

SPELEOTHEM DESTRUCTION IN THE CAVES OF THE MORAVIAN KARST (CZECH REPUBLIC)

Jiří Faimon¹ – Jindřich Štelc¹ – Jiří Zimák² – Petr Zajíček³ – Monika Schwarzová¹

¹Institute of Geological Sciences, Faculty of Sciences, Masaryk University,
Kotlářská 2, 611 37 Brno, Czech Republic

²Department of Geology, Faculty of Sciences, Palacký University, 771 46 Olomouc, Czech Republic

³Agency for Nature Conservation and Landscape Protection of the Czech Republic,
Caves Administration of the Moravian Karst, Svitavská 11–13; 678 01 Blansko, Czech Republic

Abstract: An extensive damage of speleothem (corrosion, breaking and falling of straw stalactites) was studied in the caves of the Moravian Karst. Condensation water was identified as a main agent of speleothem corrosion. An extent of destruction depends on (1) cave microclimatology (temperature/pressure gradient, relative humidity, cave geometry) and (2) human impact (changes in cave microclimatology: new entrances for visitors, new opening at explorations, and breathed water vapor by visitors). A mechanical damage was found to be major agent of straw stalactite falling. It is probably a result of vibrations of (1) natural (tectonic moving) and (2) anthropogenic (building works, traffics) origin. In addition, a tension stemming from a re-crystallization of straw stalactite calcite wall was studied.

Key words: cave, condensation, corrosion, destruction, falling, speleothem

INTRODUCTION

An extensive damage of speleothem (corrosion, breaking and falling of straw stalactites) has been observed in the caves of the Moravian Karst in the past decades of last century. A central question is whether the damage is a consequence of anthropogenic impact. During 1998 – 2005, the problem was systematically studied in visited caves (Punkevní Caves, Balcarka Cave, Císařská Cave) and in caves closed to public (Amatérská Cave). The attention was aimed to speleothem mineralogy and morphology, dripwater chemistry, cave microclimatology, soil environment, and covering vegetation. The goal of the study was to (1) identify the mechanisms of damage, (2) confirm or disprove the anthropogenic impact, and (3) propose a prospective remediation.

METHODS

Solids were studied by methods of optical microscopy, electron microscopy and microprobe analysis. Cave CO₂-levels was determined by CO₂-meter (IR-detector FT A600-CO2H linked with the ALMEMO 2290-4 V5 meter, Ahlborn, Germany). Dripwater were analyzed (1) in caves (pH was measured by WTW pH 330i, alkalinity determined by potentiometric microtitration, calcium quantified by complexometric microtitration /0.01 mol.l⁻¹ EDTA, 10 % KOH, calcein/) and in laboratory (remaining components were determined by AAS, photometry, capillary isotachophoresis).

RESULTS

The corrosion of speleothems

No corrosion impact was observed in straw stalactite inner channel. All monitored waters (except of one special drip in the Punkevní Caves) were supersaturated with respect to calcite.

Based on these finding, drip waters were not found aggressive to calcite. In contrast, a corrosion impact was frequently observed on the outer walls of straw stalactites and drapers. The possible agent is a *condensation corrosion*, at which calcite speleothem are attacked by condensed water equilibrated with cave air CO₂. This water condenses at sites, where temperature is below the dew point. Detail mechanisms are studied.

Straw stalactite falling

The study of floor flowstone from the Balcarka Cave (Moravian Karst, Czech Republic) indicates that (1) straw stalactites were falling in the past as well and (2) this falling was episodic. Many of straw stalactite show lot of fissures. They probably originate from vibrations (tectonic; anthropogenic – traffic, construction works). Based on findings of a poly-crystalline top and „monocrystalline wall” on single straw stalactites,

a mechanical tension stemming from a re-crystallization should not be excluded. The general reason of the falling was identified as a *mechanical damage*.

SUMMARY

Condensation corrosion was found to be a dominant agent of speleothem corrosion. It is controlled by (1) cave microclimatology (temperature/pressure gradient, relative humidity, cave geometry) and (2) human impact (breathed water vapor of visitors, changes in cave microclimatology, new entrances for visitors, new opening at explorations).

Mechanical damage was identified as a dominant agent of straw stalactite falling. It is probably a consequence of vibrations of (1) natural (tectonic movement) and (2) anthropogenic (building works, traffic) origin. In addition, a tension stemming from a re-crystallization of straw stalactite calcite wall is considered.

For remediation, it is necessary to consider more carefully all impacts imposed on cave system during building or exploration works. Based on local studies, it would be necessary to close some parts of cave system in order to reduce air flow. In some cases, number of visitors could be limited, based on the monitoring the extent of current cave ventilation.

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