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Karst Geomorphology

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CONNECTION BETWEEN MORPHOLOGY AND ECOLOGICAL FACTORS
OF KARST DOLINES (AGGTELEK HILLS, HUNGARY)

ABSTRACT: BÁRÁNY-KEVEI I., *Connection between Morphology and Ecological Factors of Karst Dolines (Aggtelek Hills, Hungary)*. (IT ISSN 0391-9838, 1998).

The Aggtelek Karst Region was declared as a part of World Heritage on 2 December 1995. Since the formation of the Aggtelek National Park (1985) the measures taken to limit human activity have brought about some predictable improvement in maintaining a state close to the natural conditions.

The karst depressions in Aggtelek are situated in various orographic, lithologic and tectonic situation. On this basis three main groups may be distinguished: dolines situated at the height 310-350 m, 270-280 and around 500 m.

Present paper permitted to identify first of all the connection between the doline asymmetry and ecological processes. Karst dolines are environmentally very sensitive site point of the karst region.

The climate and the microclimate play the most important role of doline development. The soil covering the karst-forming rock, through the a-biogenic and biogenic processes, controls the nature and the order of magnitude of the corrosion process.

From this point view by the side of climate and microclimate the vegetation play an important role in the intensity of corrosion.

In Aggtelek we have found lot of degraded grass plots in dolines, where animal grazing used to be intensive.

This paper present some ecological factors and their effects on the development of doline morphology.

KEY WORDS: Karst Geology, Doline Types, Karst Geoecology, Hungarian Karsts.

INTRODUCTION

The Aggtelek Karst is a small and isolated karst in the northern part of Hungary (fig. 1). Because the significance of its surface and subsurface karst, the region was declared

a Unesco World Heritage area in December 1995. Since the formation of the Aggtelek National Park (1985) measures have been taken to limit human activities, these have resulted in a steady return towards natural conditions.

The central feature of my studies are the surface forms in various lithologic, tectonic, orographic situations. My analyses permitted the identification of the doline types belonging to the most important morphogenetic units an estimation of their ecological state.

GEOLOGY AND PALEOGEOGRAPHY
OF AGGTELEK HILL

Aggtelek Karst is the part of Gemeridas. It is *hilly landscape*, the highest point not reaching 600 m. The thickness of limestone is several hundred metres. Most

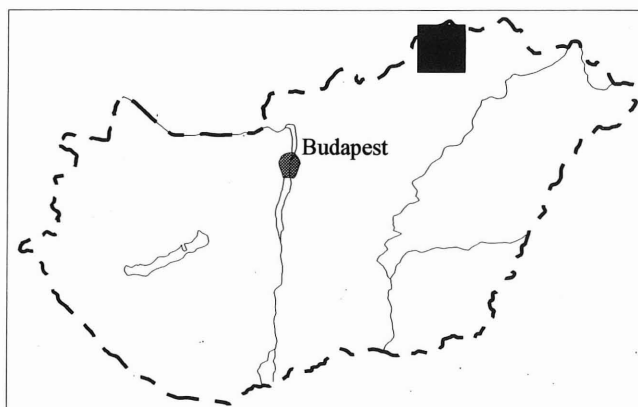


FIG. 1 - Location of Aggtelek Mountain.

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important rock forming are here the *Triassic limestones* (fig. 2).

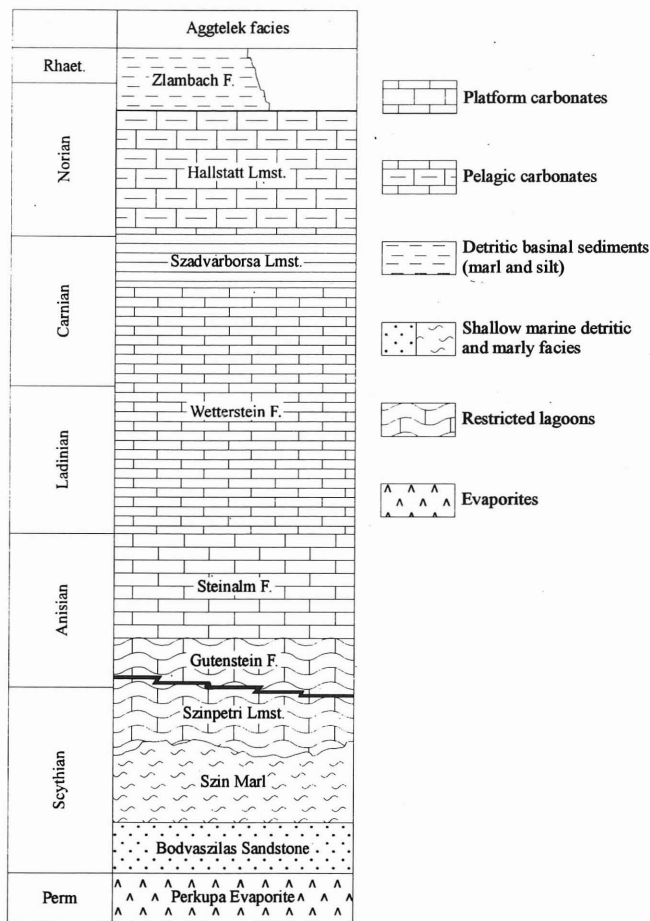


FIG. 2 - Triassic formations of the Aggtelek mountains. (After Kovacs & alii, 1989, simplified).

Sedimentation was carried out during Middle Triassic times. From the Upper Triassic onward, intra-platform basin facies started to spread over areas of the platform. After the Norian no shallow-water limestones were deposited, and also very few carbonates during the Rhaethian and Jurassic (fig. 3).

The early Triassic areas of syncline type were transformed to mainland from the Upper triassic. The Middle Cretaceous planation prevailed under tropical subhumid conditions. At the end of Mesozoic the tropical erosional surface was dismembered by major faults.

Tectonics in Aggtelek and adjacent Slovakian karst has been described by Grill (1989). The great masses of platform carbonates played a prominent role impeding the folding process. Folds were formed in the well-bedded marls and limestones and in the Lower Anisian limestones. In Aggtelek *two main deformations* can be distinguished.

The first one, of *Late Jurassic-Early Cretaceous* age, shows relatively stronger folding. The strike direction of axes varies between NE-SW in Aggtelek. The second phase occurred during the *Oligocene-Middle Miocene* interval, the axes run E-W. From the end of the Miocene up to the Pleistocene, as a result of tectonic movements, this region was transformed into exhumed low mountain with horst-graben structure.

The horst surfaces lost their young Tertiary sediment mantles and underwent mountain margin *pedimentation* at the end of *Pliocene*. In the Pliocene, orogeny caused faults in Aggtelek Mountain giving rise to plateau like surface forms.

Karstification of the Triassic limestones happened in *several phases*. The present surface shows remains of these processes (eg. a tropical cone karst in the depression of Redlake). At the end of the Tertiary, an intensive karstification took place which was able to form canyonlike valleys in the mountain where clay slate was close to the surface. One part of dolines are situated in this valleys.

FACTORS INFLUENCING SURFACES FORMS

Aggtelek Mountain is most typical karst features in Hungary. Common features are *dolines, sink holes, karren fields caves and springs*. The best known of the numerous caves in the area is the 22 km long Baradla cave (26 km long is with the Slovakian Domica cave).

Micro- and meso- forms of the karst areas in Aggtelek Mountain - the conjointly extending doline is undoubtedly the most characteristic feature of this karst topography.

Dolines are located at heights of 270-300 m (basin dolines), 300-350 m (valley dolines) and around 500 m (plateau dolines).

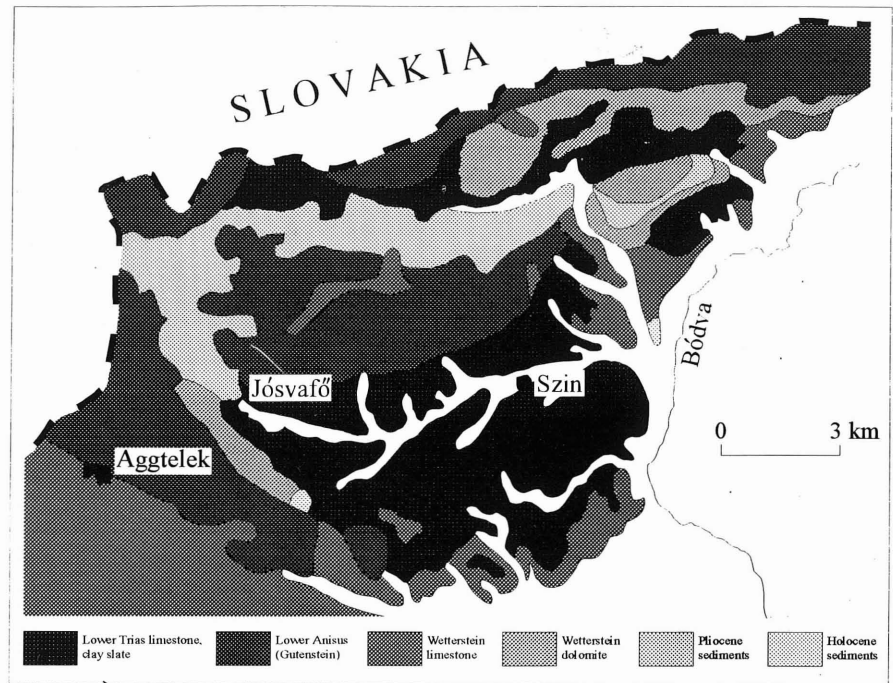
Valley dolines at 300-350 m are situated in rows and display NE-SW and W-E strikes (fig. 4). A typical fill in dark red terra rossa. The layer thickness is 5-15 m on the doline bottoms. The doline side and bottoms protected by the terra rossa exhibit definite tropical tower karst microforms. Such forms absent from the ridges and doline side not covered by terra rossa. As a result of secondary surface karst denudation processes shaping the relief.

Basin dolines are small dolines. The clay fill is 2-5 m thick. The subsoil rock forms are characterised by corrosional karren with the presence of fissure karren.

Plateau dolines have generally steeper side than the dolines at intermediate heights. This may well be connected with the fact that they contain little fill which favors the expression of the morphology of the rock surface. These dolines are filling black humus, their soil is rendzina soil.

Morphometry of dolines is an important indicator of their mode of development (Williams, 1975; Sauro, 1991; Bárány-Kevei & Mezösi, 1991). This research in the Aggtelek karst argues that ecological factors are also important in establishing the morphology of three-dimensional karsts. We were examined more than 50 dolines from Aggtelek

FIG. 3 - Geological map of the Aggtelek Hills.



lek Mountain. *Morphometrical parametres* of some typical dolines in Aggtelek Mountain are the following:

Doline	1	2	3	4	5	6	7	8
Elongation ratio	1,80	1,09	2,25	2,19	1,08	0,86	1,08	1,48
Area/Depth ratio	0,98	1,40	0,98	0,98	0,99	0,88	0,98	0,87
Peripher./Depth ratio	0,84	0,83	0,80	0,81	0,86	0,78	0,58	0,87

The elongation ratio, extents and depths of dolines depend on variations in geological and ecological elements of landscape. The tectonic movements of the Tertiary preformed the recent directions of the surface forms. Dry valleys, formed along the EW and NE-SW tectonic lines, influencing the placement of solution dolines. In fig. 4, the light patches show the *dry valleys*, and the dark patches mark the *karst cones*. Fig. also shows that the *cave and the dolines are not connected*.

Dolines provide very *sensitive monitoring points* for the environment in a karst region. The morphology of the dolines may indicate the aspects of doline-development that arise from exogenic influences. After and during the formation of the dolines, the exogenic ecological factors modify the dolines.

The reason for the *asymmetry of dolines* is the difference in microclimate, soil and flora on different slopes. Bárány-Kevei, (1992, 1995, 1996); has previously investigated the ecological relations of dolines and found the following. Different slopes receive different quantities of radiation and build up different microclimates which have an effect on chemical and biological processes in doline soils. The types and activities of soil bacteria depend on microclimate hence in the soils covering the bedrock in the

dolines they control the nature and the order of magnitude of corrosion processes necessary for solution.

Determining exogenic factor in the development of dolines is the *climate*. The different slopes further dissect the *microclimate* of doline within the microclimatic area resulted from the closedness of the karst depression. The dolines is filled up cold air at night and by the high temperature air by day stuck in the depression. The shadow effect also play an important part in the heat economy of dolines. The symmetry axis of the air temperature in the North-South segment shifts in the direction of the slope facing South. At night in case of fog the minimum temperatures shifts in the direction of the slope. The expositional differences make up it possible that the snow cover in winter remains different periods.

On the basis of my research the *exposition* and *soil type* also influence the *vegetation* in some dolines. On the S slope (exposed to N) dominated by strong self-shadow effect. The soil is composed of three levels: the upper is brown, there is a clayey one with iron, then red clay at the bottom. The dominating vegetation is composed *Festuca*, *Agrostis* and *Arrhenatherum*. The grass association is composed of sort of hydrophillic, medium nitrogen demanding species finding habitation on acid soils as well. The other extremity occurs on the W facing slopes. On this slope there is a limestone outcrop with rootkarren on its surface. Its dark upper layer contains some humus, its light brown middle layer is clayey, while its lower layer is quartz-bearing red clay. Its dominating species like *Sedum sexangulare*, *Sedum acre* and *Potentilla arenaria*. These species require very little humidity, low nitrogen demand and relatively high soil reaction value.

CONNECTION BETWEEN THE SURFACE MORPHOLOGY AND DOLINES

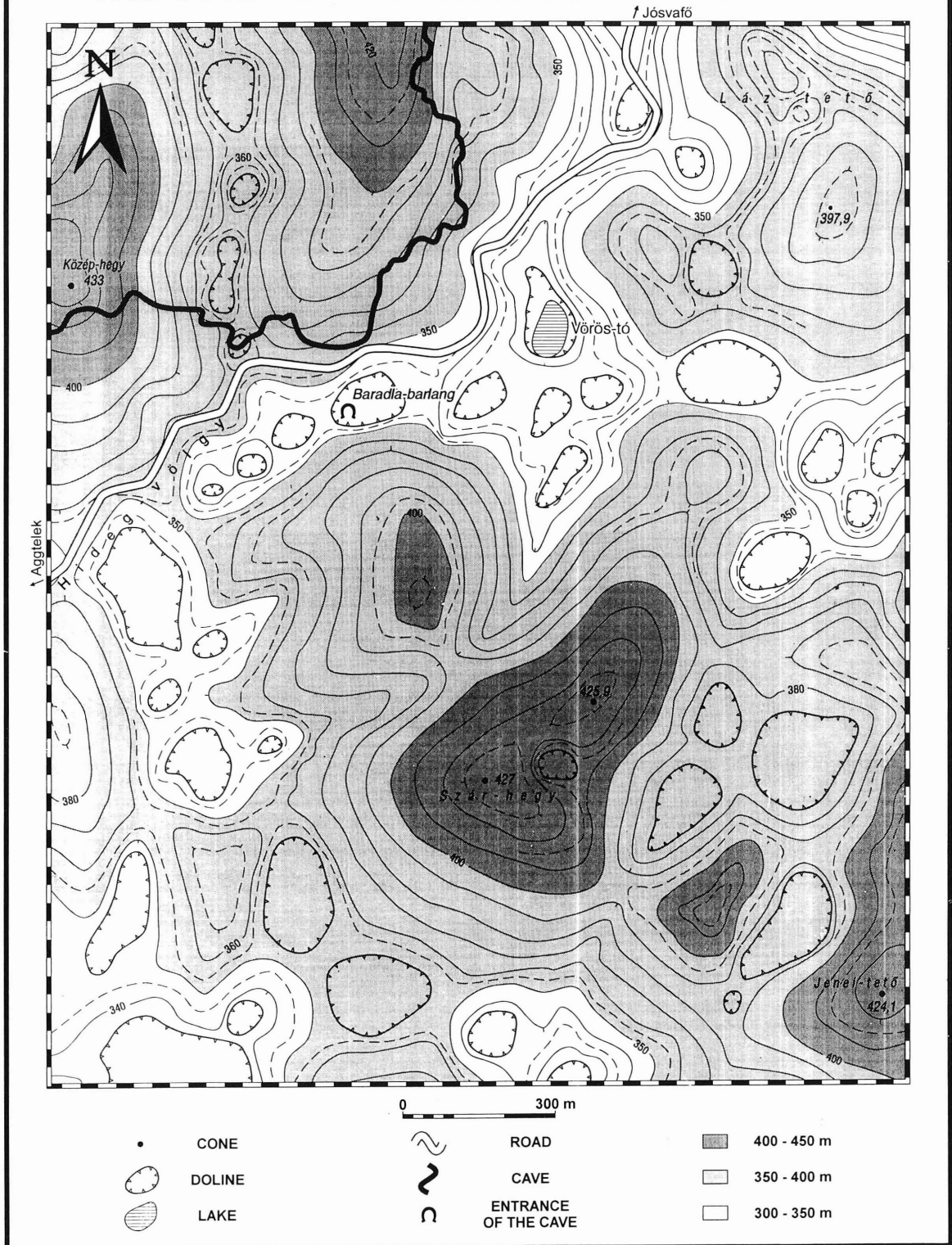


FIG. 4 - Connections between the surface morphology and dolines.

In the Aggtelek karst there are many degraded grass plots in the dolines, where there has been intensive animal grazing. The stamping and natural dunging have led to a uniform association of grass species. The pasturing animals had been preceded by deforestation, leading to the formation of secondary associations of grass species.

This in addition, to the classical-geomorphological approach to doline formation it is necessary to consider ecological factors. On the Aggtelek karst it was possible to investigate such environmental effects as they are relatively rapid.

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