The development of gypsum karst in Northern Bukovyna in Late Pleistocene – Holocene

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1 Introduction

According to the karst-speleological zoning, the Northern Bukovyna and its northern part, situated in the Middle Dniester area, belongs to the Podillia-Bukovynian karst region. Several dozen natural caves have been explored in this area. Some of the caves were developed in Cretaceous and Neogenic carbonate rocks, but their dimensions are not more than tens of meters (Ridush and Kuprich, 2003). However, most of the biggest caves in the area, like Optymistychna, Ozerna, Mlynky, Kryshtaleva and others, were developed in a gypsum layer (Low Badenian, Miocene), bedded deeply under the surface, and they are mostly of hypogenic genesis (Klimchouk and Andreychouk, 2017). The sulphate rocks are outcropped or bedded close to the surface at the northern part of Northern Bukovyna, close to the Dniester River valley. In the Bukovynian part of the gypsum area, only one relatively small maze-cave is known (Skytska (Hostri Hovdy)) (Tab. 1). The geological age of this cave is still unclear, but it is undoubtedly older than the Late Pleistocene. However, on some gypsum areas, the classic epigenic karstogenesis, with a minimal contribution of the previous hypogenic stage, is developed. Until now, caves of this type were only briefly mentioned in the karstological literature, especially regarding their geological age.

2 Methods

The speleomorphogenetic method was used for the study of karst formation, lithology and hydrological conditions, which provided information about: 1. Lithology recondition for karst development, 2. Type of water exchange system, 3. The succession of karst systems stages (Klimchouk and Andreychouk, 2017). We also constantly provided the monitoring of active karst processes in this area (Ridush and Kostiuk, 2019). In addition, paleontological and paleogeographical studies of caves sediments are conducted (Kononenko et al., 2022).

3 Results

The features of epigenic karst development are under the influence of surface water and rocks' natural porosity and fissures. The numerous caves of epigenic origin are known in the northern part of Northern Bukovyna (Table 1).
Due to the high solubility of gypsum, the karst process in the area is still active and evidently visible. For example, during the last few decades (since 1980), the new karst ditch appeared in the Chornyi Potik Valley, between the caves Nezabudka and Troitska. Because of anthropogenic activity, the new ponors appeared (caves Orange River and Red Ponor), and the older caves-ponors became inactive (Selenitovyi Ponor) in the same valley.

Table 1. Caves at the northern part of Northern Bukovyna (according to the materials of the Ukrainian cadastre of caves)

№	Name	Length, m	Amplitude, m	Prevailing genesis	Age
1.	Skytska (Hostri Hovdy)	3550	14	hypogenic	Pleistocene
2.	Chornopototska	970	6	epigenic	Holocene
3.	Pionerka	600	13	epigenic	Holocene
4.	Nezabudka-Troitska	375	5	epigenic	Holocene
5.	Balamutivska	263	8	epigenic	Holocene
6.	Fushteika	219	14	epigenic	Holocene
7.	Kremenevyh Vidschchepiv	210	14	epigenic	Holocene
8.	Elefantyna	200	4	hypogenic	Pleistocene
9.	Panska Skelia	180	12	epigenic	Holocene
10.	Ducha	144	5	epigenic	Holocene
11.	Dovhyi Yar-1	100	4	epigenic	Holocene
12.	Selenitovyi Ponor	80	5	epigenic	Holocene
13.	Martynivka	80	5	hypogenic	Pleistocene
14.	Pidlianka	75	6,5	epigenic	Holocene
15.	Orange River	70	5	epigenic	Holocene
16.	Dovhyi Yar-2 (Malecha)	40	4	epigenic	Holocene
17.	Red Ponor	23	2	epigenic	Holocene
18.	Lianka	22	8	epigenic	Holocene
29.	Voronka	20	0	epigenic	Holocene
20.	Koziachi Nizhky	17	14	epigenic	Holocene

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To the northeast of the Chornyi Potik Valley, the karst ditch Dovhyi Yar is located, there are several caves (Pionerka, Dovhyi Yar-1, Dovhyi Yar-2) were explored. Now it functions as a blind karst valley because it collects the surface runoff from the surrounding territory. Pionerka Cave is the largest cave in this microregion, with signs of hypogenic speleogenesis on the upper floor. Because of periodical flooding with rain and snow-melting runoff, its internal configuration is constantly changing. So, at the modern stage, the cave continues to develop in epigenic conditions. The lower gallery, with a periodical waterflow, contains loose, loamy flood sediments that we consider to be of Holocene age. Meanwhile, the hypogenic stage should be much older due to the geomorphological position of the territory; no ancient sediments were recorded in the cave.

Several active caves containing the Late Palaeolithic artefacts in the cave sediments are known near Balamutivka Village. But as it was evidently shown, the flints and few bone remains were washed into these caves through the ponors from the loess strata, bedded on the ancient river terrace above the gypsum strata (Kononenko, Ridush and Popiuk, 2022). Moreover, gypsum lithology in this cave undergoes intensive frost weathering in the area of daily and seasonal temperature fluctuations, which caused the relatively quick destruction of the entrance grotto of the Balamutivska Cave (Ridush, 2000; Kochergan and Ridush, 2011).

Meanwhile, the sediments containing palaeogeographical records were explored in a few caves. In the Martynivka cave, except for the Medieval cultural layers, the fauna of rodents, dated to LGM was found (Ridush et al., 2021). In the entrance grotto of the Balamutivska Cave, the Mesolithic drawings and carvings on the walls were found yet in 1951 by (Chernysh,

1959). Nevertheless, the Mesolithic age of the Rock art in this cave was discussed, and the explanation of what way the drawings could survive since the Early Holocene was given (Ridush, 2000).

Moreover, the few small dead-end galleries adjacent to the main chamber contain slender-thick (up to 1.0m) deposits of light-yellow loess-like loam with the remains of Chiroptera, Lepus sp., Vulpes sp., Rodents, Aves, Reptiles, Amphibia, Pisces, Mollusca, and Diptera puparium. The species and radiocarbon age should be determined (Ridush, 2022).

4 Conclusions

Karst development in the northern part of Northern Bukovyna is controlled by lithology, geology, and tectonic settings, as well as cycles of chemically active water. We can determine the signs of karst development by the morphology of the cave passages, as well as by the available cave deposits (paleogeographic sights). Also, karst development is influenced by human economic activity, which has been started in this region at least since the Neolithic.

The development of epigenic karst and karst denudation is still active in the territory, but its history in Late Pleistocene and Holocene should be traced after the karst sediments research. At present, it is enhanced by anthropogenic factors, in particular, economic development of the territory (ploughing, reduction of forests cove, runoff regulation etc.).

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