

OTAKAR ŠTELCL

INTENSITY OF SOLUTION IN VARIOUS TYPES OF CARBONACEOUS ROCKS IN THE CENTRAL EUROPEAN CLIMAMORPHOGENETIC REGION

In the Department of Karst Research of the Institute of Geography of the Czechoslovak Academy of Sciences in Brno the research of the intensity of karst processes has been carried out since the beginning of 1971 within the frame of the study of relief forming processes. One of the partial tasks of this research is the establishment of the solution intensity of various types of carbonaceous rocks in presentday climatic conditions. The investigations are supposed to be finished in 5 years and are carried out in several karst regions of various types of karst. Although the investigations have been performed for a short time the results obtained are so interesting that I think it suitable to present them here.

In the selection of research localities attention was paid to the fact that the main conditions affecting the intensity of karstification, such as for instance the extend and thickness of carbonates, the morphological character of the relief, the climatic conditions, the character of karst hydrography, the biological cover, etc., were comparable, the petrographical character of carbonaceous rocks being different. This is why regions were chosen where the karstifying rocks are represented by pure sedimentary limestones, dolomitic limestones, dolomites and marbles. The investigations are performed in regular two-weeks intervals. The analysis of karst waters was carried out in the laboratory of the Institute by means of usual laboratory methods.

Description of the investigated localities

Locality No. 1

is situated in the karst developed in isolated limestone blocks near the community of Vojtěchov in the Dražanská vrchovina (Highland of Dražany). The limestones are of Devonian age and are surrounded by noncarbonaceous Culmian rocks. From the orographical point of view the territory belongs to the Dražanská vrchovina (Highland of Dražany) — mean altitude a. s. l. 550 m characterized by a slightly undulated relief. The complex of Devonian and Culmian rocks was folded in the younger period of the variscan orogenesis and was later disturbed by Saxonian transversal faults. The limestones form several series of strata. The total thickness of limestones amounts to as much as 150 m. They are grey, finely up to medium grained and bank-thick-like bedded. The CaCO_3 content ranges in the individual layers between 91, 92 to 98,79 % and the MgCO_3 content between 0,61 to 1,03 %.

The limestones near Vojtěchov were subject to a long and complex geomorphological development which gave them the character of elevations representing structural forms from which the adjacent less resistant Culmian deposits have

been stripped of. The karstification proceeded in several stages in various conditions which is proved by forms of several cycles. The karst forms were fossilized in places. In the region investigated they form short ridges and hills with rocky slopes reaching altitudes between 491,2 and 534,2 m a. s. l. In the fissures and hollows of their summit parts remnants of kaolinic and quartzitic products of weathering are preserved with fragments of rocks building today the surrounding lower relief. Among the superficial forms belong blind and semi-blind valleys, sinkholes, clints, ponors and karst springs. In the underground caves developed which are genetically linked with the development of the surrounding relief of non-carbonaceous rocks. Through the limestone ridges allochthonous subsurface karst streams penetrate in the transverse direction and appear again on the opposite side at the foot of the ridges in form of several strong karst springs. The length of the subsurface karst streams amounts to about 1 km. The content of the dissolved calcium in the springs ranges between 100 and 140 mg/l, and magnesium between 3,5 and 12,5 mg/l, the total hardness reaching values of 20 to 21°GD.

Locality No. 2

is situated in the karst in the region of linear megafolds near the town Chýnov in South Bohemia. The karst phenomena are linked with small crystalline limestone occurrences forming lenses in the so-called series of Sušice-Votice, represented above all by mica schists. From the orographical point of view the whole territory belongs to the Středočeská pahorkatina (Hilly Land of Central Bohemia) reaching average altitude of 500 m a. s. l. The limestones build usually low rounded elevations and rocky valley sides. There are only few superficial karst forms here, clints and corroded cracks being most frequent. Subsurface karst forms — if they there are present at all — are not of great dimensions and have a poor dripstone décor. They are usually filled with cave deposits, among which sometimes also limonite occurs. The karst hydrography is imperfectly developed which is indicated by the small number of karst springs.

The locality investigated is formed by a limestone lense rising in form of an isolated hill called Pacova hora (586,6 m a. s. l.) above the surrounding slightly undulated relief on non-carbonaceous rocks. The carbonaceous rocks are as much as 150 m thick and are penetrated in places by amphibolite intercalations. There are two kinds of limestones here. One of them is pure, coarse grained, 5 to 10 m thick limestone, with CaCO_3 content amounting to 96,87 %. The prevailing part of Pacova hora is built of fine grained dolomitic limestone (CaCO_3 content 60,0 %, MgCO_3 content 30,5 to 39,1 %) with a rather important insoluble residue (as much as 11,04 %).

In Pacova hora is the Chýnov cave, the largest cave in South Bohemia, 400 m long, partly accessible to public. Through this cave flows a subsurface stream, which disappears in a siphon. Its outflow can be found in the valley of the creek Chýnovský potok at a distance of about 2 km from the siphon. The drainage basin of the subsurface stream has not been identified exactly so far. The content of solved calcium at the end of the subsurface stream reaches values between 48,09 and 58,1 mg/l, that of magnesium values between 9,7 and 14,4 mg/l, the total hardness ranging between 8,1 and 11,4°GD.

Locality No. 3

is the part of the karst in the region of the block-faulted structure near the village of Bozkov in North Bohemia. The karst occurs on small outcrops of

crystalline limestones and dolomites. It is a part of the moderately undulated relief of the hilly land called Podkrkonošské pahorkatiny, which was strongly affected by Saxonian radial tectonics. Superficial karst forms are rather rare here. They are represented only by clints and isolated rocks. Subsurface karst forms can be found only in places.

The locality is situated in the environs of the village of Bozkov. It consists of outcrops of crystalline calcareous dolomites of Silurian age, which together with phyllites are part of the Subsudeten crystallinum. The thickness of dolomites amounts to 100 m. The dolomites are of yellowish colour and to a considerable depth they are weathered. The CaCO_3 content amounts to 51,67 %, the MgCO_3 content to 35,74 %, the insoluble residue amounting to 12,18 %. The dolomites and the adjacent non-carbonaceous deposits are cut by a flat surface in the height of 475 m a. s. l. which was later dissected by a younger valley pattern.

In the surroundings of the village of Bozkov a 350 m long cave has been formed in the calcareous dolomites. It is partly accessible to the public. There are several lakes in the cave, drained by a strong karst spring. The exact extend of the drainage basin of the lakes is not known. The following values were established on the basis of chemical analyses of the waters of the karst spring appearing at a distance of about 100 m from the subsurface lakes: calcium 28,06 to 36,07 mg/l, magnesium 9,73 to 14,59 mg/l, the total hardness ranging between 6,72 to 7,84°GD.

Locality No. 4

belongs to the karst of strongly tectonically disturbed domes near the village of Horní Morava in North Moravia. The karst phenomena are conditioned by small occurrences of marbles which are karstified in places. In the relief they are not conspicuous owing to their small extend. They are a part of the mountain group of Králický Sněžník in the Eastern Sudeten.

The locality investigated is situated northerly of the village of Horní Morava in the uppermost section of the Morava River valley on the slopes of the Králický Sněžník at the altitude of 860 m a. s. l. The rocks are marbles forming discontinuous stripes extending from the Morava River valley over Králický Sněžník to Kłodzko in Poland. They are intercalated in mica schists of the so-called Stroň series. The karst hydrography is developed which is proved by several strong karst springs.

The marbles are slightly karstified. Superficial karst phenomena are rather sporadic and are partly covered with products of solifluction and with colluvial loams and non-carbonaceous debris. In the underground, several narrow and short caves exist, some of which are flown through by a subsurface stream. The samples were taken in the karst spring draining the caves Tvarožné díry. By means of the analyses of the karst springs the following values were established: calcium 16,03 to 24,05 mg/l, magnesium 1,22 to 3,65 mg/l, the total hardness 2,80 to 3,36° GD.

Conclusion

The survey of the intensity of solution in various types of carbonaceous rocks on the territory of the Czech Socialist Republic is given in the Table 1.

Table 1.

Locality	Vojtěchov	Chýnov	Bozkov	Horní Morava
altitude m a. s. l.	534	588	501	860
mean annual precipitation in mm	611	673	743	921
discharge in l/sec	2—4	3—5	3—5	2—4
type of carbonate	limestones	dolomit limestones	dolomites	marbles
total hard- ness in ° GD	20—21	8,1—11,4	6,72—7,84	2,80—3,36
Ca mg/l	100—140	48,09—58,1	28,06—36,07	16,06—20,04
Mg mg/l	3,5—12,5	9,7—14,5	9,73—14,58	1,22—3,65
Ca+Mg mg/l	103,5—152,5	57,79—72,6	37,79—50,66	17,25—23,69
average values Ca+Mg mg/l	128,0	65,19	44,22	20,47

On the basis of the values obtained the sequence of carbonaceous rocks can be stated according to their solubility in the conditions of the Central European climate on the territory of the Czech Socialist Republic. The relative rate of erosion in the carbonaceous rock investigated was calculated on the basis of total hardness. The base of this scale is expressed by the index 1, which is the value of least soluble marbles. When the marbles are characterized by the index 1, the indices of other carbonaceous rocks are:

marbles	index 1,0
dolomites	" 2,3
dolomitic carbonates	" 3,1
carbonates	" 6,6

The results obtained cannot be considered as definitive owing to short-term observations. In the course of further research they will be completed mainly with the results of quantitative hydrology which make the interpretation of the results obtained more exact.

INTENZITA ROZPOUŠTĚNÍ RŮZNÝCH TYPŮ KARBONÁTŮ VE STŘEDOEVROPSKÉ KLIMATOMORFOGENETICKÉ OBLASTI

Pracovníci Geografického ústavu ČSAV v Brně provádějí od počátku roku 1971 v rámci studia reliéfových pochodů též výzkum intenzity krasových procesů. Jedním z dílčích úkolů tohoto výzkumu je zjištění intenzity rozpouštění různých typů karbonátových hornin v současných klimatických podmínkách. Výzkum je plánován na 5 let a je prováděn v několika regionech náležejících různým typům krasu. V předložené práci jsou uvedeny výsledky získané v prvním roce výzkumu.

Při volbě lokalit bylo dbáno na to, aby hlavní podmínky ovlivňující intenzitu krasování karbonátových hornin (geomorfologický charakter reliéfu, klimatické podmínky, charakter krasové hydrografie, biologický kryt apod.) byly alespoň zčásti vzájemně srovnatelné, ale petrografický charakter karbonátových hornin odlišný. Proto byly vybrány regiony, kde krasovější horninou jsou velice čisté sedimentární vápence (Vojtěchov na Drahanské vrchovině), dolomitické vápence (Chýnov v jižních Čechách), dolomity (Bozkov v severních Čechách) a mramory (severní Morava). Výzkumy jsou prováděny v pravidelných 14denních intervalech.

Ze získaných hodnot je možno předběžně stanovit pořadí karbonátových hornin podle jejich náchylnosti k rozpouštění v podmínkách středoevropského klimatu na území České socialistické republiky. Relativní rychlost eroze u zkoumaných karbonátových hornin byla vypočtena podle jejich celkové tvrdosti. Základní údaj stanoveného pořadí je vyjádřen indexem 1, který označuje hodnotu nejméně rozpustných mramorů. Jestliže mramory jsou charakterizovány indexem 1, pak hodnoty dalších karbonátových hornin jsou následující:

mramory	index 1,0
dolomity	" 2,3
dolomitické vápence	" 3,1
vápence	" 6,6

Získané hodnoty v důsledku krátkodobého pozorování nelze považovat za definitivní. V důsledku dalšího plánovaného výzkumu budou doplněny především o výsledky kvantitativní hydrologie, které je dále upřesní.