Role of the Climatic Factor in Soil Formation at Boubová (Bohemian Karst, Czech Republic)

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ABSTRACT. The Boubová is covered by relict soils (non-buried soils). The role of climatic factor in pedogenesis was studied on the basis of micromorphological and chemical analysis. The studied locality is covered by terra fusca at the karst plateau and illimerized terra fusca at the karst depression. The oldest stadium of pedogenesis corresponds as a minimum with the Last Integlacial (R/W). Soil cover at the Boubová has many essential characteristics, nowadays indicates development under the climate and environmental conditions of previous period. The upper part of these soils is influenced by recent soil forming condition.

KEY WORDS: climatic factor, micromorphology, pedogenesis, terra fusca.

Introduction

The principal factors of pedogenesis are substrate, climate, organisms, relief and time. Retallack (1990) shows, that soil formation is a multivariate process, then in order to study anyone of the factors in isolation it is necessary to consider only those cases where all the other factors are constant, or at least nearly so.

Aspects of the climate role in soil development especially in the Quaternary, described by Stephens (1965) and Smolíková (1972).

The Boubová is located in the west part of the Bohemian Karst Protected Landscape Area approximately 20 km south west of Prague. The geological sequence of Prag Formation of the Dvorce-Prokop Limestone Facies (early Devonian) is typical at the study area by Chlupáč et al. (1998). This site is forested, with a coverage made up primarily of oak, hornbeam, limetree, cornel and maple. The Boubová is covered by terra fusca which was referred by Smolíková (1963). Genesis of this soil type reported by Kubiëna (1944,1970) and Smolíková (1960, 1963, 1973).

Methods and material studied

Two typical sections of the soil cover were documented. The soil profiles were described using the methodology of Catt (1990). The first profile has been sampled at south part of karst plateau (428 a.s.l.). The second profile has been located approximately 20 meters south-west of the first profile at the karst depression. The soil profiles were sampled by individual horizons except the R horizon of the profile 1. This horizon with depth of 23 cm consists of 90% unweathered limestone. Undisturbed and oriented samples were taken for micromorphological study of soils.

The pH value, content of $CaCO_3$, exchangeable Al^{3+}, Ca^{2+}, Mg^{2+}, H^+, K^+, cation exchange capacity (CEC), organic carbon (Cox) and total nitrogen content (Nt) were determined by Hraško et al. (1962).

Results and conclusions

The terra fusca soil covering both studied sections was defined as a relict soil by Kubiëna (1956). Relict soils (non-buried soils) are important for understanding the processes determining natural climatic changes and the evidence of anthropogenic factor in the evolution of soils in the Holocene.

The pH values (Table 1) of the soil profiles correspond with the content of $CaCO_3$. The soil profile 2 is more acid than profile 1.

The values of cation exchange capacity (CEC) and individual exchangeable cations (Table 2) showed some differences of the pedogenesis at the Boubová which correspond probably with relief. The results indicate illimerization as one from individual stages of soil development at the karst depression.

The A horizons have high content of carbon but the ratio C/N reflects to low quality of humus.

Soil micromorphology is used for specification of pedodogenesis individual stages. The micromorphological characteristics of soil profiles are described below.

Brief micrmorphological description of the profile 1

A 0–5 cm - the dark brown matrix consists of numerous root remains, rare fragments of coalified wood and excre-

Locality	Depth cm	pH_{H2O}	pH_{KCl}	$CaCO_3$ %	Cox %	Nt %	C/N
Boubová 1	0-5	6,65	6,20	0,3	7,58	0,70	10,83
	5-17	6,50	5,75	0,5	2,78	0,30	9,27
Boubová 2	0-7	5,20	4,35	< 0,1	6,42	0,44	14,59
	7-27	4,30	3,25	< 0,1	0,93	0,07	13,28
	27-50	4,75	3,30	< 0,1	0,61	0,05	12,20
	50-63	6,25	5,10	< 0,1	0,53	0,05	10,60
	63-85	7,10	6,30	12,0	0,24	0,04	6,00

Tab. 1. The chemical properties.

Locality	Depth cm	H^+ mmol/ 100g	Al^{3+} mmol/ 100g	Ca^{2+} mmol/ 100g	Mg^{2+} mmol/ 100g	K^+ mmol/ 100g	CEC mmol/ 100g
Boubová 1	0-5	10,5	0,08	67,58	2,81	0,95	57,40
	5-17	9,0	0,24	44,08	0,60	0,31	43,08
Boubová 2	0-7	24,5	0,67	20,31	0,59	0,20	21,03
	7-27	15,5	1,30	1,06	< 0,10	0,02	15,06
	27-50	19,0	0,49	22,84	0,14	0,24	35,98
	50-63	4,5	0,04	35,13	0,18	0,21	31,14
	63-85	2,0	< 0,04	25,13	< 0,10	0,17	24,93

Tab. 2. The properties of adsorbent complex.

ments produced probably by arthropods. In addition there are red excrements of mites, cellular structure with secondary calcification and small braunlehm nodules. Some parts of free spaces are filled with carbonate rhombohedrons. Soil skeleton is invariable by quartz grains and fragments of carbonate.

B 5–17 cm - the brown orange substance is represented by braunlehm plasma which has remarkable segregate (subpolyhedral) texture. The braunlehm plasma is crossed by narrow, conspicuosly cut fissures. There are abundant braunlehm nodules of various size. The soil skeleton is granulometricaly sorted. The primary components are grains of quartz, followed by paucity of muscovite and fragments of carbonate. There are present some remains of roots.

The individual stages of pedogenesis of soil cover at the karst plateau are following: development of the terra fusca (braunlehm plasma and braunlehm nodules of various size) then formation of A horizon and slight recalcification. The form of humus is moder (numerous remains of root, excrements produced by arthropods and mites).

Brief micromorphological description of the profile 2

A 0–7 cm - the dark brown matrix consists of droppings probably arthropods. Free spaces are numerous. Carbonate rhombohedrons in the free spaces are sporadic. There are remains of roots. In addition red excrements of mites and rare braunlehm nodules are abundant. Soil skeleton is represented by quartz grains and fragments of carbonate.

E 7–27 cm - the brownish-grey matrix is slightly humous. Some parts of matrix content sporadic braunlehm nodules. Soil skeleton is well-sorted from silt to sand. Minerals are dominated by grains of quartz accompanied by sporadic muscovite. Red excrements of mites and remains of roots are present.

B_1 27–50 cm - the brown orange matrix consists of braunlehm plasma. The fabric is of segregate (subpolyhedral) nature which is cut by irregularly distributed fissures and cracks. Illimerization is attested by the partial braunlehm plasma which is filled with channelways and fissures. Braunlehm nodules of various size occur frequently. The composition of soil skelton is monotonous. Quartz predominates, accompanied by muscovite and rare fragments of carbonate.

B_2 50–63 cm - the deeply brown orange matrix with peptized soil substance which is marked by segregate (subpolyhedral) fabric. This segregate is cut by fissures and network. There are abundant partial braunlehm plasma and braunlehm nodules. Primary components are dominated by grains of quartz but muscovite and fragments of carbonate are also present.

BC 63–85 cm - it is possible to observe fabric forms rarely. Primary components are represented by carbonate fragments, grains of quartz and rare muscovite.

The first stadium of pedogenesis at the karst depression was developed as the terra fusca in the first order warm periods (interglacial), then probably slight addition of the allochtonous component and illimerization (partial braunlehm plasma and small braunlehm nodules). Formation of A horizon and slight recalcification is the last stage of soil development. The form of humus in this horizon is moder.

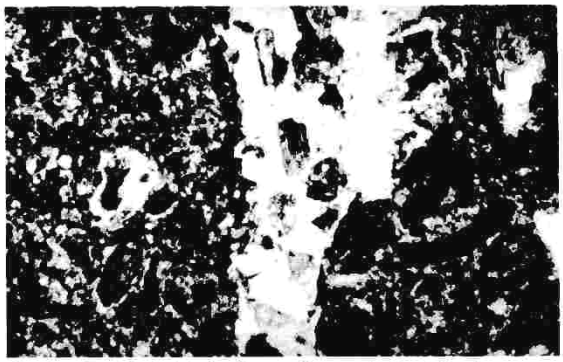

Fig. 1. Profile 2. Moder form of humus in the A horizon.

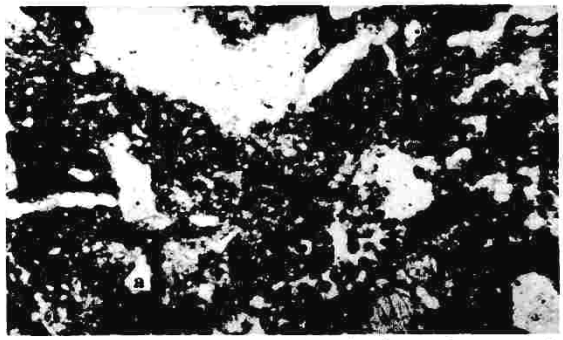

Fig. 2. Profile 2. E horizon with predominant of quartz (a) in the soil skeleton.

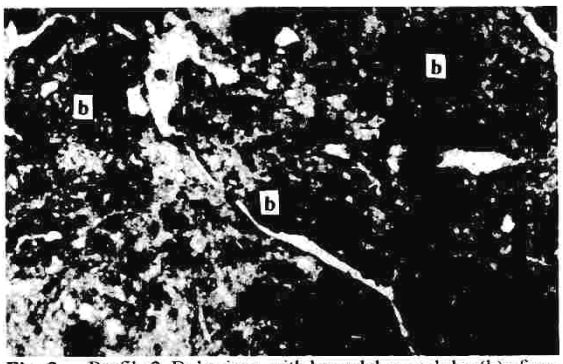

Fig. 3. Profile 2. B_1 horizon with braunlehm nodules (b) of various size.

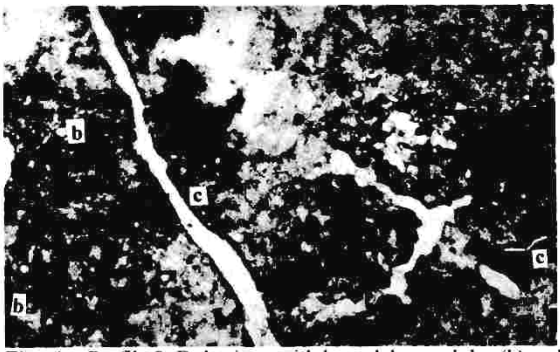

Fig. 4. Profile 2. B_2 horizon with braunlehm nodules (b) and partial braunlehm plasma (c) which is filled with channelways and fissures.

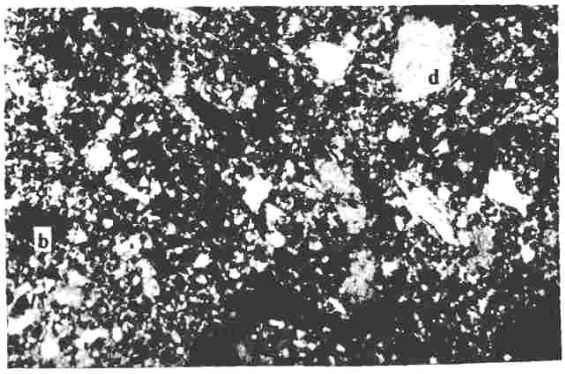

Fig. 5. Profile 2. BC horizon with braunlehm nodule (b) and fragment of carbonate (d).

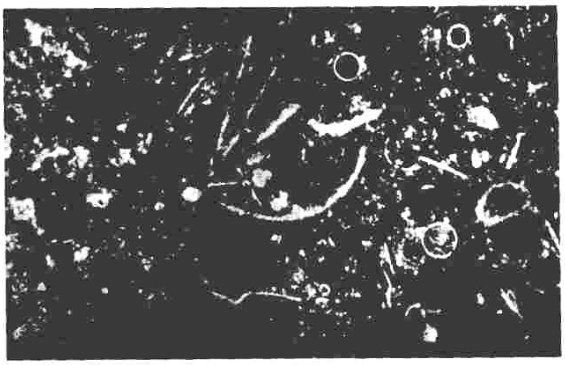

Fig. 6. Parent material: lime-mud supported structure of a bimodal calciturbidite. This carbonate bedrock microfacies corresponds to transitions from Dvorce-Prokop to Reporyje limestone (Praha Formation). Large bioclasts: planktonic styliolinids - long conical shells with "v"- or "o"- shaped sections; fragmented cephalopod shells - an "u"- shaped section of thin fossil mold with a sparite fill - in a center of figure; thin fragments of a sparite fill - in center of figure thin fragments of trilobite carapaces - undulated sections in lower part of figure.
Magnification: 4x. Description of Fig. 8 by J. Hladil. Photo: M. Šťastný

The studied locality is covered by terra fusca at the karst plateau and illimerized terra fusca at the karst depression. Occurrence of terra fusca and illimerized terra fusca at the same locality is ordinary according to Smolíková (1963). The oldest stadium of pedogenesis corresponds minimally with the Last Integlacial (R/W). Illimerization as one from individual stages in soil cover development is controlled by the climate and on the other hand by relief.

Soil cover at the Boubová has very essential characteristics and nowadays it indicates development under the climate and environmental conditions of previous period. The upper parts of these soils are influenced by recent soil forming condition. Only Rendzic Leptosol by classification Spaargen et al. (1994) can be developed on the same substrate and relief in the recent climatic condition.

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