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**GEOLOGICAL CONDITIONS - FACTOR OF ORIGIN OF
TWO DIFFERENT CAVE SYSTEMS IN TWO ADJACENT
VALLEYS (THE DEMÄNOVSKÁ VALLEY AND THE
JÁNSKA VALLEY, THE LOW TATRAS, SLOVAKIA)**

POMEN GEOLOŠKIH POGOJEV PRI RAZVOJU DVEH
JAMSKIH SISTEMOV V DVEH SOSEDNJIH DOLINAH
(DEMÄNOVSKÁ DOLINA IN JÁNSKA DOLINA,
NIZKE TATRE, SLOVAŠKA)

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Abstract

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Milan Marušin: Geological conditions - factor of origin of two different cave systems in two adjacent valleys (the Demänovská Valley and the Jánška Valley, the Low Tatras, Slovakia)

The Demänovská Valley is the most famous karst valley in the northern slopes of the Low Tatras. There the Demänovská Cave system is developed more than 30 km long. The similar karst valley, the Jánška Valley with dozens of underground karst phenomena is situated ten kilometers to the east. The total length of these caves exceeds 30 km. The geomorphological, hydrological, and karst conditions of these two valleys are similar; nevertheless there are several outstanding differences between two cave systems developed in them. The whole of the Demänovská Cave system is developed within the eastern slope of the Demänovská Valley. On the contrary in the Jánška Valley significant caves are situated on both sides of the valley. Besides this difference the Demänovská Cave system is penetrable through the whole of its length whereas cave system of the Jánška Valley is not penetrable although connection of the underground spaces was proved by various methods. The described state is caused by different geological conditions in these valleys. Both cave systems are developed mostly in the Middle Triassic Gutenstein Limestones. But the Demänovská Valley is situated in the area which is built by monocline of the Krížňanský nappe. In the territory of the Jánška Valley there is the Chočský nappe which is tectonically very complicatedly framed.

Key words: geological conditions, cave system, Gutenstein Limestones, Demänovská Valley, Jánška Valley, Slovakia.

Izvleček

UDC: 551.44(437.2)

Milan Marušin: Pomen geoloških pogojev pri razvoju dveh različnih jamskih sistemov v dveh sosednjih dolinah (Demänovská dolina in Jánška dolina, Nizke Tatere, Slovaška)

Demänovská dolina ja najznamenitejša kraška dolina v severnem pobočju Nizkih Tater. V dolini je poznan 30 km dolg jamski splet Demänovská jama. Podobna je sosednja, Jánška dolina, v kateri je ducat jam, ki skupno merijo preko 30km. Morfološki in hidrološki pogoji v obeh dolinah so podobni, jamski sistemi pa močno različni. Demänovská jama je v celoti razvita na vzhodni strani Demänovske doline, medtem ko so jame v Jánški dolini razvite na obeh straneh te doline. Demänovska jama jo enoten, vseskozi prehodni jamski sistem, medtem ko sistem jam v Jánški dolini med seboj ni povezan s prehodnimi rovi. Oba jamska sistema sta razvita v gutensteinskih apnencih. Avtor opisuje razliko med jamami v obeh dolinah različnim strukturno geološkim pogojem. Demänovská dolina leži območju monoklinale Krížňanskega pokrova, Jánška dolina pa v območju Chočskega pokrova z zelo zapleteno tektonsko zgradbo.

Ključne besede: geološki pogoji, gutensteinski apnenec Demänovská dolina, Jánška dolina, Slovaška.

INTRODUCTION

The Low Tatras are one of the most important karst areas in Slovakia. This range of mountains is located in the northern part of Slovakia. The length of the range exceeds 70 kilometers and its width is about 25 kilometers. The highest hill is Ďumbier with an elevation of 2,043 m a.s.l.. The difference between level of the Liptovská Basin and the ridges of the Low Tatras is about 1,200 meters.

According to the geological situation, an occurrence of karst phenomena concentrates mainly on the area of the northern slopes of the mountains, where the mighty series of carbonate rock strata are deposited. What is significant for that area is allochthonous type of karst, where water streams flowing from non-karst territory get to the karst rocks, where they sink to the underground, form caves and spring out to the surface from resurgences. The main representatives of karst valleys with the occurrence of the extensive cave systems are the Demänovská Valley and the Jánška Valley on the northern slopes of the Low Tatras, southwards from Liptovský Mikuláš (Fig. 1).

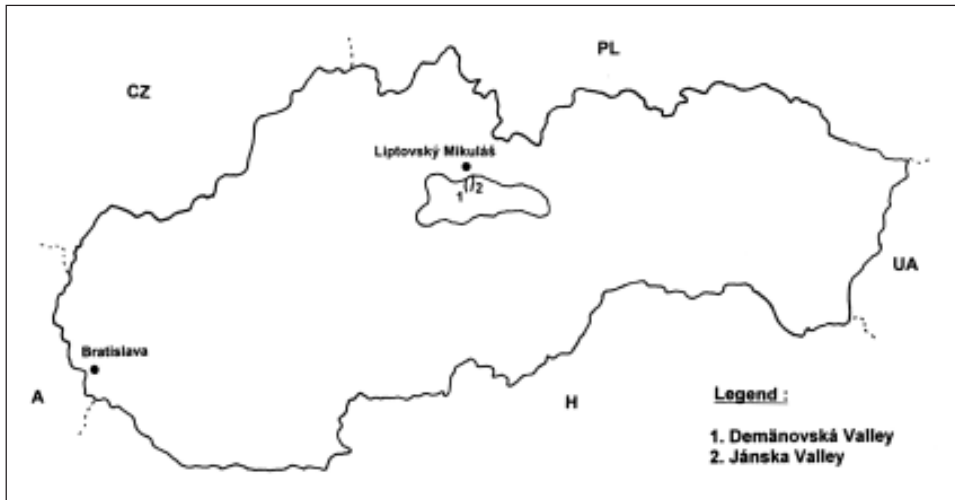


Fig. 1: Map of Slovakia with positions of the Demänovská and the Jánška Valleys in the Low Tatras (outlined).

PRINCIPLES OF GEOLOGICAL, GEOMORPHOLOGICAL, AND HYDROLOGICAL SITUATION

The Low Tatras are a part of the West Carpathians curve. They belong to Slovak core mountains with a crystalline core in their central part. That crystalline core is represented by Paleozoic magmatic and metamorphosed rocks (granite, granodiorite, diorite, gabbro, gneiss, migmatite, mica schist, phyllite). On both borders of the core there are narrow and uncontinuous belts of

autochthonous sedimentary Lower Triassic envelope series (sandstone, quartzite, conglomerates, shales). And then, several hundreds meters thick thrust sheets in the northern and the southern slopes of the mountains are located. Those nappes are built by Mesozoic carbonate rocks, mostly by various types of limestones and dolomites. So the mountains are of a complicated fold-napped frame. First of all, the slopes of the Low Tatras are built by complicatedly deposited nappes, their scales and digitations, having been variously overfolded (Biely, A., 1992; Maheľ, M., 1986).

Generally, it may be said, that the water streams springing below the ridges of the mountains cross a crystalline core, they sink down contacting the carbonate rocks, then they flow to the underground and spring out from resurgences to the surface again. A superelevation of nearly 1,000 meters between a level of springs and a level of the Liptovská Basin gives to those streams a considerable energy. That situation can be seen mainly in the northern slopes of the mountains. The water streams cut remarkable karst valleys and canyons there. Maybe the most famous and the most interesting valleys are the Demänovská and the Jánska Valleys, distant from one another about 10 kilometers.

The surficial karst phenomena are rare because a considerable steepness of slopes of the mountains does not enable development of those forms as the water trickles down the slopes relatively quickly. On the contrary, the area is rich in underground karst phenomena. About 600 caves are discovered in the whole area of the Low Tatras. The length of these caves varies from 5 metres to the 30 kilometres long Demänovská Cave.

THE DEMÄNOVSKÁ CAVE SYSTEM

This system is the longest cave system in Slovakia. It was created on the right side of the Demänovská Valley by corrosive and erosive activity of ponor allochthonous water flows of the Demänovka River and its tributaries. A system of mutually connected caves exceeds the length of 30 kilometers. It includes the Pustá Cave, Štefanová Cave, Demänovská Cave of Liberty, Údolná Cave, Cave pod Útesom, Cave No. 27, Vyvieranie Cave, Demänovská Cave of Peace, Pavúčia Cave, Demänovská Ice Cave and many other less extensive caves (Fig. 2). The cave system is rich in the different geomorphological forms, flowstone filling of various shapes as well as ice filling of the Demänovská Ice Cave (Bella, P., 1998).

After having gone across crystalline rocks, the Demänovka River gets to the karst area, where a part of its water sinks underground. In dry years the surficial channel of the Demänovka River is entirely out of water. After having gone through the cave system on the right side of the valley, the underground water flow of the Demänovka River springs to the surface from the Vyvieranie Cave. The whole cave system is created in 9 developmental levels formed by gradual incising of the Demänovka River into the rock massive. Those processes run in the close association with development of the valley on surface (Droppa, A., 1972).

It is important to say that the Demänovská Cave system is developed in the heavy-bedded Middle Triassic Gutenstein Limestones of the Krížňanský nappe. Referring to the structural and/or tectonical situation, the cave spaces had been created along bedding planes of the Gutenstein Limestones benches. But also two main tectonic systems (NW-SE, NE-SW) participated during the processes of passage origin. All mentioned structural systems influence the general course of the cave system and the character of its spaces.

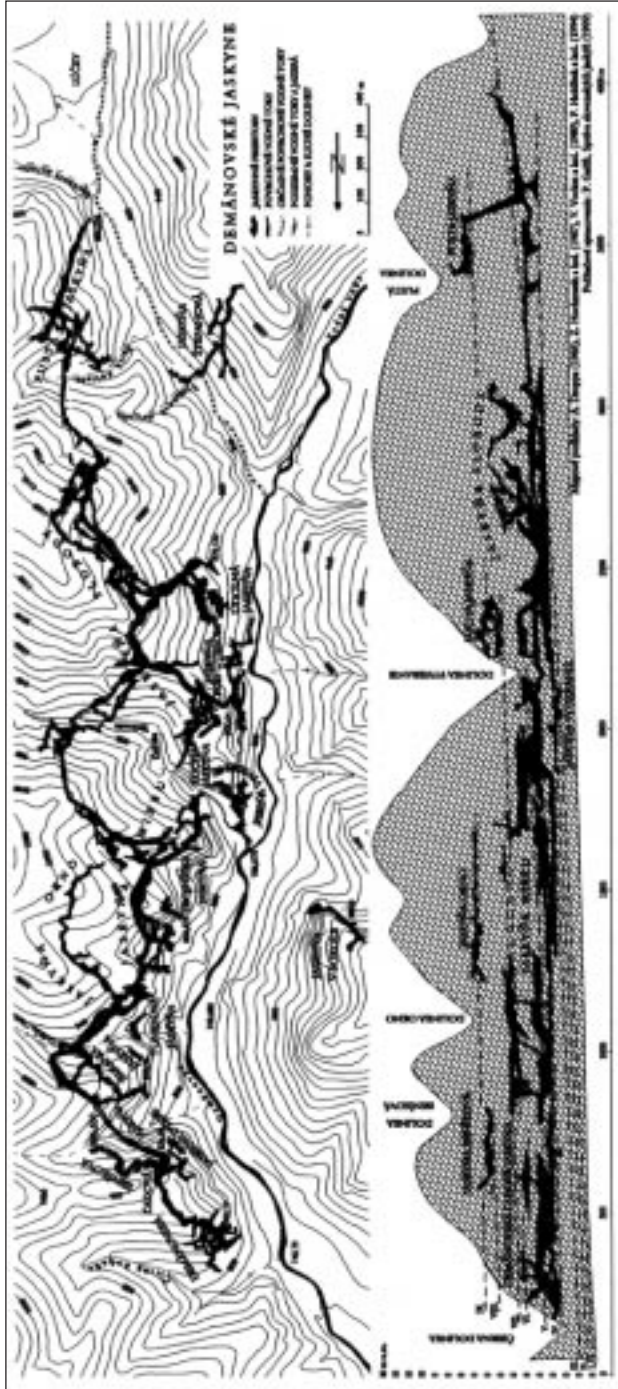


Fig. 2 : The Demänovská Cave System.
Map sources: Droppa, A. (1965), Hochmuth, Z. (1987), Vočlon, V. (1989), Holúbek, P., et. al. (1994).
Computer working out: Gažík, P., Slovak Caves Administration (1999).

CAVE SYSTEM IN THE JÁNSKA VALLEY

The Jánska Valley is situated about 10 kilometers eastwards from the Demänovská Valley. That area of the Jánska Valley includes about 170 caves. Only the most important caves are plotted on the map of the area (Fig. 3). The longest cave is the Zlomiská Cave (11,000 m long), then followed by the Stanišovská Cave (3,100 m), Nová Stanišovská Cave (2,300 m), Medvedia Cave (1,400 m), Sokolová Cave (1,300 m). Caves and shafts located high on the tributary ridges which are drained off to the Jánska Valley - the Starý hrad Cave (5,100 m long and/or 432 m deep), Javorová Abyss (2,200 m / 312 m), Cave v Záskočí (5,000 m / 284 m), Večná robota Cave (1,000 m / 224 m), Cave Slniečného lúča (500 m / 113 m) - also belong to the area of that valley. Shafts on karst platform of Ohnište - the Jelenia Shaft, Havran Shaft, Ladová Shaft (Bella, P., Holúbek, P., 1998) - belong to that area as well. Besides them there are many less extensive caves, too. The total length of the mentioned caves exceeds 30 kilometers.

The main difference between the Demänovská Cave system and the cave system of the Jánska Valley is that the former is represented by mutually connected caves, while the cave system in the Jánska Valley is not penetrable although a connection between those caves was proved by various methods such as tracing methods, bioindicative methods, and geophysical methods.

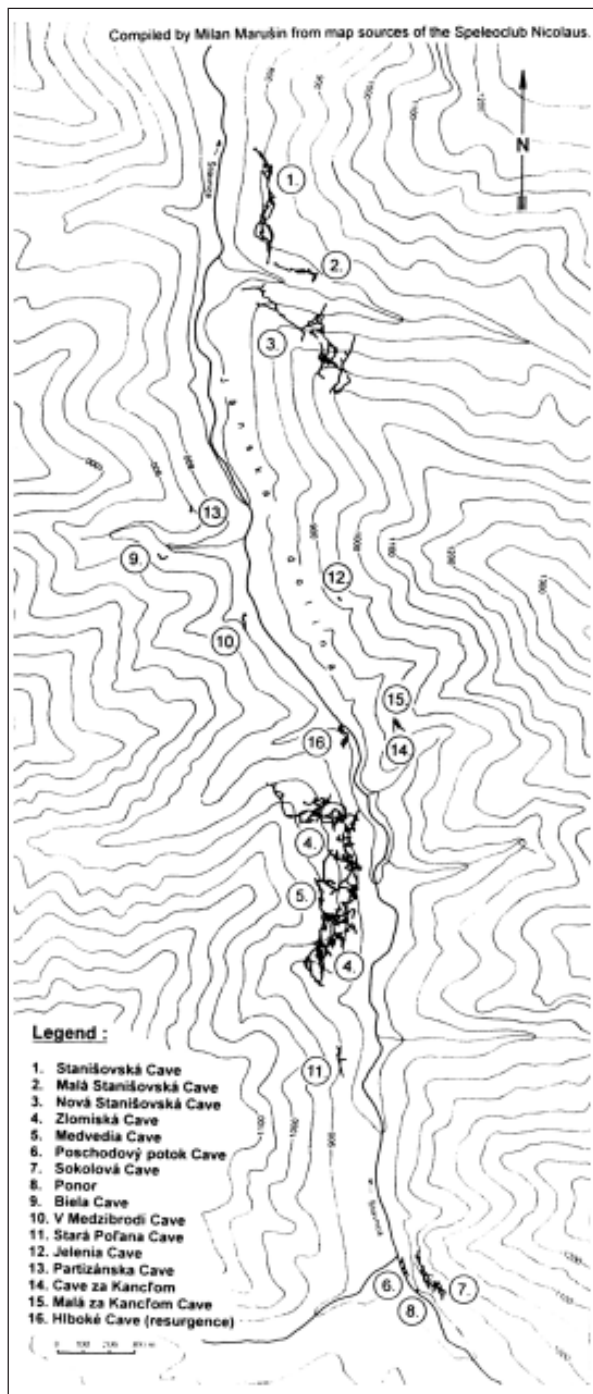
A hydrological situation is similar to the one in the Demänovská Valley. After having gone cross crystalline rocks, the Štiavnica River gets to the karst area and a part of its waters sink to the underground there. In dry years the surficial channel of the Štiavnica River is entirely out of water. According to the bioindicative and geophysical methods, the underground river flows from ponor through the right side of the valley up to the northern parts of the Zlomiská Cave, and from there into the left side of the valley up to its rising in the Hlboké Cave (Holúbek, P., Magdolen, P., 1996).

The majority of caves in the Jánska Valley is developed similarly to the Demänovské caves in the heavy-bedded Middle Triassic Gutenstein Limestones. But in comparison with the Demänovská Valley, these limestones do not belong to the Krížňanský nappe, but to the Chočský nappe. In addition, a different structural and/or tectonical character of both nappes explains a different character of both cave systems, too.

COMPARISON OF BOTH CAVE SYSTEMS

It is seen, that the cave systems in both valleys have some common attributes and some attributes are different.

The common attributes involve most of all an allochthonous fluvial-karstic character of origin of cave systems. Water streams coming from the higher non-karst area sink down to the underground in the karst area and they develop labyrinths of passages. In both cases, several developmental levels of cave passages were created. The older spaces of caves occur in the upper parts and the younger ones lie in the lower parts of the valleys (Droppa, A., 1972, Hochmuth, Z., 1997). That development runs in close association with development of the surface terrain relief, hence with development of the valleys. The another attribute in common is that the geomorphological character of areas of both valleys is generally similar. As a result, the hydrological situation is similar, too. There are the active ponors at the beginning of the karst area as



well as the underground streams and resurgences in the middle parts of the valleys. Moreover, a fact, that the both cave systems are developed mostly in the Middle Triassic Gutenstein Limestones although these limestones belong to the different tectonic elements in the both valleys belongs to the attributes in common.

A main difference between both the cave systems is their continuity. The Demänovská Cave system is penetrable practically through the whole its length, has been proved. Then, the Demänovská Cave system was developed in the right side of the valley and caves in the Jánska Valley are located irregularly on both sides of the valley. A situation like this is conditioned by the fact that two valleys are located in two different tectonic elements with a different structural and/or tectonical frame.

Fig. 3: Cave system of the Jánska Valley.

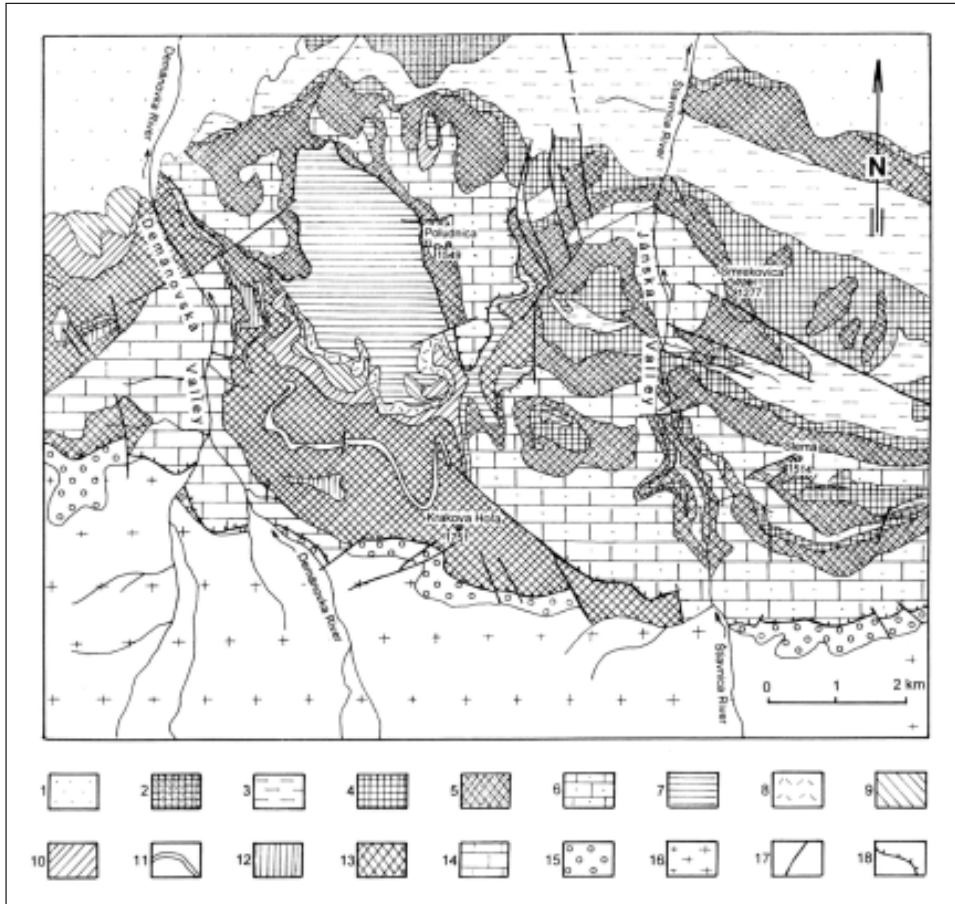


Fig. 4: Sketch of the geological situation (from the geological map of Biely, A., 1992).

Tertiary : 1 - Flysh; Paleogene sedimentary series (sandstone, claystone); Mesozoic: 2-6 Chočský nappa (Triassic): 2 - Hauptdolomites, 3 - Lunz beds (clayey shales and fine grained sandstone), 4 - Reifling Limestones, 5 - Choč Dolomites, 6 - Gutenstein beds (limestones intercalated with dolomites); 7-8 Ilanovská sequence: 7 - marly limestones (Cretaceous), 8 - limestones, sandstones, marlstones (Jurassic); 9-14 Krížňanský nape (Triassic): 9 - Carpathian Keuper (shales intercalated with sandstones and dolomites), 10 - dolomites with silicites, 11 - black bedded limestones, 12 - dark-gray and organodetrital limestones, 13 - Ramsau Dolomites, 14 - Gutenstein beds (gray to black limestones with dolomite layers); Autochthonous envelope series (Lower Triassic): 15 - sandstones, quartzites, conglomerates, variegated shales; Paleozoic: 16 - crystalline (magmatic and metamorphosed rocks - granit, granodiorite, migmatite, gneiss, mica shist); Tectonic: 17 - faults; 18 - nappa overthrust planes.

RELATION BETWEEN CAVE SYSTEMS AND GEOLOGICAL SITUATIONS IN VALLEYS

The geological situation is visible from the geological map. A karst part of the Demänovská Valley is located in a territory built by the Krížňanský nappe (Fig. 4). The Demänovská Cave system is developed on the right side of the valley inside the slopes built by the thick-bedded Gutenstein Limestones. The upper stratigraphic members of the Krížňanský nappe are deposited at the upper parts of the valley. Those are: Ramsaus Dolomites, organic limestones, tiled black limestones, dolomites with silicites, Carpathian Keuper and then an independent structural and/or stratigraphic element - the Iľanovská sequence. But it is important that the Krížňanský nappe occurs in that part of area as a remarkable monocline gently sloping to the northeast. That situation caused waters flowing into that area from the south to be drained along bedding planes of the Gutenstein Limestones benches on the right side of the valley. This is because of sloping of the limestone layers to the northeast with an angle of bedding about 35°. The main directions of the Demänovská Cave system then follow a course of two main tectonic systems: NW-SE, NE-SW. These tectonic systems are represented by fractures, fissures, and fissure systems. It can be said that a relatively simple structural situation conditioned development of the extensive interconnected cave system on the right side of the valley.

In the Jánska Valley the geological situation is much more complicated. It is not essential that the area belongs to the Chočský nappe, because a rock frame is similar as in the case of the Krížňanský nappe. In the Chočský nappe, the Middle Triassic Gutenstein Limestones have a main representation as well. They are the most important rocks for karst processes. The upper stratigraphic members of the Chočský nappe are included too: Ramsau Dolomites, Reifling Limestones, Lúnz beds. But it is important that the Bielovážska sequence building the Chočský nappe in that area is folded to the recumbent folds and it has a frame of many digitations complicatedly stacked. There are several main digitations: the Poludnica digitation, Smrekovica digitation, Slemä digitation, Príslop digitation, Benšová digitation. The geological situation is then complicated by backing folds and local digitations. So the carbonatic series have various modes of deposition in the Jánska Valley area. The layers of limestones have different directions and different angles of dip in various parts of the valley. Such complicated stacked digitations conditioned a more complicated character of the cave system laid out irregularly on both sides of the valley. The other stratigraphic members of the Chočský nappe interfolded to the Gutenstein Limestones may also have acted as the lithological obstacles limiting the karst processes. Individual caves in that valley are developed on various structures. In some places they are gently sloped bedding planes of limestones benches, elsewhere these bedding planes are steeply dipping; some cave passages follow a course of remarkable fissure systems or fractures. Some caves were developed due to a combination of these structural systems (Marušin, M., 1998, 1999, 2000-a,b,c).

CONCLUSION

The origin of two different cave systems in the same karst area can be seen in the similar hydrological and geomorphological conditions, but in different geological conditions. The Middle Triassic Gutenstein Limestones had a significant rôle in the origin of both cave systems, but

the structural and/or tectonical frame of nappes is different in the valleys.

The monocline of the Krížňanský nappe gently sloping to the NE caused the origin of an extensive cave system on the right side of the Demänovská Valley. A structure and main directions of that cave system are influenced by the bedding planes of limestones layers and by the planes of two main tectonic systems.

In contrast, the Gutenstein Limestones interfolded with other stratigraphic members of the Chočský nappe and their different mode of deposition in various parts of the Jánska Valley were reasons for the origin of the extensive, interconnected, but speleologically impenetrable cave labyrinths on both sides of the valley. Caves were developed on various tectonic structures there.

That is why the speleological situations are different in both valleys.

It can be also mentioned that the aim of one of our tasks in the Slovak Museum of Nature Protection and Speleology is to find a solution of relation between character of the cave system in the Jánska Valley and the mode of deposition of the Chočský nappe in this area. The structural and/or geological conditions of several caves have been worked out and published so far. Now the structural and/or geological mapping of the longest cave of this area (the Zlomiská Cave) is going on.

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