horizon, abundant roots, clear wavy boundary.
- A (28 – 60 cm): sandy loam, 1% of fine alluvial gravel (5-15 mm), 2.5Y/3/1.5 (dry), 10YR/3/2 (moist), moist, friable, massive, few rusty mottles, diffuse smooth boundary.
- AC1 (60 – 90 cm): sandy loam, 15% of fine alluvial gravel (5-20 mm), 2.5Y/4/3 (dry), 10YR/4/2.5 (moist), moist, friable, massive, abundant rusty mottles, black soft manganese nodules (2-5 mm), gradual irregular boundary.
- Cl (90 – 130 cm): sandy loam, 5% of fine alluvial gravel (5-20 mm), 2.5Y/4/6 (dry), 10YR/5-8-10YR2/1 (moist), contrast colours, moist, friable, massive, rusty mottles occupy 40% of soil volume, abundant large soft concentrations of manganese (up to 100 mm), diffuse smooth boundary.
- Cr (130 – 150 cm): sandy loam, 5% of fine alluvial gravel (5-20 mm), 2.5Y/4/4 (dry), 5YR/3/4-10YR/5/8-10YR/2/1-2.5Y/5/4 (moist), contrast colours, moist, friable, massive, rusty mottles occupy 15% of soil volume, abundant large soft concentrations of manganese (up to 100 mm).

**Table 11:** Soil texture of Soil profile 3, Gbely (b).

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
	[cm]	<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	10-20	12.4	2.2	4.3	5.9	10.6	52.2	12.5
A	40-50	12.8	1.7	2.9	3.5	9.7	52.9	16.4
ACl	70-80	12.8	0.3	1.2	1.8	12.6	55.0	16.2
Cl	110-120	9.7	0.2	0.7	1.4	4.7	59.7	23.6
Cg	135-145	8.8	0.6	1.0	1.2	17.0	53.5	17.9

**Table 12:** Soil physical parameters of Soil profile 3, Gbely (b).

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2,5	pF 4,2	k <sub>r</sub>
	[cm]	[g/cm <sup>3</sup> ]	[vol.%]							[cm. min <sup>-1</sup> ]
Ap	15-20	1.16	56.2	17.2	8.6	30.5	20.7	14.7	5.6	1.8910
A	35-45	1.67	36.8	22.5	3.4	10.8	24.8	16.7	4.5	0.5174
ACl	70-80	1.60	39.9	16.1	10.6	13.2	21.4	14.8	5.0	0.3258
Cl	100-110	1.65	38.2	20.5	3.9	13.8	23.0	15.7	4.8	0.8900

**Table 13:** Soil chemical parameters of Soil profile 3, Gbely (b)

Horizon	Sample	pH <sub>CaCl2</sub>	CaCO <sub>3</sub>	EC	C <sub>org</sub>	N <sub>tot</sub>	C/N ratio	P <sub>avail</sub>	K <sub>avail</sub>	K <sub>exch</sub>	Na <sub>exch</sub>	Ca <sub>exch</sub>	Mg <sub>exch</sub>	CEC	Base sat.
	[cm]		[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]	[cmol+/kg]						[%]
Ap	10-20	5.7	0.1	0.07	1.7	1391	12.1	331	210	0.7	<0.001	8.5	0.5	14.1	69
A	40-50	6.3	0.1	0.05	0.5	460	10.9	50	53	0.1	0.0	5.6	0.5	6.4	97
ACl	70-80	6.5	0.1	0.05	0.3	290	10.3	<20	45	0.1	0.0	4.0	0.5	5.5	83
Cl	110-120	6.8	0.1	0.04	0.1	249	-	<20	44	0.1	0.0	3.3	0.7	5.5	74
Cg	135-145	6.9	0.1	0.05	0.1	274	-	<20	50	0.1	0.0	2.7	0.8	5.4	67

**Table 14:** Total analyses of Soil profile 3, Gbely (b).

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
	[cm]	[mg/kg]							
Ap	10-20	1039	1988	1501	2420	76	8569	8899	284
A	40-50	250	1074	1136	1174	44	7062	7494	411
ACl	70-80	133	979	1398	1679	71	8246	9252	432
Cl	110-120	128	865	1345	1600	62	16180	7765	1652
Cg	135-145	101	677	1561	1735	65	8740	7800	250



**Figure 3:** Soil profile 3, Gbely (b).

### 3.4 Excursion point 4: Soil profile Gbely (c), Zahorska Lowland: Lamellic Luvisol from eolian sand

#### Location

Central hilly land of Zahorska Lowland covered by sand dunes, (48° 44.141' northern latitude, 17° 07.071' eastern longitude, 155 m above sea)

#### Climate

Climate type: Cfb (Koppen). Basic characteristics are in tab. 6.

#### Relief

Top of low smooth hill.

#### Land use/vegetation

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, winter rye, winter triticale, oil rape).

#### Soil profile description: Lamellic Luvisol, Gbely (c),

- A (0 – 36 cm): sandy loam, 2.5Y/4/4 (dry), 10YR/4/3 (moist), moist, loose, weakly developed large angular blocky, few roots, few fine charcoal clods (5 mm), clods of material from Bt horizon admixed in lower part of the horizon, sharp broken boundary.
- Bt1 (36 – 60 cm): sandy clay loam, 2.5Y/4,5/6 (dry), 10YR/5/8 (moist), moist, friable, massive, few clay coatings, gradual wavy boundary.
- Bt2 (60 – 75 cm): sandy clay loam, 2.5Y/4,5/6 (dry), 10YR/5/8 (moist), moist, friable, massive, strongly developed lamellar clay accumulations, gradual smooth boundary.
- BC (75 – 90 cm): sandy loam, 2.5Y/6/4 (dry), 2.5Y/5/6 (moist), moist, friable, massive, gradual smooth boundary.
- C (90 – 100 cm): sandy loam, 2.5Y/6/4 (dry), 2.5Y/5/5 (moist), slightly calcareous, moist, friable, massive, few soft calcareous nodules (5-20 mm).

**Table 15:** Soil texture of Soil profile 4, Gbely (c).

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
	[cm]	<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
A	10-20	18.8	1.0	2.9	4.9	14.5	51.7	6.4
Bt1	30-35	19.0	2.2	1.9	4.2	11.0	55.8	6.0
Bt2	40-45	31.4	3.0	2.7	3.7	12.0	43.2	4.0
BC	60-65	28.0	1.1	1.9	6.1	21.1	39.6	2.2
C	90-95	13.3	1.3	0.7	1.5	16.4	63.4	3.5

**Table 16:** Soil physical parameters of Soil profile 4, Gbely (c).

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2,5	pF 4,2	k <sub>r</sub>
	[cm]	[g/cm <sup>3</sup> ]	[vol.%]							[cm. min <sup>-1</sup> ]
A	5-15	1.60	39.2	22.2	4.3	12.7	24.9	17.7	7.0	0.0897
Bt1	30-35	1.63	38.3	19.9	5.4	13.1	22.9	16.7	7.5	0.1024
Bt2	40-45	1.81	32.6	24.7	3.7	4.1	27.5	21.8	13.2	0.0079
BC	60-65	1.59	40.3	24.9	4.3	11.1	27.8	20.8	10.3	0.0224
C	90-95	1.59	40.1	13.0	16.2	10.8	21.9	15.3	5.4	0.8686

**Table 17:** Soil chemical parameters of Soil profile 4, Gbely (c).

Horizon	Sample	pH <sub>CaCl2</sub>	CaCO <sub>3</sub>	EC	C <sub>org</sub>	N <sub>tot</sub>	C/N ratio	P <sub>avail</sub>	K <sub>avail</sub>	K <sub>exch</sub>	Na <sub>exch</sub>	Ca <sub>exch</sub>	Mg <sub>exch</sub>	CEC	Base sat.
	[cm]		[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]					[%]
A	10-20	6.5	0.2	0.10	1.0	810	12.6	306	272	0.9	0.0	6.7	0.8	10.4	80
Bt1	30-35	6.6	0.2	0.09	0.6	335	17.6	315	194	0.7	0.0	6.1	0.7	11.7	63
Bt2	40-45	6.8	0.1	0.06	0.2	316	6.0	89	240	0.8	0.0	9.0	2.0	15.2	78
BC	60-65	7.0	0.1	0.05	0.1	526	-	<20	126	0.3	0.1	7.5	1.6	11.6	82
C	90-95	7.4	1.9	0.10	0.0	100	-	<20	65	0.1	0.0	4.9	0.6	5.4	103

**Table 18:** Total analyses of Soil profile 4, Gbely (c).

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
	[cm]	[mg/kg]							
A	10-20	628	1479	1815	3030	76	8487	10057	237
Bt1	30-35	725	1562	2040	3140	79	9701	10550	258
Bt2	40-45	297	1095	4422	6032	118	19889	43253	244
BC	60-65	173	971	3191	3753	83	13612	27229	282
C	90-95	119	5480	2282	1858	50	7157	11119	218



**Figure 4:** Soil profile 4, Gbely (c).

### 3.5. Excursion point 5: Soil profile Gbely (d), Zahorska Lowland: Mollic Grumic Vertisol Pellic from Neogene clays

#### Location

Central hilly land of Zahorska Lowland with outcropping Neogene basement, (48° 44.732' northern latitude, 17° 08.684' eastern longitude, 203 m above sea)

#### Climate

Climate type: Cfb (Koppen). Basic characteristics are in tab. 6.

#### Relief

Top of low smooth hill.

#### Landuse/vegetation

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, winter rye, winter triticale, oil rape).

#### Soil profile description: Mollic Grumic Vertisol Pellic, Gbely (d),

- Ap (0 – 30 cm): clay, 2.5Y/3/2 (dry), 2.5YR/2/1 (moist), wet, plastic, subangular to angular blocky, clear smooth boundary.
- Ai (30 – 70 cm): clay, 2.5Y/3/1.5 (dry), 2.5YR/2/1, wet in upper part, moist in lower part, plastic in upper part, very firm in lower part, abundant slickensides, parallelepiped structure, 1 - 2 cm wide cracks when dry, clear irregular boundary.
- ACi (70 – 90 cm): clay, 5Y/5/2 (dry), 2.5YR/5/4, (moist), moist, very firm, abundant diffuse Fe<sup>3+</sup> mottles, abundant slickensides, parallelepiped structure, clear irregular boundary.
- Ci (90 – 120 cm): clay, 2.5Y/7/2 (dry), 5YR/5/2 (moist), slightly calcareous, moist, firm, medium to coarse platy, few fine Fe<sup>3+</sup> mottles.

**Table 19:** Soil texture of Soil profile 5, Gbely (d).

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
	[cm]	<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	5-20	66.0	12.7	12.2	5.4	1.1	2.2	0.5
Ai	45-50	72.9	12.6	9.0	3.5	0.7	1.1	0.3
ACi	80-90	73.7	16.7	6.8	1.9	0.4	0.5	0.0
Ci	100-110	72.2	16.8	9.4	1.0	0.2	0.4	0.0

**Table 20:** Soil physical parameters of Soil profile 5, Gbely (d).

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2,5	pF 4,2	k <sub>r</sub>
	[cm]	[g/cm <sup>3</sup> ]	[vol.%]							[cm. min <sup>-1</sup> ]
Ap	10-15	1.28	49.5	43.6	1.8	4.1	44.9	38.6	29.2	0.0003
Ai	40-45	1.30	50.7	44.2	1.9	4.6	45.6	39.9	31.4	0.0165
ACi	70-75	1.30	50.9	42.7	2.1	6.1	44.3	39.8	33.1	0.0003
Ci	95-100	1.29	51.4	41.9	1.9	7.6	43.7	39.6	33.6	0.0021

**Table 21:** Soil chemical parameters of Soil profile 5, Gbely (d).

Horizon	Sample	pH <sub>CaCl2</sub>	CaCO <sub>3</sub>	EC	C <sub>org</sub>	N <sub>tot</sub>	C/N ratio	P <sub>avail</sub>	K <sub>avail</sub>	K <sub>exch</sub>	Na <sub>exch</sub>	Ca <sub>exch</sub>	Mg <sub>exch</sub>	CEC	Base sat.
	[cm]		[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]	[cmol+/kg]						[%]
Ap	5-20	5.5	0.1	0.09	3.0	2774	10.6	129	562	1.5	0.1	31.4	11.9	47.7	94
Ai	45-50	5.9	0.1	0.05	1.8	1715	10.7	<20	317	0.4	0.3	30.0	14.1	46.4	97
ACi	80-90	6.8	0.2	0.19	0.9	995	9.2	<20	307	0.4	0.7	25.4	15.3	45.1	93
Ci	100-110	7.1	2.6	0.34	0.3	781	4.2	<20	316	0.4	0.9	22.8	13.3	38.6	97

**Table 22:** Total analyses of Soil profile 5, Gbely (d).

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
	[cm]	[mg/kg]							
Ap	5-20	554	2810	8597	11053	269	37131	51166	648
Ai	45-50	194	2883	9396	12756	382	37869	58113	492
ACi	80-90	200	2471	10943	14213	480	37981	61395	405
Ci	100-110	219	10676	11801	14427	518	38443	58220	350



5 a) Cracking A horizon



5 b) Slickensides

**Figure 5:** Soil profile 5, Gbely (d).



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