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Granites and granite caves in the Western Carpathians

GAÁL, L[1] and BELLA, P.[1]

(1) Slovak Cave Administration, Hodzova 11, 031 01 Liptovsky Mikulas, Slovakia; gaal@ssj.sk, bella@ssj.sk

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Abstract

Caves in Slovakia were originated mainly by karstification processes of carbonate rocks. From the reason speleological activities were oriented mainly to limestone and travertine caves. For the present caves located in the granite parts of several mountains are not complex registered and investigated. But existing knowledge resulted from the geological and geomorphological research of 16 granite caves with various morphological and genetic features, occurred in the high-mountain climatic and orographical conditions of Tatry Mts., is sufficient for their basic genetic classification. The occurrence of miniature speleothems formed by crust and pisolite formations is the interesting mineralogical feature of one investigated granite cave.

Key words: granite, granite cave, cave genesis, speleothems, Western Carpathians, Slovakia

INTRODUCTION

Mainly limestone caves are typical speleological phenomena in Slovakia. They are located in several karst areas (Slovak Karst, Slovak Paradise, Muran Plateau, Nizke Tatry Mts., Vysoke and Belianske Tatry Mts., Velka Fatra Mts., Strazovske vrchy Mts., Male Karpaty Mts. and others). Also, several non-carbonate caves were originated in basalt, basalt conglomerates, andesite, andesite conglomerate and breccia, andesite tuffs, rhyolite, basanite, sandstone, non-calcaire sandstone and conglomerate, granite, quartzite, quartz or shale as a consequence of varied geological settings of Slovakian territory. These caves are also interesting and important from the geological, geomorphological and biospeleological points of view. But caves formed in granitic rocks were investigated only sporadically for the present. Basic knowledge about granites and granite cave are summarized and presented in the paper.

GRANITIC ROCKS IN THE WESTERN CARPATHIANS

The Western Carpathians are the typical Alpine belt mountain extended mainly in the territory of Slovakia. Granites occur in its inner belts, where they form the crystalline cores of partial mountains. The most favourable conditions for weathering of granitic rocks are dominated in the highest mountains as the Tatry Mts. and the Nizke Tatry Mts. in the climatic zone above the upper boundary of forest.

Granitic rocks occur in the inner belt of Western Carpathians together with the metamorphic rocks of the Tatricum, the Veporicum and rarely in the Gemericum tectonic units (Fig. 1).

Fig. 1. Distribution of granitic rocks in Slovakia.

The Tatricum is the deepest denuded tectonic unit of the Inner Carpathians, representing relatively autochthonous towards the other advanced units. The Tatricum consists of crystalline cores with the normally lied Late Paleozoic and Mesozoic cover and Mesozoic nappe system. Granite occurs in the Tatricum in the crystalline cores of these mountains: Male Karpaty, Povazsky Inovec, Tribec, Strazovske vrchy, Ziar, Mala Fatra, Velka Fatra, Nizke Tatry, Tatry, and in the eastern parts of Branisko and Cierna Hora. Generally, they rise up together with metamorphic rocks as mica schists, gneisses, amphibolites, metasandstones and metavolcanics of Early Paleozoic, maybe Proterozoic age. Granitic rocks of Tatricum are Hercynian age. Petrographically they represent these types: leucocrate granitic rocks (mainly with plagioclase, quartz and K-feldspar, less of mica), two-mica granites to granodiorites (mainly with quartz, plagioclase, K-feldspar, biotite and muscovite and accessory monazite and ilmenite; the "*Bratislava*" type is typical in the Male Karpaty Mts., the "*Lipova*" type of radiometric age 360-340 Ma in the Mala Fatra Mts. and the Velka Fatra Mts.), porphyritic granodiorites to granites ("*Goryczkowa*" type is typical in the Tatry Mts., "*Prasiva*" and "*Dumbier*" types in the Nizke Tatry Mts.), biotite tonalites to granodiorites and hybrid granodiorites to tonalities passing locally into migmatites (Cambel and Vilinovic 1987; Kohut 1992; Broska and Gregor 1992).

In the **Veporicum** granitic, rocks occur in the Slovenske rudohorie Mts. in the middle part of Slovakia. They consist of porphyritic granodiorites to granites (the "*Sihla*" and "*Hroncok*" are the most typical types), biotite tonalites to granodiorites, leucocrate granites to granodiorites and hybride granodiorites. All veporic granites are Hercynian age (Vrana 1966; Broska and Petrik 1993).

Granite in the **Gemericum** occurs only in the several small places in the Slovenske rudohorie Mts.. They contain biotite to two mica granites of Alpinian age (Cambel et al. 1990).

WEATHERING OF GRANITES

The weathering of granites started during in the Neogene uplifting of the Carpathian Mountains. The most intensive weathering of granite is in high mountains of the Tatricum: Tatry Mts., Nizke Tatry Mts. and Mala Fatra Mts.. In the lower lying mountains granite are generally covered by forest and the coarser layer of soil.

The most favourable conditions for weathering of granitic rocks are in the **Tatry Mts.** in the northern part of Slovakia. The Tatry Mts. with the total length of 70 km is the highest mountain of Slovakia with the highest peak named the *Gerlach* (2,655 m a.s.l.). The Tatry Mts. is divided in three main parts: Zapadne Tatry (Western Tatras), Vysoke Tatry (High Tatras) and Belianske Tatry. Granites extend along its main ridge and the southern slopes, but the Belianske Tatry Mts. is prevailingly built of carbonate rocks of Mesozoic cover. Weathering of granite was the most intensive in Pleistocene during the changing of the warm and cold climatic periods. In Pleistocene, prevailing part of valleys was covered by glaciers. Many typical glacier valleys with kars, morenas and glacier lakes are found here also nowadays (Fig. 2). Other typical forms of Pleistocene periglacial weathering are the rock seas. Many steep slopes are covered by granite boulders. The recent weathering of granite is very intensive in the zone above the upper boundary of forest, e.g. over 1,600 m a.s.l. The climatic oscillations are frequent mainly in southern, sunny oriented slopes. The average time of snow cover is about 120 days of year. The weathering process results mainly by frost disintegration in consequence of climatic oscillations. The washing off of disintegrated particles is the following process of granite denudation. This weathering proceeds primarily along the gra-

vitational crevices, faults and cracks in granitic rocks. In several places some weathering microforms can be seen on the granite surface, e.g. karren-like features, single and composed kamenitza-like pans (Fig. 3), selective prepared dykes, etc.

Fig. 2. Pleistocene glacier valley in the High Tatry Mts.. Photo: P. Bella.

Fig. 3. Single and composed kamenitza-like pans on the granite surface, High Tatry Mts.. Photo: P. Bella.

In the **Nizke Tatry** Mts. (Low Tatras) the highest part of the central ridge is built of granite. The Nizke Tatry Mts. is the second highest mountain in Slovakia. They are located to the south of the Tatry Mts.. The highest peak of Nizke Tatry Mts. is the Dumbier (2,043 m a.s.l.). In this area favourable climatic conditions for the weathering of granite were mainly during Pleistocene. The Nizke Tatry Mts. were covered by several mountain Pleistocene glaciers. The glacier georelief with the typical U-shape valleys, glacial caldrons, kars, morenas, rocky seas and varied types of little selective weathering forms is related to glacial formation and development of granite surface. Several rock seas occur on the slopes of central ridge. The climatic conditions of high temperature oscillations and frequent rainfall (750 to 1,400 mm) are typically in the mountain mainly in the zone above the upper boundary of forest about 1,600 m a.s.l.. But no granite caves in the mountain area are known for the present.

Granites in the crystalline core of Mala Fatra Mts. (Little Fatra) reach above the upper boundary of forest about 1,400 m a.s.l., but in much smaller places than in the Nizke Tatry Mts.. Also, no granite caves are known from this mountain.

GRANITE CAVES AND THEIR GENETIC CLASSIFICATION

For the present, only 16 granite caves are registered in Slovakia. All of them are found in the Tatry Mts.. They represent 8.88 % of non-carbonate caves in Slovakia (180 caves) and 0.28 % of all caves in Slovakia (5,550 caves). From the point of view of genetic features these genetic types of granite caves are distinguished:

- **Weathering caves along gravitational crevices**

Jaskyna v Javorovom stite: 10.5 m long cave in the Javorovy peak of High Tatry Mts. (Vitek 1975).

Diera nad Ziarskym sedlom: 4.5 m long cave located at 1,950 m a.s.l. above the saddleback named the Ziar in the Western Tatry Mts. (Holubek 2000, 2004).

Rozsadlina v Raztoke: 6 m long fissure cave located at 1,530 m a.s.l. in the Western Tatry Mts. (Holubek 2000, 2004).

- **Weathering caves along tectonic faults**

Puklinova jaskyna: 10 m long cave under the Rumanovy peak in the High Tatry Mts. (Ksandr 1956).

Tomkova jaskyna: 7 m long cave located in the High Tatry Mts. (Puskas 1979).

Jaskyna v Ostrve: 10 m long cave with a spacious entrance (1.5 x 4 m) and 4-6 m high corridor originated along two E-W oriented subparallel faults in the western slope of Ostrva peak (1,984 m a.s.l.) in the High Tatry Mts. (Psotka and Stanik 2006, Psotka 2007; Fig. 4).

Jaskyna so stromom: 5 m long corridor originated along E-W fault (Psotka 2007).

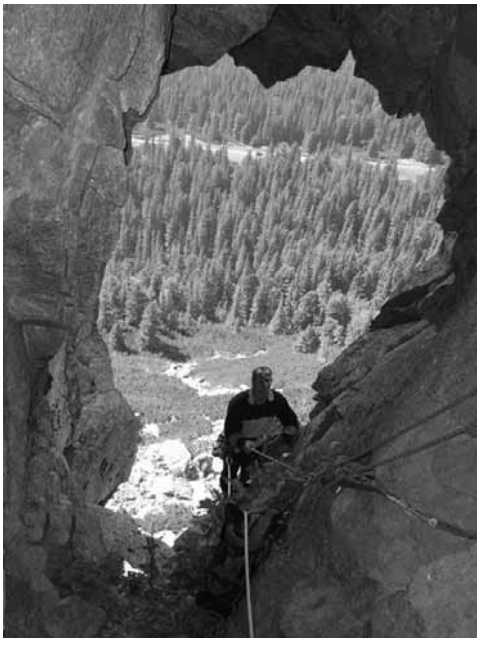

Fig. 4. The entrance of the Jaskyna v Ostrve Cave, High Tatry Mts.. Photo: J. Psotka.

• Crevice caves

Jaskyna pod previsom: 25 m long cave near the Popradske tarn in the High Tatry Mts. (Psotka and Stanik 2006, Psotka 2007).

• Boulder caves

Jaskyna s vyzdobou: 10 m long cavity among the boulders near the Popradske tarn in the High Tatry. Sporadically some 3-10 cm thick crusts and pisolites cover the cave wall and ceiling. After x-ray analysis these speleothems consist of mostly calcite, small part of biotite, chlorite, plagioclase, quartz and feldspar (Fig. 5). After Psotka and Stanik (2006), also Psotka (2007) possible source of $CaCO_3$ maybe from the hydrolysis of plagioclase; probable origin of crusts is precipitation on the lichens from aerosols transported by relatively strong air currents.

As well, the other boulder caves named *Medziblokove jaskyne I-VI* occur near the tourist path between the Obrovsky waterfall and the Zamkovskeho chalet in the High Tatry Mts. (Bella, Gaal and Holubek 2004; Fig. 6).

Fig. 5. Speleothems in the Jaskyna s vyzdobou Cave, High Tatry Mts.. Photo: J. Psotka.

CONCLUSION

Even though granitic rocks occur in the several mountains of inner belt of Western Carpathians and they are outcropped in three highest mountains above the upper boundary of forest, some granite caves are known only in the Tatry Mts.. From a genetic point of view weathering caves originated along gravitational crevices (3 caves), weathering caves originated along tectonic faults (4 caves), crevice caves (1 cave) and boulder caves (7 caves) are classified.

All caves in Slovakia, including granite caves, are as natural monuments lawfully protected by the Act on Nature and Landscape

Fig. 6. Boulder cave in the High Tatry Mts.. Photo: P. Bella.

Protection. Granite caves in the Tatry Mts. are situated in several national nature reserves in the territory of the Tatry National Park. The field measurement and investigation of another granite caves, mainly in the High Tatry Mts., are required and significant for more detailed knowledge on pseudokarst phenomena in Slovakia.

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