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PEDOGEOGRAPHIC CHARACTERISTICS OF THE KARST POLJES IN NOTRANJSKA (SLOVENIA)

ABSTRACT: LOVRENČAK F., *Pedogeographic characteristics of the karst poljes in Notranjska (Slovenia).* (IT ISSN 0391-9838, 1998).

In the poljes of the Notranjska valley one can observe a close connection between the relief forms, the parent material, the hydrological environments and the characteristic of the soils. Accordingly we distinguish at least three types of poljes: 1) poljes without gleysols, 2) poljes with gleysols and eutric cambisols, 3) poljes gleysols only.

In the smaller poljes streams flows only periodically and on their floors fine grained sediments without ground water are to be found. Therefore there are no gleyic soils. On the floors of those poljes middle deep or deep chromic cambisol is prevailing. The Babno polje and the Rakovsko-Unsko polje can be classified under the first type. The marger poljes are marked by small streams. The waters deposited mostly fine particles of loam clay. The surface streams deposited also bigger fluvial gravel. On the wet loam and clay, gleysols can develop and on the dry gravel, eutric cambisols evolve. The Loško, the Cerkniško polje and the Logaško polje can be classified under the second type.

The exception is the Planinsko polje where all the surface waters, feed from karst springs, depositedy only loam-clayey sediments. As the parent material contains the ground water, the result is development of gleysols. For this reason the Planinsko polje can be classified under the third type of poljes.

KEY WORDS: Karst poljes, Soils, Notranjska Valley, Slovenia.

RIASSUNTO: LOVRENČAK F., *Caratteristiche pedogeografiche dei polje carsici nella Valle di Notranjska (Slovenia).* (IT ISSN 0391-9838, 1998).

Nei polje della Valle di Notranjska esiste una stretta dipendenza tra le forme del rilievo, le condizioni idrologiche, il parent material (roccia madre) e le caratteristiche dei suoli. Con riferimento ai suoli possiamo distinguere almeno tre tipi di polje: 1) polje privi di suoli di tipo gley, 2) polje con suoli di tipo gley o eutric cambisol, 3) polje soltanto con suoli di tipo gley.

Sul fondo dei polje più piccoli, dove si verificano solo episodicamente fenomeni di scorrimento d'acqua, si trovano sedimenti a grana fine che non sono quasi mai saturi d'acqua e pertanto non vi si trovano suoli di tipo gley. I suoli prevalenti sono invece dei calcocambisol o dei chromic cambisol. Il Babno polje e il Rakovsko-Unsko polje possono essere riferiti al primo tipo. I polje più grandi sono caratterizzati da piccoli corsi d'acqua. Le acque depositano prevalentemente sedimenti a grana fine di tipo «franco» o argillosi. I corsi d'acqua depositano anche sedimenti più grossolani come ghiaie. Sui sedimenti franchi e argillosi si sviluppano suoli di tipo gley e sulle ghiaie suoli del tipo eutric cambisol. Il Losko, il Cerknisko e il Logasko polje possono essere attribuiti al secondo tipo.

Il Planinsko polje rappresenta un'eccezione in quanto tutte le acque di deflusso sono alimentate da sorgenti carsiche e depositano soltanto sedimenti franco-argillosi. Poiché il parent material è saturo d'acqua ne consegue lo sviluppo di suoli di tipo gley. Pertanto il polje di Planinsko può essere riferito al terzo tipo.

TERMINI CHIAVE: Polje carsici, Suoli, Valle di Notranjska, Slovenia.

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Na poljih v Notranjskem podolju se kaže ozka povezanost med reliefnimi oblikami, matično podlago, vodnimi značilnostmi in lastnostmi prsti. Glede na to povezanost ločujemo tri tipe polj: 1) polja brez oglejenih prsti, 2) polja z oglejenimi prstmi in evtricnimi kambisoli, 3) polja samo z oglejenimi prstmi.

Na tistih poljih, ki so manjša in po njih teče voda le periodčno, so na njihovem dnu drobno zrnati delci brez talne vode. Zato na njih ni oglejenih prsti. Na dnu polj prevladuje globoka do globoka rjava pokarbonatna prst. V ta tip polj sodita Babno in Rakovsko-Unško polje. Na večjih poljih so manjše rečice. Tekoče vode so odložile drobno zrnato ilovico in glino. Poleg tega so površinsko tekoče male reke odložile večji rečni prod. Na ilovici in glini, ki sta vlažni so nastale oglejene presti, na produ, ki je suh pa plitve in globlje rjave prsti. V ta tip polj sodijo Loško, Cerkniško in Logaško polje.

Izjema je Planinsko polje. Voda ki priteka nanj je samo iz kraških izvirov. Zato odlaga samo drobno zrnate usedline. Na tej matični podlagi v kateri se zadržuje talna voda so nastale oglejene prsti. Zato Planinsko polje sodi v tretji tip kraških polj.

KLJUČKE BESEDE: Kraška polja, prsti, Notranjsko podolje, Slovenija.

INTRODUCTION

Just as the relief forms are characteristic of the karst, so are the soils a distinct factor of the karst landscape. This prompted the karst researchers to undertake investigations of the karst soils as one of the karst landscape factors (Urushibara 1976; Atalay 1995; Barany-Kevei, Musci 1995 etc.). Panoš (1990, 1995) classifies pedokarstology under the group of sciences which deal with natural components. Pedokarstology focuses on genetic processes and regulari-

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ties of spatial differentiation of soil covers in connection with the karst surface.

In order to promote a better understanding of the karst soil characteristics, we set out to investigate them in several regions of Slovenian karst. Soils in dolines and between dolines were investigated in different parts of Slovenia, i.e. on the karst surface in the vicinity of the Škocjanske jame caves and also in the proximity of and on the karst polje floors. In this article we wish to demonstrate some of the distinctive soil characteristics of karst poljes in the Notranjska valley, situated in the south-eastern part of Slovenia.

The Notranjska valley is situated amidst the higher karst plateaus: the Snežnik (1797 m), the Javorniki (1269 m) and the Hrušica (1265 m) on the south-western side, and the Bloke (731 m) and the Menišija karst plateau on the north-eastern side. The Notranjska valley is a long, low karst surface, varying in altitude between 750 and 476 m, consisting of karst poljes, ouvalas and dry valleys. The valley stretches towards the Dinaric Alps, from the south-east to the north-west. There are several karst poljes: the Babno polje, the Loško polje, the Cerkniško polje, the Rakovsko-Unško polje, the Planinsko polje and the Logaško polje. Soils in these poljes usually differ from the soils on the edges, largely due to relief forms, parent material and hydrological characteristics.

SOIL FORMING FACTORS

As for the geologic structure, the Notranjska valley is rather uniform. The two most common rock types are: limestone and dolomite. The poljes were formed where the two types of stones intermingle, at the Idrija joint, which crosses the Planinsko polje, the Rakovsko-Unško polje, the Cerkniško polje, the Loško and the Babno polje. On the southern side of the valley the Cretaceous and the Jurassic limestones can be observed while the northern side – apart from the limestone – is characterised by the Triassic dolomite. It is characteristic of the Rakovsko-Unško polje that it is dominated by the Triassic dolomite, which was tectonically fractured. The polje floors are covered by a layer of Quaternary sediments, mostly loam. In the Cerniško polje, the Cerkniščica river, flowing on the surface, mainly deposited dolomite gravel in the form of a wide alluvial fan. Similar process took place in the Logaško polje. Such a geologic structure exerted profound influence on the soil characteristics.

The larger part of the Notranjska valley is dominated by a continental climate. The Dinaric high plateaus, thus, avert the Mediterranean influence, which is more noticeable with regard to the temperatures than to the distribution of the precipitations. In the colder half of the year the temperature inversion often takes place in closed depressions. Cold air accumulates on the depression floors, while their higher parts are exposed to the sun rays and are for this reason warmer (Habič, 1981). The meteorological data from Planina clearly depict the climatic characteristics of the valley. The average January temperature in Planina is – 1,1 °C and the average July temperature rises to 18,2 °C. The average annual temperature reaches 9,0 °C. The monthly average quantity of precipitation is 100 mm – with the maximum in October and the minimum in March. The annual quantity of precipitation fluctuates between 1218 and 1821 mm (Pučnik, 1980).

The poljes on the floor of the Notranjska valley are characterised by distinct hydrological characteristics. The essential difference is that some poljes have a few running waters flowing and some not. The dry poljes are the Babno polje and the Rakovsko-Unško polje. Only after a heavy and long-lasting rainfall, streams can be observed on their floors. The permanently running karst waters flow across the Loško, the Cerkniško, the Planinsko and the Logaško poljes. The narrow ponors of the poljes cannot swallow the water fast enough after heavy rainfalls, due to which the water overflows sometimes larger and sometimes smaller surfaces in both the larger poljes: the Cerkniško and the Planinsko polje. Consequently intermittent lakes come into existence. Especially in Autumn and in winter water eventually flows away. Such water characteristics influence soil characteristics and bring about differences in soils between the poljes which have been overflown for a longer period and those poljes which have been overflown for a shorter period.

Climatic conditions are favourable to forest along the entire Notranjska valley. Forests originally thrived on polje edges and in drier areas also on the polje floors. The rather moist areas are covered by vegetation of damp and wet grasslands, found especially on the poljes floors: *Molinietalia caeruleae, Caricetalia davallianae*, and in the Cerkniško polje also: *Scheuchzerietalia palustris, Magnocaricetalia* and *Phragmietalia communis* (Ilijanić, 1979). Along the polje edges, the *Arrhenathetalia elatioris* grasslands mix with *Brometalia erecti* grasslands. The *Genista triangularis-Pinetum* forests thrive on the dolomite e.g. in the Rakovsko-Unško and in the Logaško poljes (Puncer & *alii*, 1976).

SOIL CHARACTERISTICS

According to the parent material, landforms and hydrological characteristics, several types of soils can be distinguished in the karst poljes of the Notranjska valley. The floor of the Babno polje is dominted by chromic cambisols. Rendzinas and leached cambisols developed on its edges.

In the Loško polje, the chromic cambisols on the limestone and on the dolomite mix with rendzinas. Apart from them the leached chromic cambisol on the limestone is to be found there (Petrič, 1977).

In the Cerkniško polje the gleysols appeared in the parts with clay loam sediments and in parts where the influence of the ground and inundation water is stronger. On the drier sediments, deposited by the Cerkniščica river, eutric cambisols on fluvial sediments came into existence. Rendzinas are mixed with luvisols along the polje edges.

The situation in the Rakovsko-Unško polje is comparable to the one in the Babno polje. Deep chromic cambisols

stretch across the polje floor. Along the edges the soil cover is constituted from two soil types, rendzina and chromic cambisol.

The Planinsko polje is situated to the north-west of the Rakovsko-Unško polje. With regard to the sediments it partly resembles the Cerkniško polje since in both poljes clay-loam sediments can be observed on their floors. Just as a minor perennial stream flows on the floor of the Cerkniško polje, there is one on the floor of the Planinsko polje. Both rivers overflow and consequently the soils become more wet. As a result of this, the larger part of the Planinsko polje floor is covered by gleysols.

The Logaško polje is situated at the far end, in the north-west of the Notranjska valley. According to Gams (1974) it is marked by a more or less flat floor. It belongs to the less distinct border poljes. The polje floor is covered by shallow holocene sediments, deposited by surface waters from the dolomitic border. Shallow sandy cambisols developed on such parent material. These soils undergo the leaching process. The gleysols are not strongly present. The polje edges are characterised by rendzinas (Mihevc, 1976).

In order to promote a better understanding of the karst polje soils we wish to show a few soil characteristics of the Rakovsko-Unško polje (fig. 1). The dolomite parent material along the polje edges is corroded. The more or less deep fissures, filled with deep or shallow soils can be found there. Therefore rendzina mixes with deep chromic cambisol. Rendzina is marked by the A-C profile. The soil profile is approximately 20 cm deep. The A horizon contains 13,4 % of the organic matter, 14,51 % of $CaCO_3$ and displays a sandy clay texture (table 1, profile 1).

TABLE 1: Some characteristics of the soils in the Rakovsko-Unško polje

Prof.no.	Place	Horizon	Depth cm	Sand %	Silt %	Clay %	Texture	pH (KCl)	$CaCO_3$ %	org. mat. %
1	Slivice	A_h	0-20	59	14	27	SC	6,86	14,51	13,4
		C	20-							
2	Rakek	A_{h1}	0-20	30	48,3	20,7	SCL	7,04	0	9,14
		A_{h2}	20-87	30,4	45,3	21,3	SCL	7,33	4,15	3,05
		(B)rz	87-147	22,5	17,8	59,7	C	7,15	1,36	1,22
		C	147-							
3	Rakek	A_h	0-30	29,7	45,5	24,8	SCL	6,91	0,68	5,86
		B_{t1}?	30-100	20,4	44,8	34,8	CL	6,90	1,1	2,85
		B_{t2}?	100-	10,8	41,2	48	C	6,68	0	1,34

Texture: SC - sandy clay, SCL - silty clay loam, C - clay, CL - clay loam

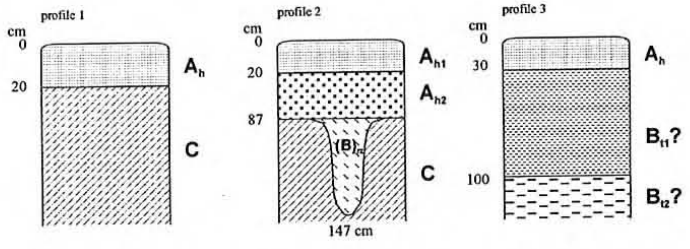

FIG. 1 - Profiles through the soils on the Rakovško-Unško polje.

Chromic cambisol is deeper and especially when in fissures it is more than 100 cm deep. Its profile consists of the A-(B) rz - C horizons. Stritar (1991) refers to them as fissures, filled with chromic cambisols. The reddish, clayey horizon (B)rz below the A horizon is characteristic of these soils. Even the recent analyses of the texture of this horizon proved a high percentage of clay. There is more than 50% (between 50-60%) of tiny clay pieces in this horizon which form the clay texture. Most often the A horizon of these soils contains 5-10% of organic matter. The percentage of $CaCO_3$ usually does not exceed 10%. Soil reaction is almost everywhere neutral, the pH value is around 7 (table 1, profile 2).

The soils on the polje floor differ from the soils along the edges in that they are deeper and that their profile mainly consists of three horizons. The profile consists of the light Ah horizon which abounds in roots. It is dark reddish brown, 30 cm deep, and is recognisable by its silty clay loam texture with 24,8% of clay; it contains about 5% of organic matter and very little free $CaCO_3$; its reaction is neutral.

The black brown horizon (maybe B_{t1}) lies below it, reaching 100 cm in depth; it is marked by clay loam texture with an even larger share of clay than in the upper horizon, a lower percentage of organic matter, and about 1% of free $CaCO_3$; its reaction is neutral. This horizon stretches across the reddish brown horizon (maybe B_{t2}) of clay texture, with the highest percentage of clay in the entire profile (table 1, profile 3).

CONCLUSION

With regard to the Notranjska valley poljes one can observe a close connection between the relief forms, parent material, hydrological and soil characteristics. Accordingly we distinguish at least three types of poljes (fig. 2):

1. poljes with chromic cambisols without gleysols
2. poljes with gleysols and eutric cambisols
3. poljes with gleysols only

In the minor poljes water flows only periodically. Fine-grained sediments can be observed on their floors. Due to the absence of long-lasting floods and the low level of ground water, the gleyic process did not take place and therefor no gleysols developed there. The medium deep or deep chromic cambisol is prevailing on the polje floors here. The Babno polje and the Rakovsko-Unško polje can be classified to this type of poljes.

In the larger poljes with minor running waters flowing from the surroundings, the soil forming process took a different course. The running waters, deriving from the karst springs, deposited fine-grained particles of loam and clay. Apart from this, surface waters also deposited larger-in-size fluvial gravel. Each of these sediment types contributed as a different sort of parent material to the soil development. For this reason the soils on the loam clay parent material have to undergo the gleying processes in which the gleysols can come into existence.

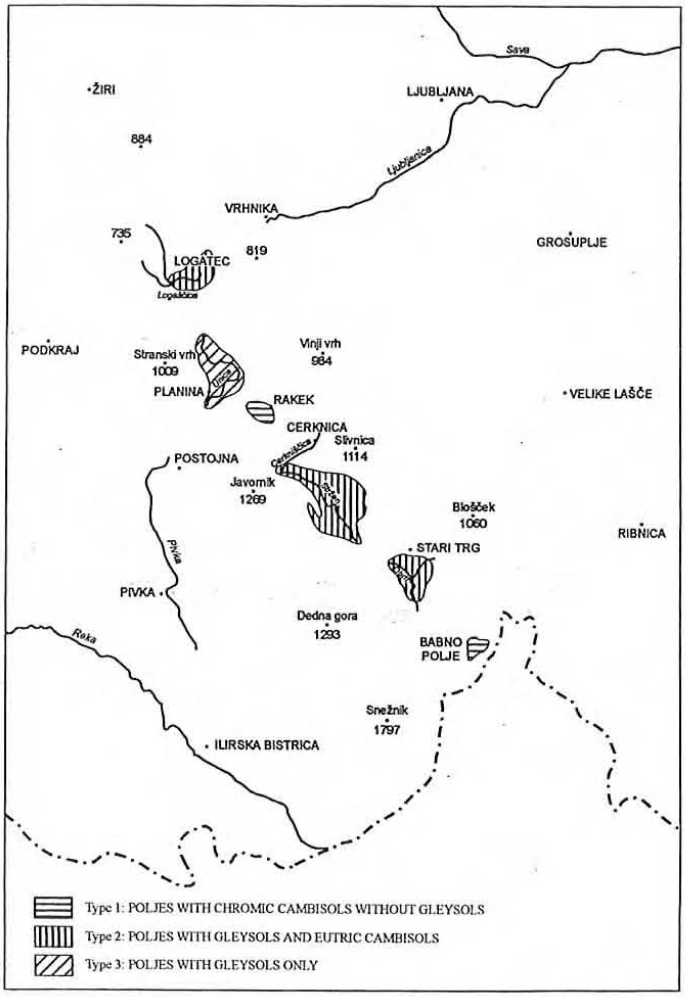

FIG. 2 - The Pedogeographic types of karst poljes in Notranjska (Slovenia).

The ground and inundation waters do not exert a profound influence on the rather permeable gravel; that is why the shallow or deeper eutric cambisols came into existence. The Loško polje, the Cerkniško polje and the Logaško polje can be classified to this type of poljes.

The Planinsko polje, which is the most typical karst polje in the Notranjska valley, however, makes the exception. It has no surface streams flowing from the surroundings. All the water here derives from the karst springs. For this reason it deposits only fine-grained loam-clayey particles, where the ground water usually remains and causes the appearance of gleysols. Thus, the Palninsko polje provides a typical example of this type of poljes.

Such a variety of soil types on the polje floors also influenced land use. Plants can be grown on the dry polje floors, where the chromic cambisols are prevailing. On account of this, the largest part of the floor is covered by fields and meadows.

The grass vegetation develops on gleysols along the streams, on the floors of the damp poljes, only. In wetter parts, the swamp vegetation is prevailing. Plants like corn, potato, wheat and different fodder plants thrive better in drier areas with eutric cambisols.

It is such a distribution of soils, which is on the karst polje floors more favourable to the growing of plants, that offers better conditions for their growth. Border areas are less suitable for farming due to soils having different depths. This is what makes the karst surface different from the non-karst surface, where it is possible to grow plants on a wider and rather uninterrupted surface.

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