KARSTMORPHOLOGICAL RESEARCH IN THE MECSEK MOUNTAINS, SOUTH HUNGARY

KRAŠKO MORFOLOŠKE RAZISKAVE V POGORJU MECSEK NA JUŽNEM MADŽARSKEM

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Prejeto / received: 1. 9. 1998
Károly Barta & Tamás Tarnai: Kraško morfološke raziskave v pogorju Mecsek na južnem Madžarskem

Med manj znanimi in manj raziskanimi kraškimi področji na Madžarskem je pogorje Mecsek. Štiriletne raziskave so potrdile obstoj jamskega sistema, dolgega več kilometrov, pod najmočnejšim kraškim izvirom Vízfő (zahodni Mecsek). Članek predstavlja metode in doseže geomorfoloških in hidroloških terenskih raziskav po predhodnem študiju literature. Obenem s čiščenjem vhoda v jamo so bili opazovani kraški procesi in oblike. Predstavljeni so vplivi mlade tektonike na razprostranjenost in povezave v zbirnem področju, na povezavo površja s podzemeljskim tokom in razvoj jame.

Ključne besede: kraška morfologija, jamski sistem, Mecsek, južna Madžarska.

Abstract

Károly Barta & Tamás Tarnai: Karstmorphological research in the Mecsek Mountains, South Hungary

Besides less investigated and less known karst areas are Mecsek Mountains in South Hungary. For four years research has been conducted to confirm the existence of a cave system several kilometres in length beyond the most abundant karst spring of the Western Mecsek, the Vízfő Spring. Attempts have been made to find the optimal site for opening an entrance to the cave. The article is meant to show the methods and achievements of preliminary geomorphological and hydrological field surveys, which were preceded by a thorough study of literature. Parallel to clearing the entrance to the cave, observations of karst processes and features were also made. The article presents the findings concerning the impacts of young tectonic movements on the extension and links of the catchment area, the communication between surface and underground water-courses and cave formation.

Key words: karst morphology, cave system, Mecsek Mountains, South Hungary.
The research area and our aims

In the western part of the Mecsek Mountains there are Triassic karstic rocks on the surface. The area of the Western Mecsekien Karst is 38 km² and it is situated on the northern part of the Jakabhegy Anticline. The Triassic strata of sandstones, mudstones and limestones crumpled into anticline at the boundary of Cretaceous and Eocene. The central, highest part of the anticline was eroded as we can see on the map and profile (Fig. 1).

The Western Mecsekien karst is similar to the karst of Aggtelek and Bükk Mountains (N. Hungary) but its morphological features are more mixed: there are lots of dolines, sinkholes, dry
The biggest spring in the karst area is found near the village Orfű (in Fig. 1). The cave spring is explored to a length of 170 m but a sump more than 20 m deep does not allow further exploration. Because of the spring’s size and water output (4 m$^3$/min.) we can suppose a bigger cave system beneath the karst area. In our research has been directed at:

1. Collecting more evidence of the existence of this cave system and finding answers to some interesting morphological and genetic problems met during this research.
2. Determining the optimal point for exploring.
3. Estimating the size and the length of the system.

The geomorphology and access to the cave

The catchment area of the Vízfű Spring is 16 km$^2$ which includes non-karstic areas totalling about in 5 km$^2$ (the upper part of the Körtvélyes and Szudáó Valleys and near Bűdöskút Spring) (Fig. 1). It is a typical allogenic karst, the streams from the non-karstic area disappear in sinkholes (F$_1$-F$_7$) and continue their way under the surface and appear together again in the Vízfű Spring. We can find dry valleys on the karst surface as the continuations of the non-karstic valleys. These are the remnant forms of the valley network which formed before the young tectonic movements. During the Quaternary the mountain rose more than 100 m, the karst water table sunk, and therefore the valleys became dry. Doline forming processes started at the bottom of the valley without non-karstic catchment area. Valleys contains non-karstic catchment area deepened until their bathycapture. Now these valleys are eroded during only bigger floods. There is an interesting exception to these processes: the Remeterét Valley. This valley has undeveloped dolines but well developed sinkholes, which means that there was a large stream not long ago here. But now it has no non-karstic catchment area. We can find the answer in the profile along the valley (Fig. 2):

1. There are two peculiarities in the run of the valley. First, the head of the valley is missing. Generally valley profiles are hyperbola shaped but in the case of the Remeterét Valley we cannot find the initial steeper stage. The valley starts as a well developed valley immediately from the
watershed and it has uniform gradient. We can explain this occurrence by the young tectonic
movements. Sharp faults bound the rising part of the mountain (see Fig. 1), in the north the
spring line (A-F) shows them. By the side of these steep lines the erosion increases, the
valleys move backwards and can reach the valleys over the watershed. Presumably this happened to the first
part of the Remeteré Valley. We can suppose that the valley had 4-5 km² non-karstic catchment area on
the basis of the valley’s size, developed sinkholes, undeveloped dolines and its profile. More
evidence would be to find sandstone-gravel in the valley’s sinkholes.

2. The other peculiarity has a similar cause. Let us compare the lower part of the Remeteré Valley
with of the Szuadó Valley. Their steeper stages show the youth of the rising. If we look at Fig. 1,
we can see that the Mész Valley is the direct continuation of the Remeteré Valley. Before the
elevation they was only one valley which ran from Remeteré to Abaliget, and the Szuadó Valley
was its side valley. As the mountain rose a small gully moved backwards until it reached the
junction of the two valleys. This gully formed along the faults which are responsible for the
direction of the Szuadó Valley because their direction is the same. After this capture the Mész
Valley became dry and the stream of the Szuadó Valley turned away to north.

It is hard to estimate the age of these two events but we can correlate them. If the Remeteré
Valley had become dry earlier than the Mész Valley then the stream from the Szuadó Valley
would have eroded on its continuation, the Mész Valley. In the opposite case the Remeteré
Valley would have deepened further while dolines would have formed in the dry Mész Valley.
In the first case the Mész Valley would be deeper and more developed, in the second case the
Remeteré Valley would be so. But actually they are in the same level, so we can estimate that
the above two events have approximately the same age. We can see the classic example of the
capture in its process to the west of the Orfű Hill (Fig. 3).
In our opinion it is possible to get to the cave from the Vízfő spring (F in Fig. 1) or from the sinkholes. Because of the sump near the spring the chance is the exploration of the sinkholes. As we mentioned earlier the catchment area contains three non-karstic areas.

The smallest of these is the Büdöskút Valley in sandstone, the area of which is 0.35 km². This valley has some sinkholes (F₆-₇) near the boundary of the karstic and non-karstic rocks but the really big sinkholes are only downstream at its meeting with the Remeterét Valley (F₄-₅). The small catchment area and the small stream cannot have formed these big sinkholes. It may be supposed that the Remeterét Valley’s former non-karstic catchment area is responsible for their formation.

The Körtvélyes Valley has a 0.65 km² non-karstic catchment area but we cannot find any sinkholes. The stream leaks to the junction with of the limestone over a length of 1 km.

The Szuadó Valley’s non-karstic catchment area is 3.4 km² in sandstone and mudstone. We can find three sinkholes in the valley (F₁₋₃). After comparing their size and their development with the Remeterét Valley’s we have supposed the total mentioned 4-5 km² as the catchment area of the Remeterét Valley. In spite of its more developed sinkholes it is less suitable to exploring the cave because of the inactivity of the sinkholes. They are filled with clay and alluvium, as the former exploring attempts have proved. So the Szuadó Valley’s sinkholes seemed the best place for the exploration.

Fig. 3: Classic example of the capture west of the Orfű Hill. The difference in height between the bottom of the Mész Valley and the saddle separating it from a small, regressing gully is only 7 m.
Among the three sinkholes there is only one which is permanently active, the highest one (F₁). During floods the stream flows over it sinks through the second sinkhole (F₂ - Fig. 4). This Gilisztás Sinkhole is more developed than the Szuadó Sinkhole. It is able to swallow up to 5-6 m³ water per minute. It was explored to a length of 4 to 5 m but it threatened to collapse and work stopped. On the other hand it is very difficult to divert the stream, so we have decided on the Szuadó Sinkhole. The third sinkhole (F₃) seemed to be completely filled up.

**Estimating the passage sizes**

One of the speleologists’ main problems is determining the size of the cave that they want to explore. If we know the approximate size of the passages then we can decide whether it is worth while starting the exploration or not. In our research we have tried to apply morphometrical methods to determine the expected sizes. The method can be used in allogenic karst where the non-karstic catchment areas connecting to the different sinkholes can be compared.

Our aim has been the estimation of the unknown passage sizes based on measurable surface parameters. The main parameters are the extension of the non-karstic catchment area and the water output of their streams. We can apply it if only the next conditions of the different catchment areas are similar:
- geological structure,
- development of the areas,
- relief conditions,
- climate.

If these conditions are similar, then the passage sizes underlying the sinkholes depend on mainly
on the size of the non-karstic catchment areas because the similar climate on both gives similar
annual rainfall, the similar sediment types and the catchment areas’ size can determine the rate of
flow and the amount of the sediment carried by the stream. The obvious connection is that bigger
caves belong to bigger non-karstic catchment areas but we wanted to show a numerical relation
between them.

Naturally we must be careful to applying the method because there are lots of other factors
which we are unable to show but which play very important role in the cave forms, e. g. softer rock
strata, tectonic faults, etc.

Four non-karstic catchment areas have been compared:
1. Szuadó Valley,
2. Körtvélyes Valley,
3. Büdöskút Valley, where a 100 m deep cave has been explored in 1996,
4. The neighbouring Abaliget Cave’s active sinkhole (A and A1). This cave is known for 1 km
   and A1 is its only sinkhole. Table 1 shows some parameters about the sinkholes, completed
   with the typical cross sections of the explored passages since that time.

<table>
<thead>
<tr>
<th>Sinkholes</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Szuadó Sinkhole</td>
<td>3.4 km²</td>
<td>240 l/min</td>
<td>4-5 m³/min</td>
<td>1-1.2 m² 2.7-3.3 m²</td>
</tr>
<tr>
<td>Spirá Sinkhole</td>
<td>0.35 km²</td>
<td>0 l/min</td>
<td>3-4 m³/min</td>
<td>0.1-0.2 m² 0.6-0.8 m²</td>
</tr>
<tr>
<td>Viganvár Sinkhole</td>
<td>2.5 km²</td>
<td>5 l/min</td>
<td>1-2 m³/min</td>
<td>?</td>
</tr>
<tr>
<td>Körtvélyes Valley</td>
<td>0.65 km²</td>
<td>114 l/min</td>
<td>1-2 m³/min</td>
<td>-</td>
</tr>
</tbody>
</table>

*a* - the non-karstic catchment area of the sinkhole,
*b* - the rate of the stream sinking in the sinkhole (October, 1997),
*c* - the flood rate of the stream sinking in the sinkhole (former measurements),
*d* - the area of the sinkholes’ typical cross section (narrower and wider parts).

* there is no visible sinkhole, water continuously disappears at the bottom of the valley.

Comparing the first two sinkholes we can notice the strong link between the examined parameters
examined (Figs. 5-8). The area of the cross sections reflect very well the extension of the non-
karstic catchment areas. The Körtvélyes Valley is a very good example of the different erosion
depending on different conditions. We can notice that the rate of the hard sandstone, which is
responsible for the erosion, is much less on this catchment area than on the others. This is the reason
of the small sinking capacity.
Fig. 5: The plan and profile of the Szuadó Cave with some typical cross sections.
Fig. 6: The profile of the Spirál Cave with some typical cross sections.
Based on these data and in the light of the size of the two caves’ explored parts we can expect that passages of the cave system belonging to the Vízfő Spring are twice large at least than the Abaliget Spring’s system.

We started to explore the Szudó Sinkhole in November 1994. Now the cave of the sinkhole is 150 m long and 50 m deep. We hope that we have found the way to the Vízfő System.

Naturally the estimate of the passage size does not guarantee that the examined cave will be passable. During the exploration we never know when and where we find a big breakdown or a sump which prevents further exploration.

In the future we would like to continue the exploration and to expand our comparative research to the spring caves and their catchment areas. We want to compare the absolute size of the catchment area, the rate of the karstic and non karstic and non-karstic catchment area with the caves’ sizes.

Fig. 7: Typical stream passage in the Szudó Cave.
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Fig. 8: Typical cross section in the inner parts of the Spirál Cave.
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KRAŠKO MORFOLOŠKE RAZISKAVE V POGORJU MECSEK NA JUŽNEM MADŽARSKEM

Povzetek

Na Madžarskem je relativno veliko kraških področij, najbolj znan je dobro raziskani kras v okolici Aggteleka, ki je vpisan v seznam svetovne naravne dediščine pri UNESCO, planota Bükk in termalne jame v okolici Budimpešte. Poleg teh znanih področij so še manj znana in manj raziskana, kakršno je pogorje Mecsek na južnem Madžarskem. Štiriletne raziskave so potrdile obstoj jamskega sistema, dolgega več kilometrov, pod tamkajšnjim najmočnejšim kraškim izvirom Vízfő (4 m³/min) v zahodnem delu pogorja Mecsek pri vasi Orfű. Poskušali smo najti najprimernejše mesto za prodor v jamo in ugotoviti njeno velikost.
Članek predstavlja metode in dosežke geomorfoloških in hidroloških terenskih raziskav po predhodnem študiju literature. Obenem s čiščenjem vhoda v jamo smo opazovali kraške procese in oblike. Članek predstavlja vplive mlade tektonike na razprostranjenost in povezave v zbirnem področju, komunikacijo med površjem in podzemnim tokom in razvoj jame. Raziskovali smo ponorno jamo Szuadó (150 m daleč in 50 m globoko) in upamo, da bomo skozi njeno lahko prodrli do sistema Vízfő.