Acta Geodyn. Geomater., Vol. 4, No. 3 (147), 39-49, 2007

CHARACTERIZATION OF ANTHROPOGENIC INFLUENCE ON THE SOIL COVER ON SELECTED LOCALITIES OF PRAGUE

Anna ŽIGOVÁ [1)]*, Martin ŠŤASTNÝ [2)], Jana KREJČOVÁ [3)] and Pavel HÁJEK [2)]

[1)] *Institute of Geology, Academy of Sciences of the Czech Republic,v.v.i., Rozvojová 269, 165 00 Praha 6 - Lysolaje, Czech Republic*
[2)] *Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, v.v.i., V Holešovičkách 41, 182 09 Praha 8, Czech Republic*
[3)] *Crop Research Institute,v.v.i., Drnovská 506, 161 06 Praha 6 - Ruzyně, Czech Republic*
**Corresponding author's e-mail:* zigova@gli.cas.cz

(*Received* August 2007*, accepted* September 2007)

ABSTRACT
The character of soil cover in anthropogenically affected areas was determined on the basis of soil morphology, particle size distribution, soil chemical properties, soil organic matter properties and mineralogy of clay fraction. The degree of anthropogenic influence was variable in the individual soil profiles. This is probably the first time that data on hot-water extractable carbon distribution in soil profile were obtained from the territory of Prague.

KEYWORDS: soil development, clay mineralogy, anthropogenically affected areas of Prague, loess, hot-water extractable carbon

INTRODUCTION

The area of Prague has undergone a long and continuous prehistoric development, with the Neolithic sites in the north and the relatively recent Medevial colonizations in the south. Numerous archaeological finds were described in detail by Lutovský et al. (2005).

The first infomation on soils in Prague was published by Počta (1905). The significance of paleosols for soil evaluation of the Quaternary was established by Smolíková (1967, 1968, 1975). Engineering aspects of soils and sediments were discussed in a paper by Záruba (1948). The state of agricultural soil resources was the subject of the study by Damaška and Němeček (1966). Haberle et al. (2004, 2006) studied the effect of mineral nitrogen on soils in field experiments.

Disturbance of stability of soil development in urban areas of Prague by construction activities is a common phenomenon. Žigová and Šťastný (2006) reported some aspects of this phenomenon. The present study is focussed on the character of soil cover in conditions of anthropogenic influence.

MATERIAL AND METHODS

The research was conducted in territories with anthropogenic impact without natural vegetation.

The climate in Prague is a function of natural conditions and the influence of urban building. The climatic gradient is almost 100 mm for the mean annual precipitation and almost 1 °C for mean annual temprature along the north–south transect. The territory of Prague belongs to the warm region T 2 in the classification of Quitt (1971). The southeastern part is a moderately warm region MT 10.

The rocks are mainly shales of Proterozoic age (Praha – Internacionální) or Ordovician age, the latter belonging to the Arenig and Llanvirn series (Praha – MO) and Beroun series (Praha – Bohdalecká). The soils are developed on loesses of the Würm glacial period (Chlupáč, 1999; Kříž, 1999; Kovanda, 1992).

Profiles with different levels of anthropogenic influence were selected for the present paper.

The coordinates are given in the WGS 84 system.

The study area of Praha – Bohdalecká (Fig. 1) in the southeast, in the district of Vršovice, is located 248 m above sea level, with coordinates 50°03.586' N and 14°28.172' E. The profile was sampled at a site with all horizons preserved, during a construction activity. A frost wedge reaching to a depth of approximately 3 m was observed here (Fig. 2).

The soil profile of Praha – Internacionální (Fig. 3) in the northern part of Prague, in the district of Suchdol, is situated 290 m above sea level, with coordinates 50°06.915' N and 14°31.456'E. In this case, construction activity was started on the present surface.

The profile of Praha – MO (Fig. 4) is situated in the centre of Prague in the district of Hradčany, in the precinct of the Ministry of Defence. This area is located 255 m above sea level, with coordinates 50°05.703' N and 14°23.849' E. The profile was buried beneath a landfill layer 2.5 m thick. Material of horizon C is different. Loess is followed by a colluvium of marl and finally by loess. A propasal of improvement at this site was published by Cílek (2001).

Morphological descriptions and horizon designation follow the guidelines of FAO (2006). Colors were identified using the Munsell Soil Charts (1994). Soil horizons and types were classified according to the World Reference Base for soil resources (WRB, 2006). Some layers of the profiles are formed by redeposited soil material. This material is herein referred to as pedosediments (M). The samples were collected from individual horizons with the exception of landfill layers at Praha – MO and uppermost 14 cm of the profile at Praha – Internacionální. Particle size distribution was determined by the pipette method, pH_{H2O} was measured with an electrode SenTix21 (soil:solution ratio 1:2.5), $CaCO_3$ was determined by volumetric method, Cox was determined by wet combustion, total N by the Kjeldahl method, base saturation, cation exchange capacity (CEC) and exchangeable K^+, Na^+, Mg^+, Ca^+ by the Mehlich method. Hot-water extractable carbon determination followed the method of Ghani et al. (2003) with a minor modification: 50 ml distilled water were added to 2 g of soil (size < 0.25 mm) in 100 ml Erlenmeyer bottles in the first stage of preparation. The samples were placed into a drier for 24 h at the temperature of 80 °C. In the course of warming, heated samples were stirred five times and then, filtered extracts were measured. Samples of clay (size < 0.001 mm) for X-ray diffraction were separated by sedimentation from a dense suspension in distilled water and mounted on oriented slides (Jackson, 1979). The specimens were studied first air-dry, and then saturated in ethylene glykol at 80 °C for four hours in a furnance and finally heated in a muffle furnance at 550 °C for four hours. X-ray diffraction spectra were obtained on a diffractometer Philips PW 3710 under the following working condition: CuKα radiation , 40 kV, 55 mA, goniometric shift 1°. min^{-1}, 2Θ. Semiquantitive values were calculated from individual mineral basal peaks.

RESULTS AND DISCUSIONS

SOIL MORPHOLOGY

A brief morphological description of the studied profiles is presented in Table 1.

The profile of Praha – Bohdalecká is specific in its variable thickness of the individual horizons. All hozions contain small rock fragments. Some pedosediments may be missing at some parts of this site. M_1 horizon is influenced by human activity. Horizons M_1, M_2, M_3, M_4, M_5 have different structures, contents of rock fragments and anthropogenic material, and the abundance of roots and worm casts. The buried profile below the pedosedimets consists of horizons Btb_1, Btb_2 and Ck only. The structure of horizons Btb_1 and Btb_2 is well developed medium subangular blocky, but the content of clay coatings is different. Soil horizons have been indicated a soil with a pedogenetic clay differentation. Pseudomycelia are a form of secondary carbonates in horizon Ck. The absence of the overlying horizons prevents to classify the soil type in detail. Pedogenic process of clay illuviation is typical for Albeluvisol and Luvisol.

The profile of Praha – Internacionální was classified as Haplic Chernozem. The uppermost 14 cm of the profile show a higher content of anthropogenic material and a poorly developed structure. The original color of this part of the profile is dark grayish brown. Yellowish brown-colored layers 1 cm thick were decribed only locally. Structure of A horizons is well developed from medium angular blocky to fine angular blocky with the presence of worm casts. The contents of anthropogenic fragments in A horizons are variable. Bk horizons consist of pseudomycelia, and clay coatings were documented in horizon Bk_1 only. Secondary carbonates in horizon Ck have the form of pseudomycelia and hard hollow concretions.

Morphology of landfill layers in the profile of Praha – MO were examined and classified as Technosol. Individual horizons of Technosol differ in their colors. The uppermost 40 cm are dark yellowish brown, next 10 cm are yellow, being followed by dark brown 20 cm and finally by gray 180 cm. This soil has a poorly developed structure, high content of various anthropogenic material and rock fragments. Individual horizons of the buried soil have different anthropogenic material and rock fragments. Buried soils have probably a polygenetic character because clay coatings have been preserved in horizons Ab_1 and Ab_2. Clay differentation was probably the first stage of pedogenesis. A change in the condition of soil development led to the development of Chernozem. This stage is documented by the well developed structure and the presence of worm casts. Horizons ICk and III Ck consist of pseudomycelia, hard hollow concretions and soft concretions. The structure of horizon IICk is medium prismatic.

Morphological anylysis showed that anthropogenic influence affected the frequency of anthropogenic material in the upper parts of the profiles, especially at the site of Praha – Internacionální.

PARTICLE SIZE DISTRIBUTION

The results of the particle size distribution are shown in Table 2.

Soil horizons M_1, M_2, M_3, M_4, M_5 at Praha – Bohdalecká showed differences in particle size

Table 1 Morphological description of soil profiles
MEAB - medium angular blocky, FIAB - fine angular blocky, MESB - medium subangular blocky, FISB - fine subangular blocky, MEPR - medium prismatic, MECR - medium crumbly, COGR - coarse granular, MEGR - medium granular, PM – pseudomycelia, HHC - hard hollow concretions, SC - soft concretions, CFF – common very fine and fine, FFF - few very fine and fine

Horizon, depth (cm)	Colour (moist)	Structure	Rock fragments	Anthropogenic material	Clay coatings	Forms of secondary $CaCO_3$	Roots	Worm casts	Boundary
Praha - Bohdalecká									
M_1 0-20	10YR 3/2	MEAB	Very few	Very few	None	None	CFF	Common	Clear
M_2 20-40	10YR 4/3	FIAB	Very few	None	None	None	FFF	Very few	Clear
M_3 40-53	10YR 5/3	FISB	Very few	None	None	None	None	Very few	Clear
M_4 53-83	10YR 6/4	FISB	Very few	None	None	None	None	Very few	Clear
M_5 83-117	10YR 5/6	FISB	Very few	None	None	None	None	Very few	Abrupt
Btb_1 117-144	7.5YR 6/4	MESB	Very few	None	Common	None	None	None	Clear
Btb_2 144-189	7.5YR 6/6	MESB	Very few	None	Many	None	None	None	Abrupt
Ck 189-226	10YR 7/4	MEPR	Very few	None	None	PM	None	None	Abrupt
Praha - Internacionální									
A_1 14-39	10YR 3/2	MECR	Very few	Few	None	None	FFF	Few	Clear
A_2 39-73	10YR 3/3	FIAB	None	Very few	None	None	VFF	Very few	Clear
Bk_1 73-83	10YR 4/4	MESB	None	None	Few	PM	None	Very few	Clear
Bk_2 83-113	10YR 5/6	MESB	None	None	None	PM	None	None	Clear
Bk_3 113-136	10YR 7/8	MESB	None	None	None	PM, HHC	None	None	Clear
Ck 136-284	10YR 6/6	MEPR	None	None	None	PM, SC, HHC	None	None	Clear
Praha - MO									
Ab_1 0-45	10YR 3/1	MEGR	Very few	Very few	Few	None	VFF	Many	Clear
Ab_2 45-87	10YR 3/2	COGR	Very few	None	Few	None	VFF	Common	Abrupt
Ck 87-165	10YR 7/4	MEPR	None	None	None	PM, SC, HHC	None	None	Clear
IICk 165-281	10YR 6/1	MESB	Common	None	None	None	None	None	Clear
IIICk 281-321	10YR 5/8	MEPR	Very few	None	None	PM, SC, HHC	None	None	Clear

Table 2 Particle size distribution.

Depth cm	**<0.001 mm** %	**<0.01 mm** %	**0.01-0.05 mm** %	**0.05-0.25 mm** %	**0.25-2.00 mm** %
Praha - Bohdalecká					
0-20	9.8	29.1	24.7	14.7	31.5
20-40	9.1	32.8	23.4	18.2	25.6
40-53	19.0	40.0	25.7	13.2	21.0
53-83	18.1	42.8	24.4	15.9	16.8
83-117	20.8	46.0	26.9	13.0	14.0
117-144	29.6	37.1	38.6	14.9	9.5
144-189	26.0	42.4	36.7	15.0	5.9
189-226	19.7	35.2	31.7	19.4	13.7
Praha - Internacionální					
14-39	25.0	44.1	43.7	5.0	7.2
39-73	28.6	47.3	46.2	4.6	1.9
73-83	28.8	49.8	45.2	3.9	1.1
83-113	20.1	40.9	45.6	11.8	1.7
113-136	22.2	37.0	49.2	13.0	1.0
136-284	23.7	47.4	36.5	12.6	3.4
Praha - MO					
0-45	30.8	52.4	34.0	8.9	4.6
45-87	32.2	48.9	40.3	7.4	3.4
87-165	18.9	42.7	43.1	11.0	3.2
165-281	31.1	47.8	17.5	32.0	2.7
281-321	24.9	43.8	31.0	13.6	11.5

distribution, especially in the fractions of 0.05–0.25 mm and 0.25–2.00 mm. This type of particle size distribution indicated that M horizons were formed from different types of material. Horizons Btb_1, Btb_2 and Ck are characterized by a high content of fraction 0.01–0.05 mm. Horizons Btb_1 and Btb_2 show an elevated content of particles of <0.001 mm in size. The absence of overlying horizons prezent to determine the stage of clay illuviation. The individual horizons were defined with respect to textural classes as follows: M_1 – sandy loam, M_2 – loam, M_3 – loam, M_4 – loam, M_5 – clay loam, Btb_1 – loam, Btb_2 – loam, Ck – loam.

Fraction of 0.01–0.05 mm dominates the profile of Praha – Internacionální. Elevated contents of fraction 0.25–2.00 mm were observed in horizon A_1. This is covered by a layer with high content of anthropogenic material 14 cm thick. The individual horizons were defined with respect to textural classes as follows: A_1 – loam, A_2 – clay loam, Bk_1 – clay loam, Bk_2 – loam, Bk_3 – loam, Ck – clay loam.

Fraction of 0.01–0.05 mm dominates all horizons of the profile of Praha – MO except for horizon IICk, which consists of marl colluvium. Ab_1 and Ab_2 horizons have a high content of particles <0.001 mm in size: a feature ussually characteristic for soils affected by the process of clay illuviation. The individual horizons were defined with respect to textural classes as follows: Ab_1 – clay loam, Ab_2 – clay loam, ICk – loam, IICk – clay loam, III Ck – loam.

The particle size distribution of the examined profiles showed a general tendency. Prevailing particle size category of soils is 0.01–0.05 mm. In case that a part of the profile is formed under higher or direct anthropogenic influnce, the content of fraction 0.25–2.00 mm is elevated. The elevated content of particles <0.001 mm in size (Praha – Bohdalecká and Praha – MO) indicates the process of clay illuviation.

SOIL CHEMICAL PROPERETIES

The datas of soil chemical properties are summarized in Table 3.

Profile Praha – Bohdalecká is neutral in horizon M_1. Further down, the value of pH is weakly basic as far as to horizon Btb_1, weakly acid in horizon Btb_2 and finally neutral in horizons Btb_2 and Ck. In contrast, the pH value is neutral in horizons A_1, A_2, Bk_1, Bk_2 at Praha – Internacionální. Horizons Bk_3 and Ck show basic pH values. The profile of Praha – MO is weakly basic.

The content of $CaCO_3$ correspond to the type of parent material, pH and type of the pedogenic processes.

Base saturation reaches a value of 100 % in the profiles of Praha – Internacionální and Praha – MO.

Table 3 Chemical properties of soil profiles.
CEC – cation exchange capacity , BS – base saturation, K^+ - exchangeable K, Na^+ - exchangeable Na, Ca^{2+} - exchangeable Ca, Mg^{2+} - exchangeable Mg.

Depth cm	pH_{H2O}	$CaCO_3$ %	BS %	CEC mmol/100 g	K^+ mmol/100 g	Na^+ mmol/100 g	Ca^{2+} mmol/100 g	Mg^{2+} mmol/100 g
Praha - Bohdalecká								
0-20	7.03	1.4	89.0	26.6	0.66	0.14	24.00	1.92
20-40	7.18	1.0	100.0	23.5	0.44	0.20	21.32	2.03
40-53	7.18	<0.1	92.0	18.6	0.40	0.23	14.75	2.05
53-83	7.18	<0.1	70.0	16.8	0.42	0.20	12.36	2.10
83-117	7.17	<0.1	74.0	17.3	0.22	0.26	12.42	2.40
117-144	7.10	<0.1	85.0	23.9	0.28	0.42	19.54	3.40
144-189	6.88	<0.1	90.0	21.0	0.24	0.75	16.74	3.73
189-226	7.57	1.8	100.0	16.8	0.17	0.74	17.67	2.58
Praha - Internacionální								
14-39	7.43	0.7	100.0	21.5	0.51	0.03	20.17	1.56
39-73	7.79	<0.1	100.0	20.9	0.31	0.07	17.98	1.61
73-83	7.84	1.2	100.0	20.7	0.35	0.13	20.39	1.58
83-113	8.10	16.0	100.0	16.2	0.27	0.11	19.09	1.36
113-136	8.25	14.0	100.0	14.7	0.27	0.11	19.55	1.48
136-284	8.25	9.5	100.0	18.9	0.27	0.14	23.20	2.51
Praha - MO								
0-45	7.38	<0.1	100.0	24.3	0.35	0.36	20.16	3.12
45-87	7.48	<0.1	100.0	21.0	0.27	0.61	18.33	2.61
87-165	7.91	13.0	100.0	15.3	0.22	0.53	19.45	2.01
165-281	7.88	0.2	100.0	9.7	0.27	0.14	9.43	1.65
281-321	7.88	1.2	100.0	15.7	0.26	0.20	15.36	2.53

This value is rather variable at Praha – Bohdalecká. Horizon M_4 has a base saturation of 70 % and horizon M_5 has a base saturation of 74 %. In other horizons, the base saturation exceeds 85 %.

CEC is relatively higher in upper parts of soil profiles and decreases with depth. Low value of CEC in horizon IICk (Praha – MO) coresponds to the character of parent material in this horizon.

The distribution of exchangeable bases in the soil profiles is similar. Ca is the main exchangeable base in all studied profiles. Elevated contents of exchangeable Na and Mg were documented in the profile of Praha – Bohdalecká (horizons Btb_1, Btb_2, Ck) and Praha – MO (Ab_1, Ab_2). The ratio among exchangeable Ca, Mg, K and Na is favourable.

Soil chemical properties were influenced only to a small degree. Variability of chemical properties in the M horizons at Praha – Bohdalecká is rather a result of the formation of pedosediments in natural conditions. On the other hand, horizon M_1 was above direct anthropogenic influence. Probably this influence was weak, much like in the case of Praha – Internacionální. As indicated by the obtained results, Technosol at Praha – MO was not influenced by chemical properties of the buried profile.

SOIL ORGANIC MATTER

The data of soil organic matter in the studied profiles is presented in Table 4.

Cox content and Nt are higher in the upper parts of the profiles. The highest value of organic content was documented in the pedosediments of the profile of Praha – Bohdalecká.

The content of hot-water extractable carbon (HWC) can be marked as an important indicator of the state of the soil organic matter, which can substitute so far used parametrs (for instance humic acids, fulvic acids etc.) characterizing organic matter of soil types. HWC is one of the more sensitive indicators, which can differentiate between ecosystems such as market gardening and cropping or pastoral and native bush. Given its strong positive correlation with soil microbial biomass, mineralizable N and soil aggregate stability, it appears that HWC can be used as an integrated measurement of soil quality (Ghani et al., 2003). The value of HWC in mg/kg in the profile descreases with depth, much like the value of Cox. This coresponds with data of Cheshire (1979). The high content of HWC in upper parts of the profiles may reflect low microbial activity or humus form with low stability. From this point of view, soil organic

Table 4 Soil organic matter.
HWC - hot-water extractable carbon.

Depth cm	Cox %	HWC v % Cox	HWC mg/kg	Nt %	C/N
Praha - Bohdalecká					
0-20	3.20	2.22	833	0.229	13.97
20-40	2.20	2.43	701	0.205	10.73
40-53	1.48	2.74	455	0.134	11.04
53-83	0.92	4.34	568	0.116	7.93
83-117	0.80	4.34	473	0.100	8.00
117-144	0.68	3.29	322	0.076	8.94
144-189	0.24	4.25	170	0.050	4.80
189-226	0.16	7.27	189	0.050	3.20
Praha - Internacionální					
14-39	1.48	0.79	372	0.143	10.35
39-73	0.84	2.44	222	0.108	7.78
73-83	0.36	1.92	94	0.070	5.14
83-113	0.20	6.00	150	0.050	4.00
113-136	0.12	8.19	131	0.050	2.40
136-284	0.20	0.59	113	0.056	3.57
Praha - MO					
0-45	1.12	0.46	56	0.146	7.67
45-87	0.44	4.46	223	0.071	6.20
87-165	0.12	7.28	131	0.050	2.40
165-281	0.12	7.75	93	0.111	1.08
281-321	0.12	8.45	169	0.052	2.30

matter at Praha – Bohdalecká can be defined as less stable than that in other profiles.

The values of HWC in % Cox in the profiles show an opposite tendency than the HWC in mg/kg. This can be primarily explained by its rapid utilization as an available source of energy within biochemical transformation in soil and by its higher mobility due to the increasing contents of HWC in % Cox with depth.

The C/N ratio is higher in upper horizons in the soils. The C/N value showed that the stock of N at Praha – Bohdalecká is lesser than at Praha – Internacionální and Praha – MO.

MINERALOGY OF THE CLAY FRACTION

Mineral composition of the studied soils is controlled by the parent material. Mineralogical character of the fraction of <0.001 mm is given in the diagrams in Fig. 5.

Quartz and illite are the dominant components at Praha – Bohdalecká. Horizons M_1, M_2, M_3, M_4, M_5 differ in the proportions of kaolinite and feldspar. Gypsum was identified in horizon M_5. Horizon Btb_1 revealed a considerable amount of illite (ca. 29 %) and an elevated amount of kaolinite. Horizon Btb_2 revealed similar amounts of the individual identified mineral phases, only with an increase in the contents of chlorite, quartz, and a decrease in the content of kaolinite. Horizon Ck contains quartz, and a relatively high amount of kaolinite, which may be derived from the weathering crusts of the original substrate. Proportions of illite and chlorite are low in the given horizon.

The profile at Praha – Internacionální is dominated – besides quartz – by illite. In addition, feldspar and plagioclase is present here. The proportion of chlorite is very low with the exception of horizon Bk_2, where chlorite contents are increasing. The presence of smectite was encountered in horizons Bk_2, Bk_3 and Ck. Dolomite was found in powdered samples from the whole profile. Horizon A_1, which is probably affected by anthropogenic processes, is poorer in quartz, richer in illite, and contains also amphibole. Horizon A_2 showed a high proportion of quartz and a very low content of clay minerals. It is the horizon least affected by weathering processes, as suggested by the relatively high feldspar and plagioclase content. In horizon Bk_1, on the other hand, the contents of feldspar and plagioclase are lower. Horizon Bk_2 showed high proportions of illite and kaolinite and very low amounts of quartz. Horizons Bk_3 and Ck differ to a small degree in their quartz, kaolinite and smectite contents.

Semi-quantitative mineral composition analyses at the site of Praha – MO revealed the dominance of quartz and illite. Powdered samples from horizons IICk and IIICk, with alternating pedogenic substrates, contained hematite and goethite. Amphibole is present in horizons Ab_1, Ab_2 in accessory amounts. Elevated contents of quartz and feldspar and plagioclase may be associated with the contact with anthropogenic landfills. Unlike in horizons ICk and IIICk, no feldspar and plagioclase are present in horizon IICk and the content of illite is elevated. This is in agreement with the alternation of pedogenic substrates: horizon Ck corresponds to loess, IICk corresponds to marl colluvia and IIICk corresponds to loess.

All the studied soil profiles are dominated by quartz and illite. The quartz : illite ratio varies throughout the individual profiles. At Praha – Bohdalecká, variable proportions of the minerals were found in horizons M_1, M_2, M_3, M_4, M_5, which have the character of pedosediments. Their formation was probably contributed by the anthropogenic factor. Horizon Btb_1 at Praha – Bohdalecká revealed a prominent increase in the illite content and also an increase in the kaolinite content. Similar proportions of mineral phases were described by Sirový (1973) as characteristic features of soils subjected to the clay illuviation. Elevated illite content in the top part of the Praha – Internacionální profile is not accompanied by an elevated kaolinite content, which is a typical feature for Chernozem according to Sirový (1966). The lower illite : kaolinite ratio at the site of Praha – MO can be explained by the probably polygenetic origin of the soil.

CONCLUSION

Soil formation is a multivarate process, where natural and anthropogenic factors and their interactions are responsible for the character of the soil profile.

The degree of anthropogenic influence on the individual soil profiles was different. Especially the upper parts of soil profiles have been affected: they show elevated proportions of fraction 0.25–2.00 mm.

The values of HWC in % Cox primarily corresponds to its rapid utilization as an available source of energy within biochemical transformation in soil and by its higher mobility due to the increasing contents of HWC in % Cox with depth.

Soil organic matter at Praha – Bohdalecká can be defined as less stable than that in other profiles.

Mineral composition of soils are dominated by quartz and illite.

The character of pedogenesis was affected by anthropogenic influence to a small degree and the differences generally result from natural conditions of soil development.

In the territory of Vršovice, Suchdol and Hradčany, conditions of the development of soil cover were documented based on detailed soil analysis.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. Antonín Janda and the Ministry of Defence for the possibility to collect samples in their precinct. The project was supported by project A300130504 of the Grant Agency of the Academy of Sciences of the Czech Republic and the Research Plan Z30130516.

REFERENCES

Cílek, V.: 2001, Flopping in the subject of Ministry of Defence in Praze, Speleo, 33, 13-15.

Cheshire, M.V.: 1979, Nature and origin of carbohydrates in soil, Academic Press, London, 216.

Chlupáč, I.: 1999, Walking tour by geologic history of the Prague and of neighbourhood, Academia, Praha, 279.

Damaška, J. and Němeček, J.: 1966, The general and agronomical characteristic of the soils available within the area of the Central research institute of plant production in Prague-Ruzyň, Vědecké práce Ústředního výzkumného ústavu rostlinné výroby v Praze-Ruzyni, 10, 153-162.

FAO: 2006, Guidelines for soil description, Rome, 97.

Ghani, A., Dexter, M. and Perrott, K.W.: 2003, Hot-water extractable carbon in soils: a sensitive measurement for determining impacts of fertilisation, grazing and cultivation, Soil Biology & Biochemistry, 35, 1231-1243.

Haberle, J., Kroulík, M., Svoboda, P., Lipavský, J., Krejčová, J. and Cerhanová, D.: 2004, The spatial variability of mineral nitrogen content in topsoil and subsoil, Plant, Soil and Environment, 50 (10), 425-433.

Haberle, J., Svoboda, P. and Krejčová, J.: 2006, Uptake of mineral nitrogen from subsoil by winter wheat, Plant, Soil and Environment, 52 (8), 377-384.

Jackson, M.L.: 1979, Soil chemical analyses - Advanced course, Madison, Wisconsin, 895.

Kovanda, J.: 1992, General geological map of the Prague and of her neighbourhood. ČGÚ. Praha.

Kříž, J.: 1999, Geological monuments of the Prague, ČGÚ, Praha, 280.

Lutovský, M., Smejtek, M., et al.: 2005, Prehistoric Prague, Libri, Praha, 1038.

Munsell Soil Color Charts: 1994, Revised Edition, Munsell Color, NY.

Počta, F.: 1905, Der Boden der Stadt Prag. Eine Geologische Studie, Sitzungsberichten der königl. böhm. Gesellchaft der Wissenschaften, Prag, 35.

Quitt, E.: 1971, Climatic regions of the Czechoslovakia, Studia geographica, 16, 1-82.

Sirový, V.: 1966, Clays minerals in the soils of ČSSR, Rostlinná výroba, 12 (6), 697-700.

Sirový, V.: 1973, Mineral composition of the clay fraction in soils on Czech territory. Sixth Conference on Clay Mineralogy and Petrology, Praha, 339–352.

Smolíková, L.: 1967, Zur Mikromorfologie der jungpleistozänen Böden von Sedlec bei Praha, Časopis pro mineralogii a geologii, 12, 277-286.

Smolíková, L.: 1968, Mikromorphologie und Mikromorphometrie der pleistozänen Boden-komplexe. Rozpravy Československé akademie věd, Řada matematických a přírodních věd, 78 (2),1-46.

Smolíková, L.: 1975, Relict braunlehm of cromer age in Suchdol near Prague, Časopis pro mineralogii a geologii, 20, 393-404.

WRB: 2006, World reference base for soil resources. World Soil Resources Reports, 103,1-88.

Záruba, Q.: 1948, Geologic subjacent and foundation conditions of the central Prague, Státní geologický ústav České republiky, Praha, 81.

Žigová, A. and Šťastný, M.: 2006, Pedogenesis of the territory of Prague affected by human activity. In. Šarapatka, B. and Bednář, M. (Eds.) Pedogenesis and qualitative changes of the soils in the conditions nature and anthropic impacted territories, 35-38. Sborník referátů z 11. pedologických dnů, Kouty nad Desnou, 20-21.9.2006.

Fig. 1 Profile Praha – Bohdalecká.

Fig. 2 General view at the locality Praha - Bohdalecká with frost wedge.

Fig. 3 Profile Praha – Internacionální.

Fig. 4 Profile Praha – MO.

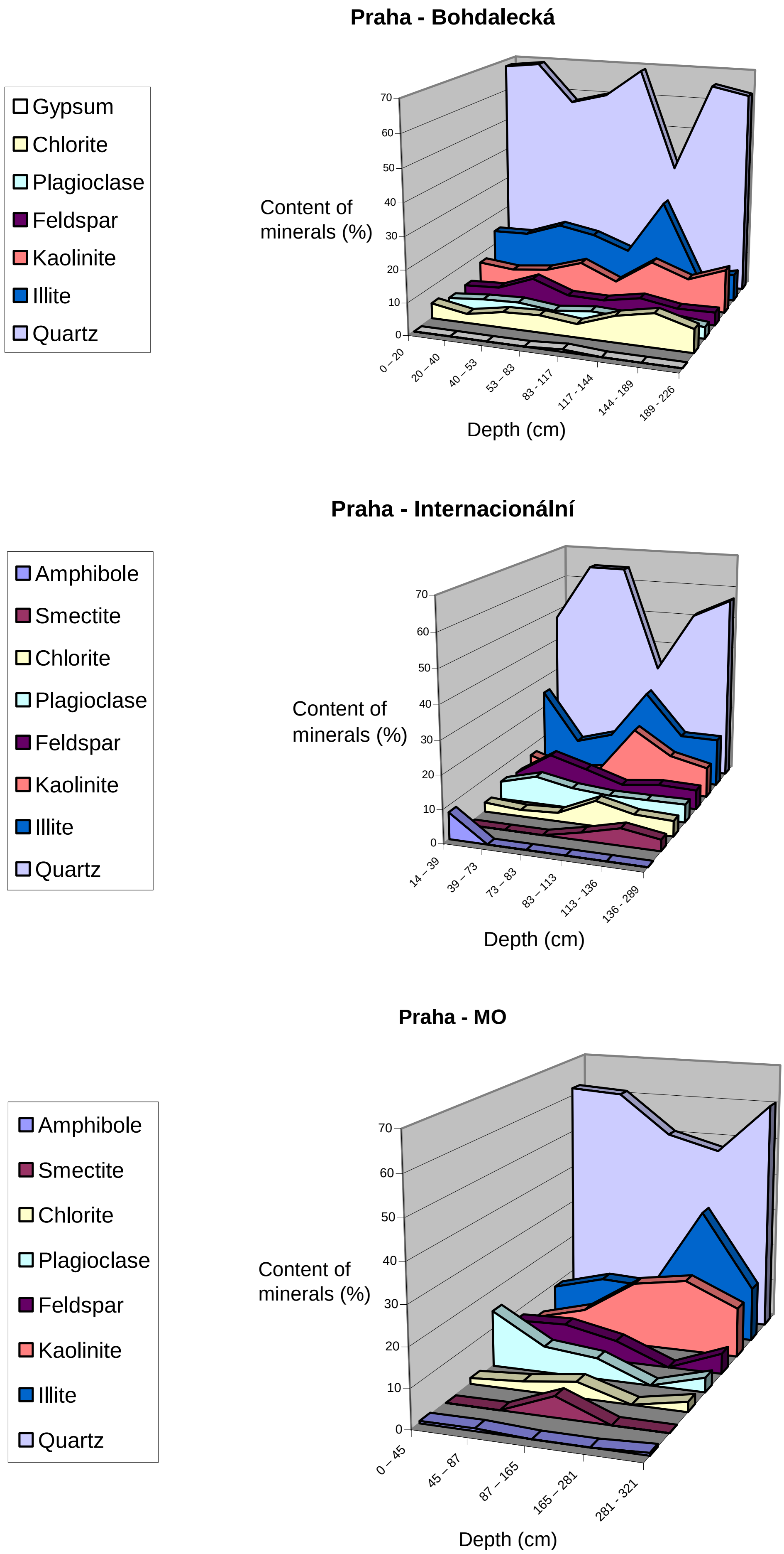

Fig. 5 Mineralogy of clay fraction.