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FIELD PRACTICE OF ENVIRONMENTAL ENGINEERING B.SC. STUENTS IN ALSÓ-HEGY (A DIDACTICAL VISUAL KARSTIC GUIDE, ARRANGED IN THEMATIC ORDER)

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Abstract

The education of the environmental engineers (B.Sc.) includes a high quality theoretical knowledge, practical skills and ecological approaches. A field practice is the best method to get practical knowledge in the nature. Alsó-hegy and its surrounding, where the field trip concentrated, is an excellent place to observe the karstic phenomenon. The report does not follow the time schedule of the trip. The observations are separated according to their topics, to emphasize the didactical aspects of field practice. The vertical caves (zsomboly) are important part of this lecture, because the Alsó-hegy is the famous for their vertical caves. This paper contains demonstrative pictures to help to understand the discussed phenomena. The overwhelming part of pictures was taken during the field practice. The figures of this paper were made by the participants of the field practice.

***Keywords**: Field practice, karstic phenomena, cave genesis, demonstrative examples*

1. INTRODUCTION

The overwhelming parts of the drinking water come from the subsurface water sources in Hungary. Meaning full part of them are karstic springs. Therefore, it is important to know the karstic phenomena well for the environmental engineers in Hungary. A field trip is the best way for the students to be familiar with real environmental situations [1-3].

Aggtelek National Park (Aggteleki Nemzeti Park, ANP), including Alsó-hegy, is a typical karstic region, which is excellent for the observations of the karstic phenomena [4-6]. This area belongs to shallow see Wetterstein formation (Limestone). The rocks of this area deposited approximately 220 million years ago in Mesozoic, Triassic period [5]. The five million years genesis has produced the recent formations. The amount of rainfall is about 680 mm in an average year, which is enough for the recent, permanent karstic activity.

2. DISCUSSIONS

2.1 Basic chemistry of lime stone

The limestone can be solved by water. The solvation processes become intensive in the presence of carbon dioxide according to the equilibrium equation (1).

$$CaCO_3 + H_2O + CO_2 \leftrightarrow Ca(HCO_3)_2 \qquad \text{Eq (1)}$$

The solvation process is intensive in the surface and in the cracks of rocks. The equilibrium goes into the right direction under these conditions. The source of the water is the rain and snow. The source of the carbon dioxide is the atmosphere, and decomposition of living creatures on the soil. The calcium hydrogen carbonate has good water solubility, which results in the degradation of limestone. The carbon dioxide cannot escape from the water solutions in the rock fissures, because the cracks are closed systems and the weight of the water columns produce bigger pressure than one atmosphere.

2.2 Solution process of the limestone

The solution of limestone has a positive feedback character. It means, if the limestone starts to dissolve produce a small hole somewhere, the solution processes become more intensive in the hole, than in the smooth surface. The solution processes go further in the bottom of the hole instead of the higher points. In the bottom of the holes the residence time of the water is longer than in the crests, therefore the solvation is more intensive in the holes. In this way the holes become deeper and deeper, and the crests remain relatively unsolved. This positive feedback processes result in uneven, bumpy surface formations. It is called devil plowing. The solutions can be directed and amplified the small tectonic fissures and soft (more soluble) rocks. The bigger formation of this positive feedback is the dolines, where a circle shaped valleys have their deepest points close to their center. The water of rain and snow-broth flows dawn into the deepest point of the dolines. The solvation of the limestone is the most intensive in the deepest point, because it meets the biggest amount of the water. The big flow of the water can produce solvation under the surface, so called sinkholes (Figure 1). The sinkholes are frequently the entrance of caves. The high speed water flow results in an improved genesis of underground holes in the sinkhole caves. The chemical solution processes are amplified with the mechanical corrosive effects.

The water flow drags rock particles rubbing and broadening the holes. There are some caves in Alsó-hegy, which have such geneses (e.g. Meteor, Pócsakő, Bába völgy, 404 caves)

Figure 1. The Pócsa-kői-víznyelő Barlang sinkhole cave. The explored cave is 51 m deep and 81 m long [6].

There is another form of the caves: the pit holes or vertical caves (zsomboly) formation. These caves have deep vertical shafts. The entrance of these cave can be a small hole, but the shafts are freqently more than 50 m deeps (Figure 2). The entrance of these caves generally are in the upper part of the dolines. The layers of limstone are in vertical positions in Alsó-hegy. The soft layers are solved intensively, which have enlarged solving the harder layers too, if the crack get enough water supplies. The pits become broader and broader with the depth of caves, producing conical shapes. If the thick watertight sediments deposite on the bottom of the shaft, the deepening of this saft could not go further.

In this case, the water solves a next shaft from the nearby rocks, which deepens the cave further [7]. A typical pithole cave in Alsó-hegy consist of the parallel vertical holes in different depths. The Vecsem zsomboly of Alsó-hegy, one of the deepest cave in Hungary, has 6 vertical shafts with 236 m depth. The Alsó-hegy is an excellent terrain to study the vertical caves, because their occurences are very dense there [6, 8].

Figure2 The narrow entrance of Tektonik Cave. The explored cave is 51 m deep and 81 m long [4].

2.3 Deposition of limestone in the caves

On the other hand, the carbon dioxide can escape from the water solution to the air in the caves and springs. The equation 1 goes to the left direction, which result in the precipitation of the solid limestone, producing dripstone, popcorn and tufa formations.

The hanging dripstones are called stalactites. If the water solution slips along a narrow fissure, the formation of dripstone started with a straw (Figure 3). The straws are tube, where the water solutions flow inside of the tubes and the calcite crystals precipitate at the end of the tubes. The pressure decreases in free open space at the end of the straw. This pressure drop results in bubbling out the calcium dioxide from the solution, and precipitation of calcium carbonate.

Figure 3Straw dripstones in Baradla Cave. This picture show the starting phase of stalactites.

Later, the holes of straws clog and the water flow dawn outside of stalactites. The stalactites can be several meter long (Figure 4). The water loses their carbon dioxide contents during flowing down on the surface of stalactites. The escaped carbon dioxide also produces precipitation, creating limestone layer on the surface of stalactites. The dropping or flowing water produce stalagmites on the floor of caves (Figure 5). The stalagmites are columns, which are built up from dripstones. The stalagmite can be bigger, than stalactites, because the too heavy stalagmites fall down from the ceiling of caves.

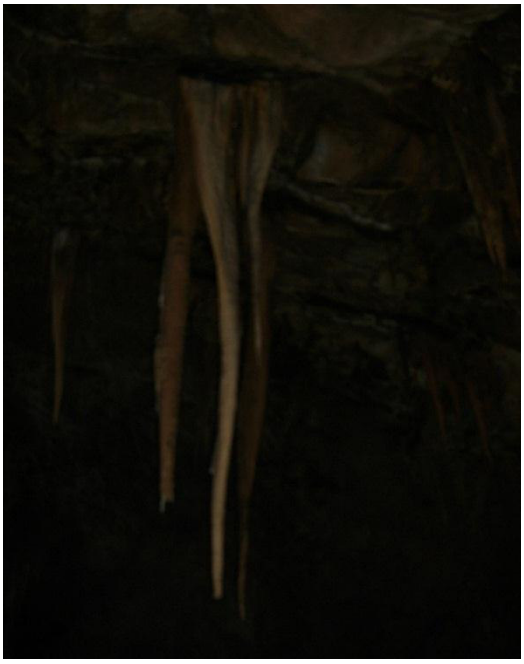

Figure 4Stalactites in Baradla Cave. The tips of stalactites were broken by floods.

The atmospheres of the caves are saturated with water vapor, creating aerosol. The drops of the aerosols also contain calcium hydro carbonate and carbon dioxide, which also produce precipitations of calcite crystals. However these precipitations are not regulated by the gravitation forces, but the peak effects play important role in genesis of helictite formations. The helictites are narrow needle shaped formations in various directions. They frequently show bended shapes.

Figure 5A characteristic stalagmite in Baradla Cave. The black color is an anthropogenic effect.

The stagnant water in the pool of the caves is oversaturated with calcium carbonate. This oversaturation also causes precipitations producing tufa, fresh water limestone depositions. The precipitations happen in the surfaces (Figure 6). The most typical shapes of these precipitations are the cascades of pools.

Figure 6 Tufa dam in Béke Cave. The tufa dams separate the pools being different levels.

The precipitations can be realized on the surface of the pools and on the stalactites and stalagmites (Figure 7). The stagnant pool can produce big crystals.

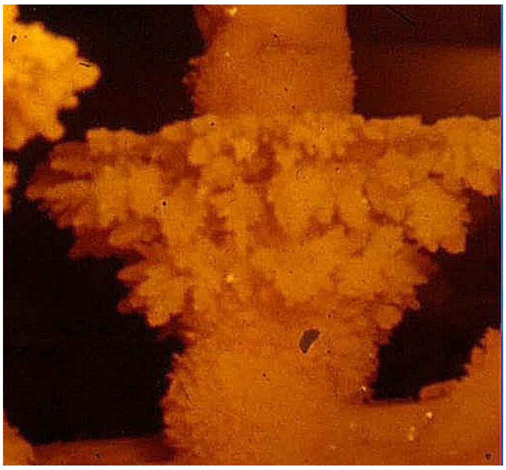

Figure 7 Crystal precipitations from a pool in Big Winds Cave (Italy)

The tufa type precipitations can also be results of decreased solubility power of cooled down water. The best example for this precipitation is the Pamukkale in Turkey.

The cooling water produces another underwater precipitations formation, called popcorns (Figure 8). These pea shaped formations have aragonite crystals instead of calcite.

The color of pure calcium carbonate is white, but several dripstones show other colors. The black colours of dripstones are the results of anthropogenic effects as the Figure 5 demonstrates well. The Baradla cave has been visited since the Stone Age. Up to the middle of 20th century the people light with torch. The torches produce not only light, but a big amount of soot. The soot deposited on the dripstones and colored them. The white spots are, the own color of calcite. These white deposition have born after the electric illuminations had been introduced, which had not produced soot. On the other hand, the intensive lightening results in green color, algae deposition on dripstones. The brownish yellow colours of dripstones come from clay residues of limestone. The red colors come from the painting effects of iron oxide (rust) traces.

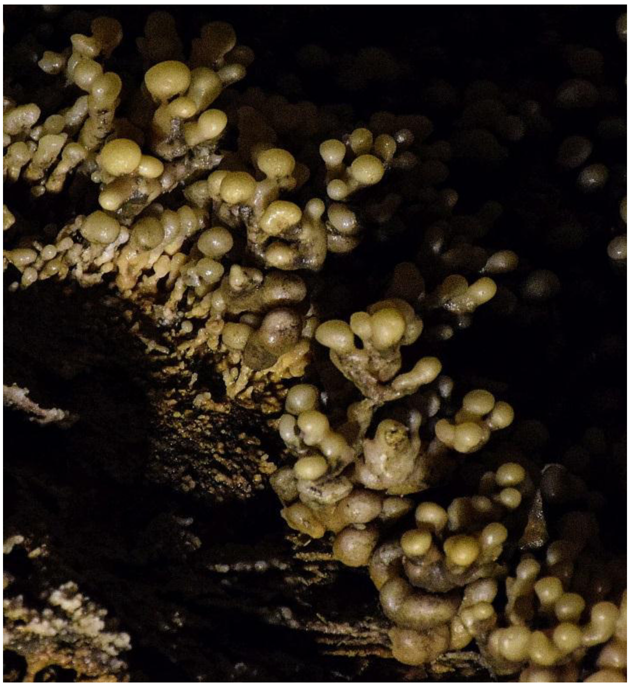

Figure 8 Popcorn formations in Rákóczi Cave. The popcorn aragonite precipitations are results of cooling thermal water.

Conclucion

It is necessary to hold field practice to get a realistic knowledge of karst phenomena for students. A visual guide helps a lot to understand the observed formations. We are preparing a complete more detailed audio-visual guide for karstic phenomena. It will be very useful not only for environmental engineer students, but it will give good information for others too (e.g. tourist, high school students).

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