Volcanic Caves in Bulgaria

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Introduction

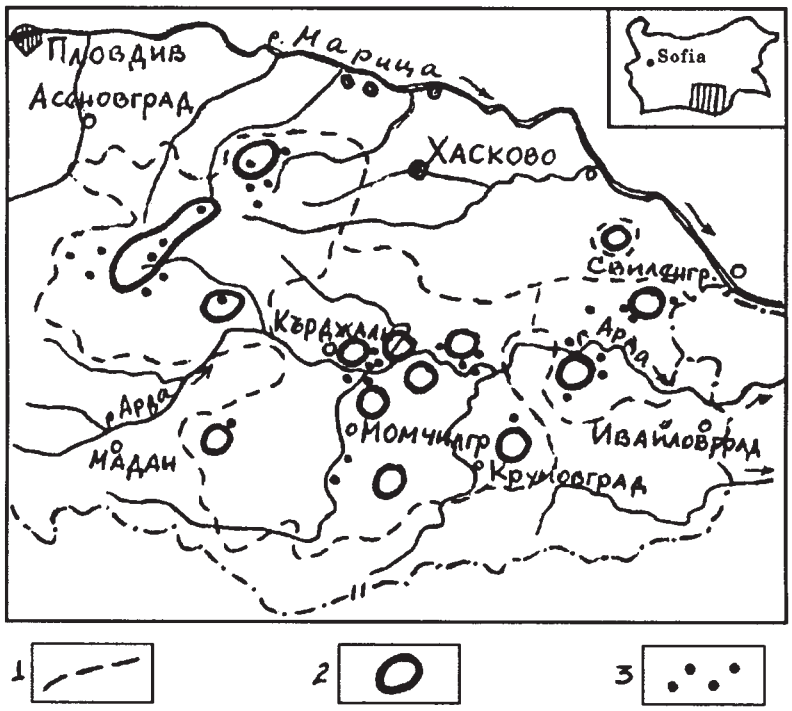
The largest area of the Balkan Peninsula covered with volcanic formations is in the eastern margin of the Rhodope Massif. Its area is about 3,600 square kilometers. The Rhodope paleovolcanism is one of the best known volcanic structures in Europe (Boyanov, 1961). During the Lower and Middle Oligocene, the eastern Rhodope underwent vigorous volcanic activity, with several stages at the bottom of a warm, shallow sea and partly above sea level (Tzankov and Spassov, 1968). The volcanic activity had several phases with simultaneous action of two magma sources. It was cyclic and possessed many central and unstable volcanic structures. Andesites, latites, trachytes, trachyandesites, dacites, rhyolites, tuff, and agglomerates are represented. Repeated deposits of submarine volcanics with marine sediments have undergone elevation of 2,000 to 2,500 meters (Tzankov and Spassov, 1968).

Within the eastern Rhodope paleovolcanics are three secondary structures:

1) Northeast Rhodope structure. This includes the prototypical "Borovichki" volcanic massif and a wide lava flood in the Metchkovetz, Dragonia, and Sini-vruh hills.

In this structure is a large ring-shaped volcanic structure (Dragoinovo) with a diameter of 16 by 19 kilometers (Spiridonov and Rivera, 1978).

2) Southeast Rhodope structure. This embraces a part of the middle drainage of the Arda River and a part of the southeast of the Rhodopes massif, with major volcanic constructions of several paleovolcanoes: Irantepenski, Dambalashki,



1. Граници на Източнородопската вулканична област
2. Палеовулкански структури (Paleovolcanic structures)
3. Вулкански пещери (Volcanic caves)

Yurkidendagski, Kardjaliyski, Perpereshki, Sveteileysky, and some smaller examples.

3) Madjavoro structure. This embraces the eastern part of the Rhodopes along the middle drainage of the Arda River. It includes the Madjarovo paleovolcano.

Some specialists use slightly different boundaries, but the differences are trivial (Boyanov, 1961; Galabov, 1937; Ivanov, 1960).

Many caves exist in this paleovolcanic area. They differ in size, morphology, and genesis. Until about 25 years ago, it was believed that such caves did not exist in Bulgaria, or, on the other hand, it was believed that such caves were of no interest to speleology (Trahteev and Georgiev, 1968).

In the past 25 years, more than 80 caves have been found in this area, thanks to research of members of the Aida Cave Club in the town of Haskovo. Since 1977 their research has followed a program of research on volcanic caves of the Bulgarian Federation of Speleology (Kolev, 1987).

Origin of Volcanic Caves in the Rhodopes

The Rhodope volcanic caves are the result of primary volcanic processes plus a series of exogenic and endogenic processes. Their origin and morphological characteristics are determined by specifics of the Rhodope paleovolcanism, characteristics of sedimentation, some post-volcanic processes, and several weathering processes: lateral erosion, denudation, suffosion, and thermal erosion.

In the specialized speleological literature there are several generic and morphological classifications of volcanic caves (Maksimovich, 1975). Basically there are two types of volcanic caves: primary and secondary.

Primary caverns are those formed during emptying of lava. These are lava tubes, lava pits (shafts or vertical conduits), gas bubbles, and caverns beneath lavafalls. In the Rhodopes, the last two types are common. Usually they have smooth walls and vaulted roofs. Some are enlarged by processes of physical weathering, suffosional undermining, lateral erosion, or other processes. Primary cavities served as a base for development of the larger caves. This is the origin of such caves as Prilepnata Peshtera (Bat Cave) and Gumburdek (Ringing Cave) in the middle Arda region; Kaleto II, III, IV in the region of the ring structure of Dragoinovo; and the caves near Madjarovo and on Sheinovetz Peak.

An example of a lava tube cave is Kaleto I on the slopes of a paleovolcano near Mostovo Village. This cave is about 30 meters long and up to four meters in diameter. Its ceiling is covered with lava pendants up to five centimeters long and with crystal gypsum druses up to five millimeters long.

Caverns beneath lavafalls are formed during the successive emptying of two lava streams. For example, Golymata Peshtera, with a total length of 51 meters, was formed by the emptying of a lavafall over previously cooled lava. In the middle Arda region, the caves called Topal Kadirovata Doupka and Malkata Peshtera have the same character. They are formed in a rhyolite canopy. Lateral erosion modified them.

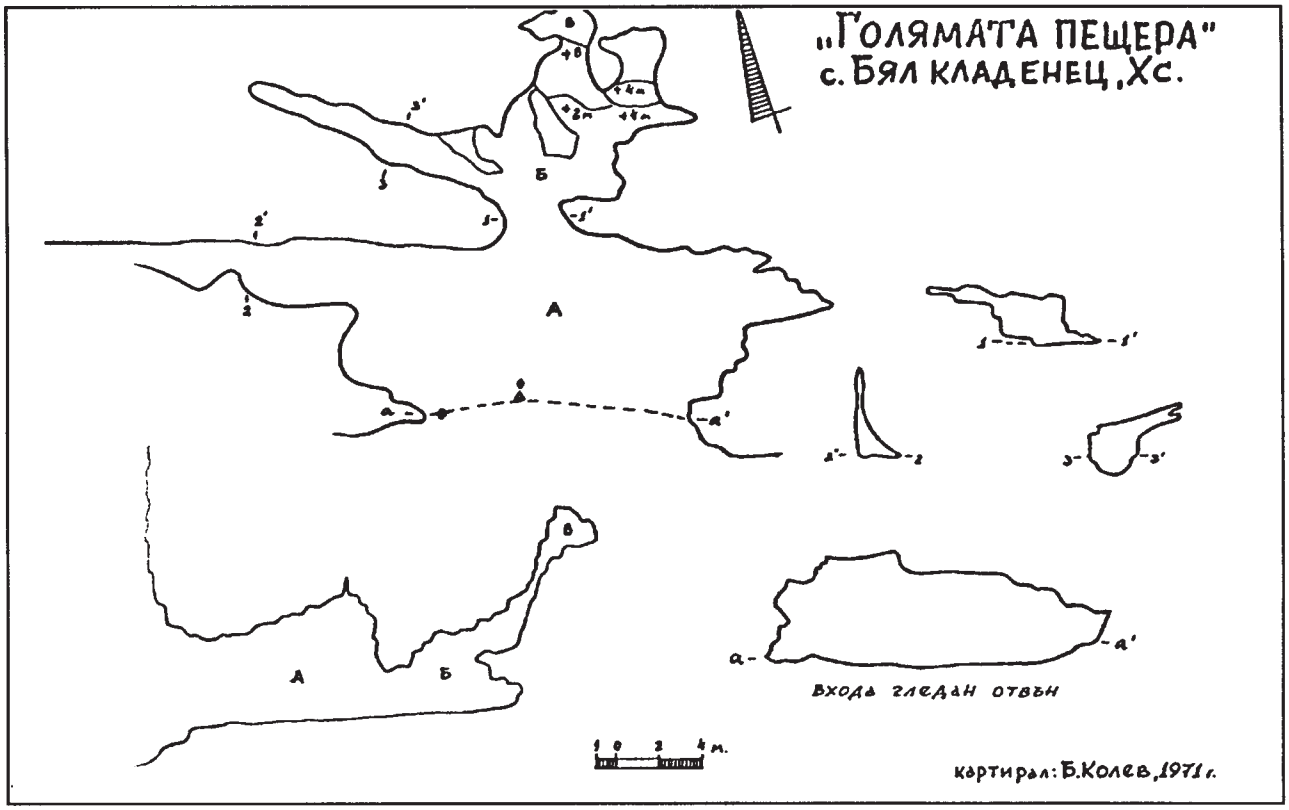
Secondary volcanic caves include all the caverns formed in lava and tuff, tuffite, and pyroclastic rocks by weathering and from falling water. In the Rhodopes there are several types:

1) Suffosion-erosional. These are mostly in tuff and are small. Suffosion and erosion are the main genetic factors. Examples are the cave near Dobrovoletz Village and the cave called Ogledalnata (passage) near Golobradovo Village.

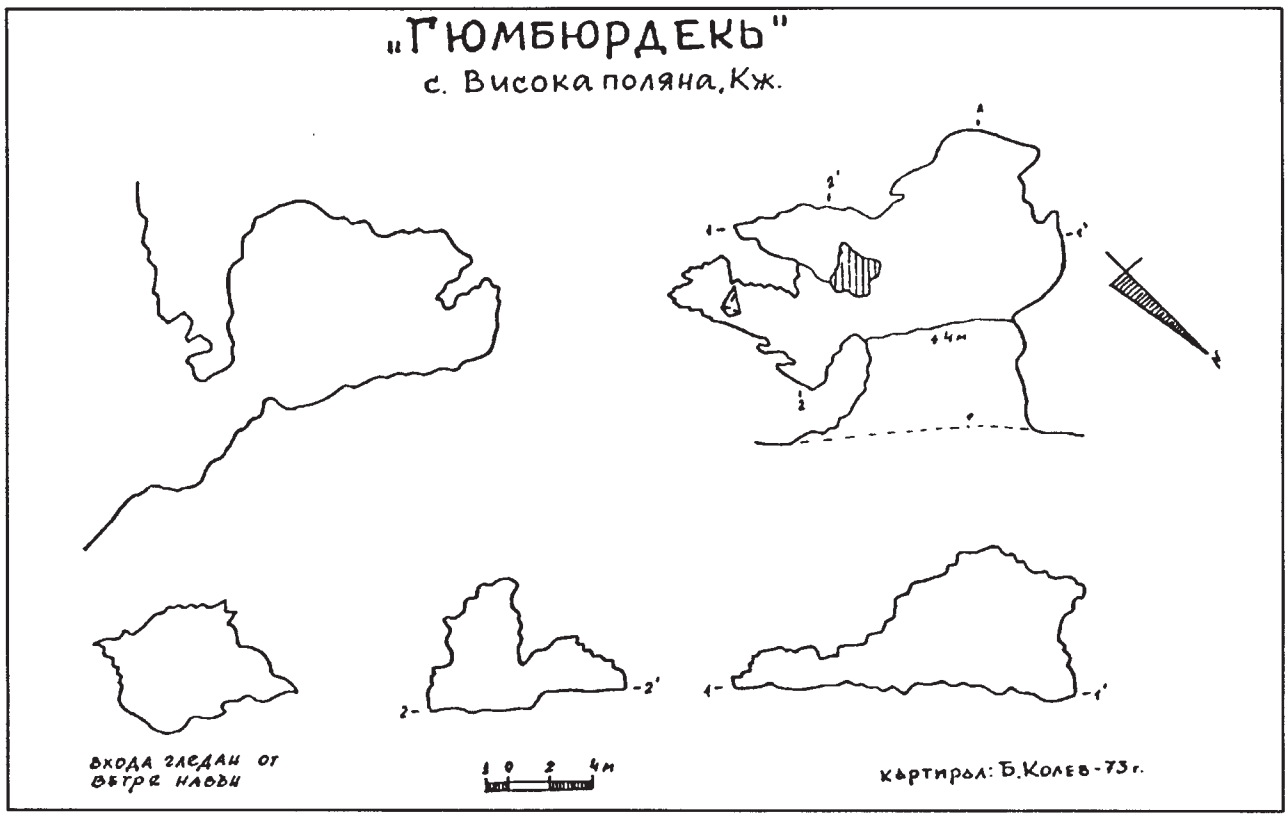
2) Lateral erosion. These comprise most of the volcanic caves of the Rhodopes. They are formed by lateral erosion in the valleys of the great rivers. They are found chiefly on contacts between the hardest lava rocks and underlying tuffs, tuff-breccia, lava breccia, and other pyroclastic rocks. They mark old lateral levels of the river. These include Vichegradskata, Podskalna 1 and 2 Caves, caves in the middle Arda region near Mostovo Village, and caves near Studen Kladenetz Gorge.

3) Denudo-erosional. These are caves formed in subvolcanic bodies (massifs), uncovered by denudation of the volcanic massifs. This is the genesis of most of the caves in the northeast Rhodopes structural depression and in the Dragoino ring structure, such as Jultata Peshtera, Probitiya Kamak, Myurekovata Peshtera, Lipovitza, and so on.

4) Gravity-erosional. These are formed in blocky fissured volcanic rocks by supplemental enlargement and hollowing by erosion and other weathering processes. This is the character of



Golymata Cave (B. Kolev, 1971)



Gumburdek (B. Kolev, 1973)

Golyamata Peshtera near Nochero Village, Ivanov Kamak near Sarnitza Village, and others.

5) Rock bridges and arches. These are formed mainly in pyroclastic rocks as a result of lateral erosion and flowing surface waters, and are in valleys of the great rivers. They include Duptchen Kamak and Hobota in the middle Arda region and Probitya Kamak (Kolev, 1987).

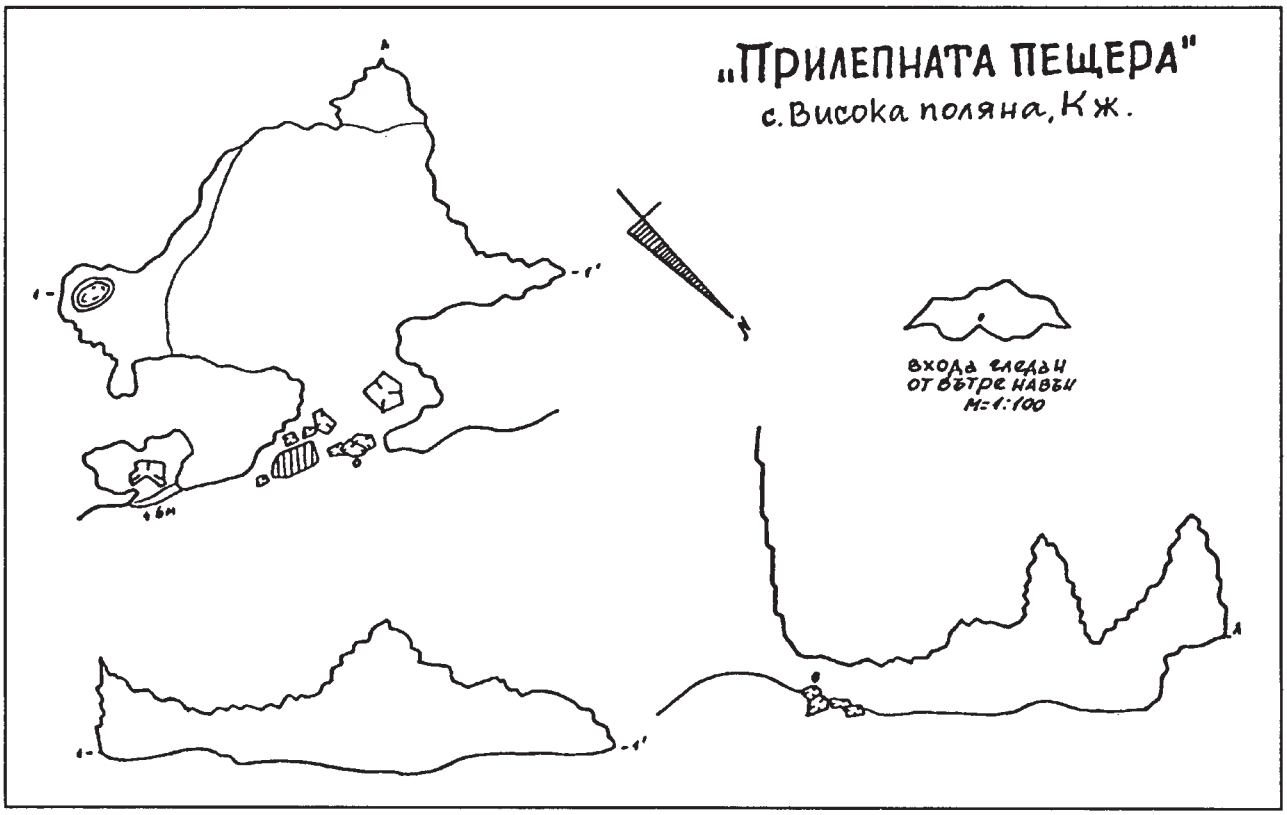
The pattern of distribution of caves in the Rhodopes is not uniform. Twenty-six are known in the northeast Rhodope structure, 44 in the southwest structure, and 14 in Madjarovo. They are especially numerous in the valley of the Arda River and along the valleys of its tributaries, on the slopes of the Dragoinovo ring structure, around the crater of Madjarovo paleovolcano, and on high elevation denuded surfaces.

Secondary Minerals in the Volcanic Caves

Of the 227 cave minerals known (Shopov, 1989), 18 are known only in volcanic caves. Those of the Rhodopes are classified as follows:

1) Volcano-weathering. These are formed as a result of weathering of volcanic rock. This group includes gypsum, allophane, gibbsite, soda, and thermonatrite. Gypsum is represented by crystals two to five millimeters long on the ceiling of most of the caves. According to Hill and Forti (1986) it is the most common mineral of volcanic caves. Allophane is represented by a crust 50 centimeters long and 10 centimeters thick in Gyumburdek Cave. Gibbsite is represented by pale yellow porous sediments lavishly impregnated with soda and thermonatrite in Prilepnata Cave (Shopov *et al.*, 1987; Shopov, 1988). This is the second recorded observation of thermonatrite and third of soda in caves.

2) Volcano-guanogenic. These minerals are formed by the action of guano on the volcanic rocks, including acetamide, newberryite, and purpurite. Small quantities of acetamide are found in sediments of Prilepna Cave together with soda and thermonatrite (Shopov, 1988) and determines their brown color. This is the first recorded occurrence of this mineral in caves (Shopov, 1989). Newberryite and purpurite form a rose-colored crust in Gumburdek Cave. They are formed as a result of interaction of bat guano with the cave walls which



Prilepnata Cave

are the source of magnesium and manganese. This is the second recorded occurrence of purpurite and the fifth of newberryite in caves.

All the cited minerals were determined by x-ray diffraction analysis. Their further analysis will be published separately.

Other Interests

These caves also are of biospeleological interest. Troglophiles familiar to karstic biospeleologists are most common. In Prilepnata Cave in the middle Arda are about 1,200 individuals of the big horseshoe nosed bat, *R. ferrumeguinum*.

Some of these volcanic caves are also important archaeologically. Vichegradska Cave was inhabited during the neolithic period and bronze age (Djambasov, 1958; Mikov, 1933). Some others were used for cultural purposes and for sanctuary by ancient Thracians, for Christian sanctuaries, and for shelter by the local population during the Middle Ages (Kolev, 1983).

Summary

Volcanic caves in Bulgaria have many interests and require multidisciplinary study. The dry climate and the presence of bat guano has resulted in the formation of several rare cave minerals.

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