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Some forms of carbonates in the soils of Slovakia

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The territory of Slovakia is approximatively to 30% covered with soils originated on carbonaceous rocks. On limestones, dolomitic limestones, dolomites or marlaceous rocks (very seldom on magnesites, too) rendzinas originated, while on loesses, widespread in the lowland regions, chernozems and brown earths; on carbonaceous alluvia, meadow and alluvial soils were originated. Despite the dissimilarity of soil types, the content of carbonates in the soil profile is a common mark of all of them. Of course, this content in the profile of various soils is quantitatively and qualitatively very oscillating.

In our previous works, we pointed out that in soils on loess (in the carbonaceous chernozems of the Danubian lowland) and on the carbonaceous alluvia of the Danubian plain (in meadow soils and meadow chernozems), formation of carbonates *in situ* took place as well [3, 4]. In the chernozems on loess, this is mainly caused by the specific water regime which conditions the formation of carbonaceous pseudomycelium [3], while in soils on alluvial sediments, the carbonates may also precipitate from the mineralized underground waters.

Therefore, in this work, we concentrated ourselves on the micromorphological study of carbonate forms in the soil which is considered to be very important for the solution of many questions connected with the dynamics of the origin and evolution of soils. The shape, size and mineralogical composition of these forms reflect the specificity of the conditions of their origin. In the past, this fact was especially pointed out by Kubiëna, who explained the origin of some forms of microcrystalline calcite in the soil by the concentration and pH of the medium's solutions. He established that the forms and sizes depended on the quantity and largeness of pores, on the composition, concentration and reaction of the soil solutions [7].

Minašina, who studied the change processes in loess provoked by the soil-forming phenomena, devoted a great part of his work to the forms of carbonates and their distribution. The importance of studying the forms of carbonates, for the examination of fossile soils, was emphasized

by Morozova [9]. Parfenova-Yarilova paid more attention to the description and morphological marks of the different forms.

METHOD OF THE WORK

We studied the shapes and sizes of carbonate forms and their partial mineralogical composition, in thin soil sections, by microscope. The thin sections were prepared by the method of Brewer [2]. The individual fractions and separated carbonate forms were studied by means of immersion oils by microscope and by means of DTA according to the method of Šurigina-Yarilova [11]. Several carbonate forms were studied röntgenographically on using powder preparations.

RESULTS AND DISCUSSION

We ascertained that soils, developed on limestones or similar massive carbonaceous rocks, contained principally carbonates inherited from the parent rocks [12]. Their mineralogical composition depends upon the mineralogical composition of these rocks, and their quantitative content, upon the degree of leaching the carbonates from the soil profile. They are usually formed by fragments of the parent rocks.

These fragments are often strongly corroded, pelletized and strongly disturbed, even intracrystallinically. Some fragments were turbid, under microscope, and did not extinct in any position, other ones had, in the centres, conserved crystalline cores. In conformity with the degree of disturbance, the borders of someones were metasomatically substituted by humo-ferrous substances (Fig. 1). This metasomatic suppression was especially intensive on more humid places, in soils on debris carbonaceous materials.

In rendzinas, beside fragments of parent rocks, we also meet forms which are obviously "pedogenetic" ones [12].

The soils developed on loess contain merely slight amounts of carbonate forms "inherited" from the sediments [12]. By studying these soils, we ascertained the predominance of forms generated in loess or carbonaceous alluvia "epigenetically", i.e. after the accumulation of the mineral mass. In various soils we observed symptoms of their further translocation due to the soil-forming processes.

In many soils, we found fragments of the shells of molluscs exhibiting marks of recrystallisation, mostly fossile ones, but we found also recent forms.

Based on micromorphological study, we divided the carbonates of soils, according to their origin, in four groups:

1. The *allochthonous* ones get into the soil from other places, eventually from the underlying parent rocks. Their structure can be primary,

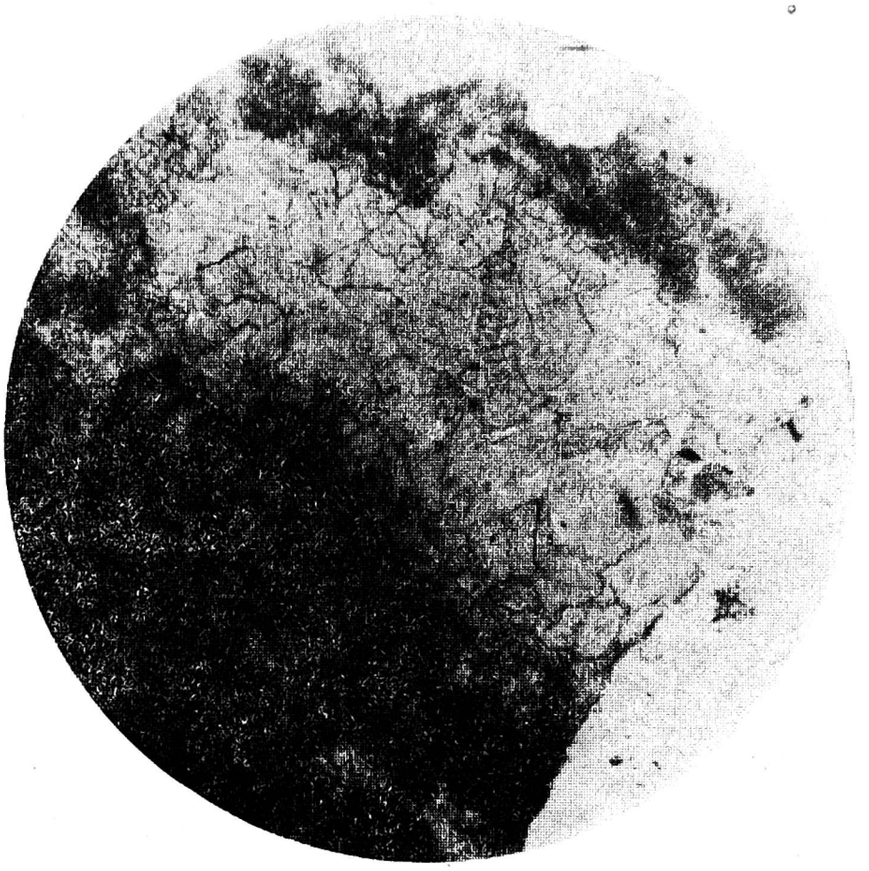

Fig. 1. Weathered fragment of limestone in a soil with conserved crystalline core. On the borders, metasomatic surpressing of the limestone by humo-ferrous substances. Magnif. ×53, II N (Photo J. Čurlík).

intermediary or even secondary. Therefore, their actual denomination "primary", after Parfenova-Yarilova [10], may not be considered as fully adequate.

2. The *autochthonous* ones originated in the places of their actual occurrence. Neither here, we consider the denominations "secondary" or "pedogenetic" as fully adequate. The allochthonous forms can also be secondary ones. The denomination "pedogenetic" does not hold true as far as soils on loess or carbonaceous alluvium are concerned. There occur carbonates which originated both in diagenesis and pedogenesis processes. It is very difficult to distinguish these forms.

3. The *indifferent* ones are of uncertain origin. They exhibit marks of the first and second group.

4. *Fragments of the shells of organisms* are substantially of an allochthonous origin, but we range them in a separate group because of their specific character.

The allochthonous forms represent fragments of carbonaceous rocks and minerals. They have irregular shapes, sometimes, with marks of dressing. Under microscope, they are often turbid, eventually pelletized on the edges.

The autochthonous forms exhibit great manifoldness. They are formed by microcrystalline up to cryptocrystalline carbonates, rarely even by larger macrocrystals. Kubiëna [4] reports that the microcrystalline to

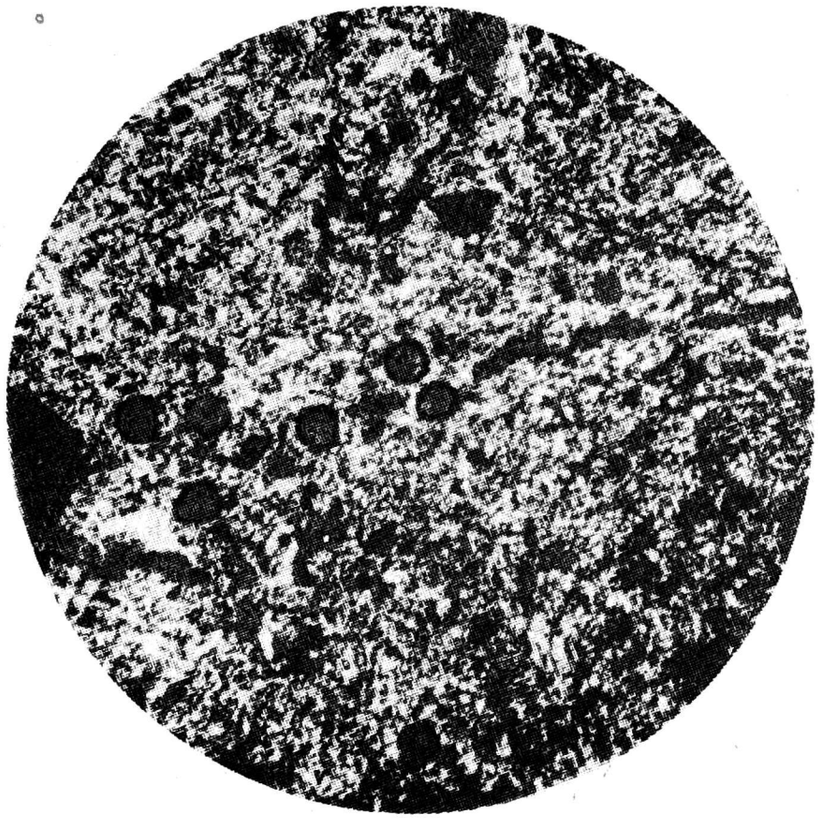

Fig. 2. Autochthonous carbonates in the form of cement, uniformly distributed in the soil plasma. Magnif. ×43, X N (Photo J. Čurlík).

Fig. 3. Irregular films of cryptocrystalline carbonates in the soil plasma. Magnif. ×43, X N (Photo J. Čurlík).

cryptocrystalline forms originate from concentrated solutions, while the crystalline forms from less concentrated solutions.

From the manifold forms, we determined mainly the following ones:

(a) The microcrystalline to cryptocrystalline carbonates in the form

of cement (Fig. 2). They are regularly or irregularly distributed in the soil plasme. Sometimes, they form irregular agglomerations of sizes up to 0.8 mm.

(b) Irregular films in the plasma were found in the soils on carbonaceous alluvia (Fig. 3).

(c) Cryptocrystalline and microcrystalline concentrations around the pores with dissimilar orientation of the crystals on the pore walls (Fig. 4).

Fig. 4. Microcrystalline forms of autochthonous carbonates in the pores. Magnif. ×48, X N (Photo J. Čurlík).

(d) Larger radial, rayed crystals of oval or elongated shapes were found in loess only (Fig. 6).

(e) The tabular forms consisting of cryptocrystalline carbonates, ascertained in soils on loess, indicate an intensive leaching from the higher soil horizons.

(f) Lublinit — needle-shaped calcite was found in chernozems and brown earths on loess and in meadow soils on carbonaceous alluvium (Fig. 5).

(g) Cryptocrystalline forms of carbonates of several generations, enveloping the grains of minerals and fragments of rocks, were found in alluvia of the Little Danube.

By detailed study, we succeeded to determine three generations of carbonates which indicate repeated sinking and rising of strongly mineralized underground waters from which, due to a strong evaporation water regime, the carbonates were precipitated. Many of these forms have

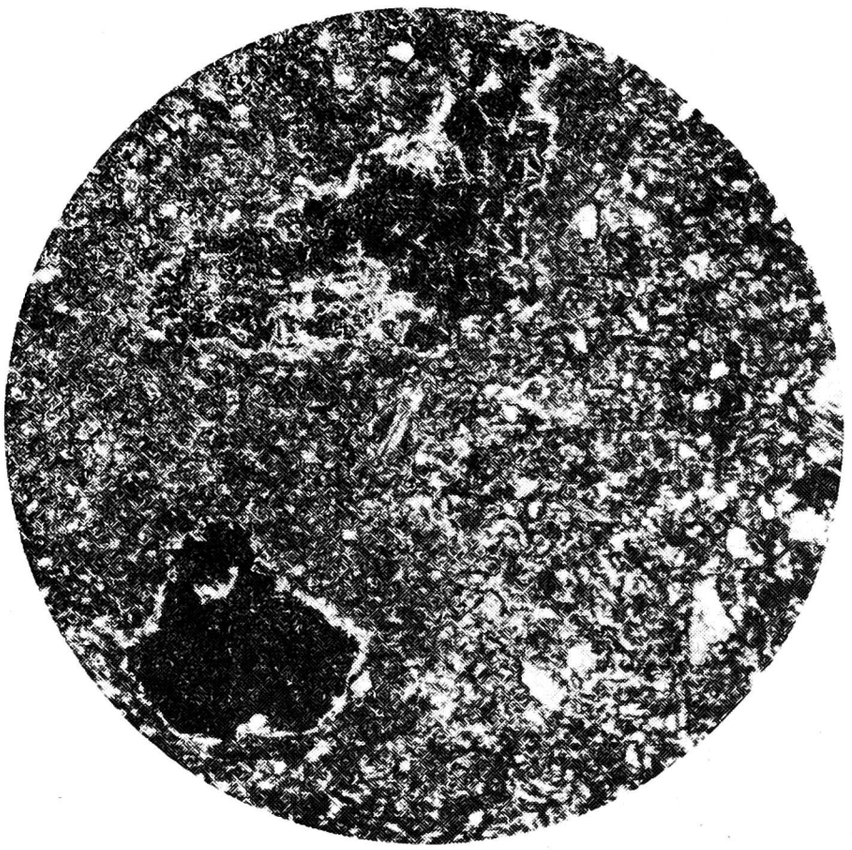

Fig. 5. Lublinit — needle-shaped calcite in the pores. Magnif ×46, X N (Photo J. Čurlík).

Fig. 6. Radial, rayed forms of carbonates in the pores of loess. Magnif. ×43, X N (Photo J. Čurlík).

been ascertained in the soils on loess or alluvium. The autochthonous forms here are epigenetic ones.

Mineralogical analysis showed that many of the described forms of carbonates were formed both by calcite and dolomite [5]. The presence of dolomite, in the soils on alluvium, were determined röntgenographically, by DTA, by separating the fine coats enveloping the grains of various minerals or fragments of rocks. In soils on loess, the dolomite is present in tubular forms as well.

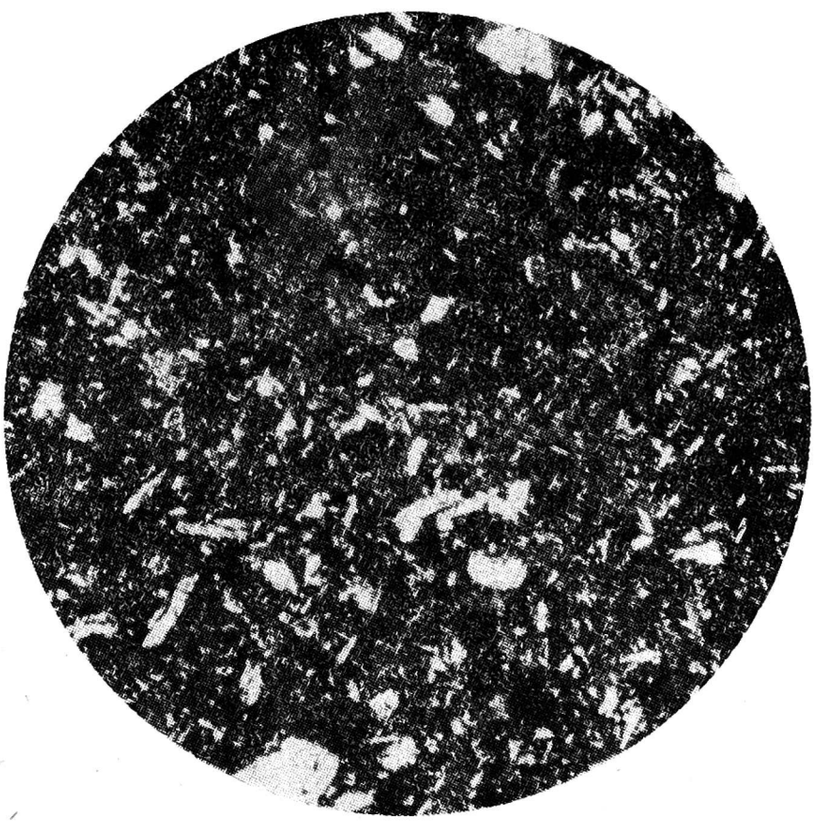

Fig. 7. Small needle-shaped crystals of hydromagnesite in the soil. Artificial "Mg-salinization" in the environs of the old magnesite works. Magnif. ×48, X N (Photo J. Čurlík).

Hydromagnesite was found in soils only exhibiting secondary "Mg-salinization", in the environs of the old magnesite plant. It forms small needle-shaped crystals in the soil plasma of originally acid brown earth on mica schists (Fig. 7). Its presence can neither be excluded in some other soils.

The mineralogical composition of allochthonous forms depends on their origin. The fragments of shells are formed by aragonite and calcite.

CONCLUSION

Based on micromorphological study of the carbonates in some soils of Slovakia, we divided the carbonates, according to their origin, in following groups:

(1) allochthonous carbonates,

(2) autochthonous carbonates,

(3) indifferent carbonates,

(4) fragments of the shells of organisms.

The autochthonous forms of carbonates, in soils on loess or on the alluvia of the plain areas of Slovakia, have many similar marks. The majority of forms originated epigenetically, i.e. after the accumulation of the mineral mass.

We ascertained by mineralogical and physico-chemical methods (DTA, Röntgen) that in the soils on loess and alluvia, both the calcite and dolomite occurred as autochthonous forms.

Fig. 8. Fragment of a mollusc shell with slight weathering of the external prismatic layer. Magnif. ×43, X N (Photo J. Čurlík).

SUMMARY

The aim of the present work was the micromorphological study of carbonate forms in some soil on loess and on carbonaceous alluvia of Slovakia. Based on these investigations of the carbonate forms we can divide them according to their origin in the following groups:

1. Allochthonous forms which get into the soil from other places, eventually from the underlying parent rock. Their texture can be primary, intermediary or even secondary.

2. Autochthonous forms which originated on the places of their actual occurrence. Their texture is a secondary one.

3. Indifferent forms of uncertain origin. They have some marks of the first and second groups.

4. Fragments of the shells of organisms. Although they are substancially allochthonous ones, for their specific character we include them in a separate group.

We ascertained by mineralogical and physico-chemical methods (DTA, Röntgen) that in the soils on loess and alluvia both the calcite and dolomite occurred as autcchthonous forms.

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