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Recently growing subaqueous flowstones: Occurrence, petrography, and growth conditions

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ABSTRACT

Subaqueous flowstones have been studied in two resurgence caves in Slovak Karst (southern Slovakia), namely Krásnohorská and Drienovská Caves. The flowstones litter streambeds within the distance of several hundred meters upstream from resurgences. They form laminated crusts within channels of the underground streams flowing through the caves. Layers composed of columnar sparry calcite alternate with those composed of microcrystalline calcite. The latter are enriched in fine, detrital, non-carbonate components, which resulted in crystallization of microcrystalline calcite instead of sparry calcite. The growth rate of the studied flowstones reaches 0.96 mg/cm²/day, which corresponds to ca. 0.3 mm per year. Seasonal observations conducted between November 2010 and September 2012 reveal that deposition of subaqueous flowstones in the studied caves significantly depends on the local hydrological conditions. During the periods of low flow, SI_{calc} values of underground stream increase and columnar sparry calcite grows. Conversely, during peak flow periods SI_{calc} values decrease and subaqueous flowstones are subjected to destruction, both by mechanical erosion and corrosion. The decreasing discharge, just after peak flows, causes deposition of fine-grained particles, which results in precipitation of microcrystalline layers. Subaqueous flowstones grow in complete darkness and in atmosphere with elevated CO₂ content, similarly to typical speleothems, but they are fed with turbulent stream water, similarly to calcareous tufas. Their growth rate is higher than those of 'normal' flowstones fed with a film of water seeping down; it falls within a range of growth rate of calcareous tufas, though near the lower limit of this range. Therefore, subaqueous flowstones represent an intermediate link between other speleothems and tufas deposited outside the cave environment.

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1. Introduction

Carbonate speleothems have attracted a growing interest in recent years, particularly as a reliable palaeoclimatic archive (Fairchild and Baker, 2012). Many speleothems, from almost all regions of the world, have been a subject of insightful studies mostly based on geochemical properties (e.g., Lundeen et al., 2013). The most common objects of such studies are stalagmites which enable high-resolution sampling (e.g., Kotlík et al., 2012; Muñoz-García et al., 2016). Other speleothems have drawn attention due to their specific shape or origin. Many papers deal with such unusual speleothems as cave pearls, helictites, moonmilk, etc.

Petrography of many speleothems has been studied and described, including uncommon ones (see Hill and Forti, 1997 and references therein).

Subaqueous flowstones, which in contrast to 'normal' flowstones, grow in underground streams, seem to have been overlooked. There exist merely a few papers dealing with this type of speleothems. White (1956) noted their occurrence in Birmingham Crawlway Cave (Pennsylvania, USA). Later on, Hill (1992) described such a type of speleothems from Blanchard Spring Caverns (Arkansas, USA) and coined the term 'subaqueous flowstone'. Wicks and Engeln (1997) observed precipitation of carbonates in cave streams in Devil Icebox Cave (Missouri, USA) but they neither classified these carbonates as speleothems nor characterized them in detail. Hill and Forti (1997) summarized the state of knowledge about subaqueous flowstones. The paucity of published data on subaqueous flowstones contrasts markedly with their ubiquitous

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formation in many caves including some well-known show-caves such as Akiyoshido Cave (Japan). In fact, they appear to be the least commonly described of the most commonly occurring speleothems.

This paper focuses on subaqueous flowstones from two caves in Slovakia, namely Krásnohorská and Drienovská Caves. The aim of the present study is to clarify their petrography, decipher factors

controlling their growth, and to test their value as a palaeoenvironmental proxy.

2. Geological setting

Slovak Karst is situated in eastern Slovakia, Western Carpathians (see Fig. 1). The area is protected as a part of a national park. It is a

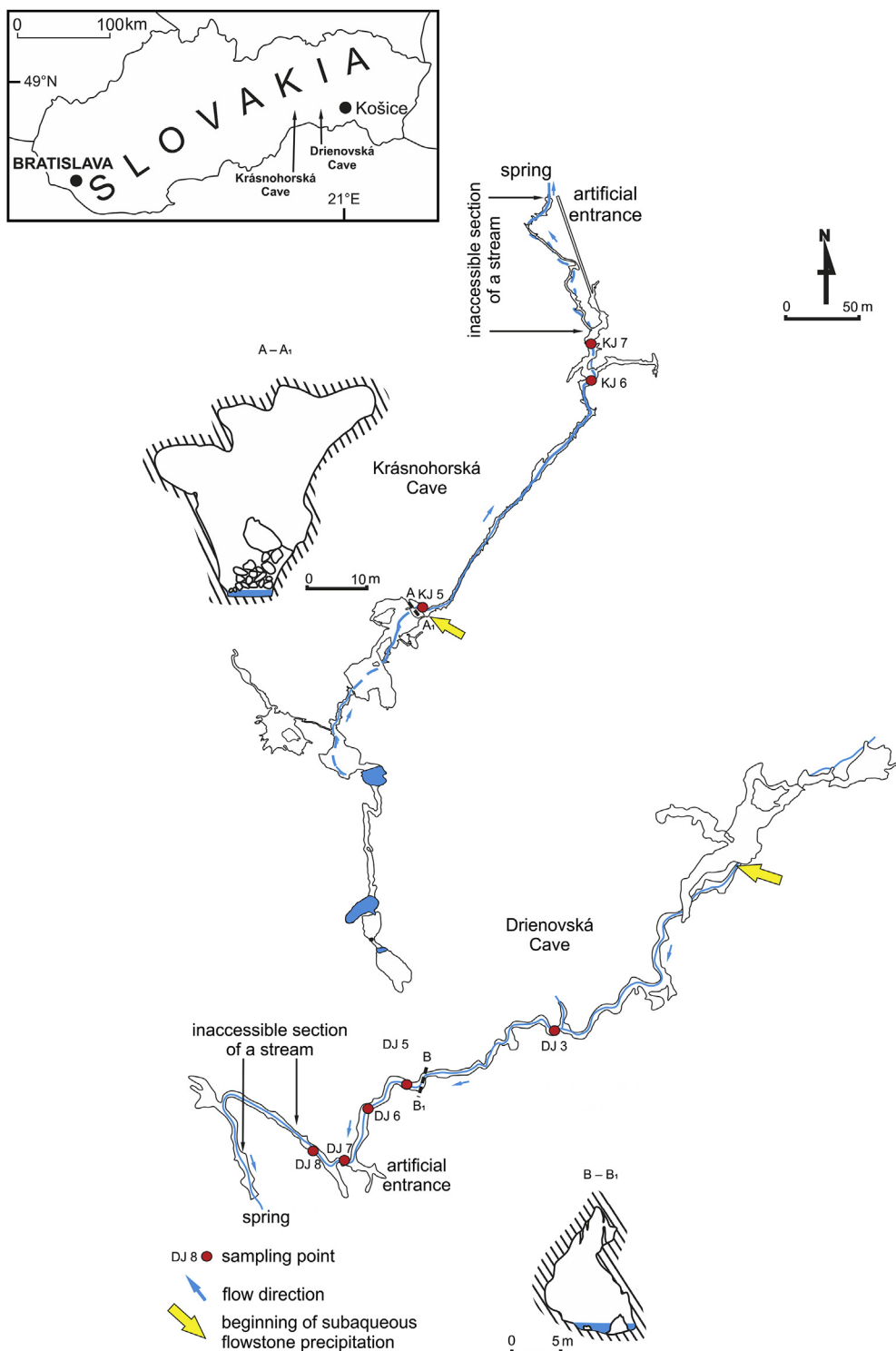


Fig. 1. Location of Krásnohorská Cave and Drienovská Cave: maps of the caves with position of sampling points. The precipitation of subaqueous flowstones commences from the points marked with large arrows and continues downstream.

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