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Relocating the Lysenia Cave: Geodetic, Geological, and Geodynamic Aspects of the Region

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SUMMARY

Lysenia Cave, located near the village of Kolyndiany in Chortkiv District, Ternopil Region, was investigated in 1965; however, over the following decades, the precise location of its entrance was lost. The aim of this study was to reconstruct the location of the cave using historical geodetic data, determine its present-day spatial coordinates, and assess the geological and geodynamic characteristics of the surrounding area. The reconstruction of the cave entrance location was based on archival magnetic azimuth data, a modern model of the Earth's magnetic field, GNSS measurements, and geoinformation methods. As a result of field investigations conducted in 2026, the cave entrance, which had been completely buried by slope deposits, was rediscovered and cleared. To confirm the identification, laser scanning of the underground cavity was performed and a 3D model of the cave was created. Comparison of the resulting model with the 1965 topographic survey plan revealed a clear correspondence between the configuration of the principal passages and internal features, thereby confirming the identification of the cave. The reconstructed location of Lysenia Cave was compared with the modern geological map of the area. The cave is situated within the Neogene sedimentary succession of Western Podillia, providing a basis for further investigation of the lithological and structural controls on its development. The complete burial of the historical entrance by slope deposits, together with relief deformation and other morphological features, indicates ongoing slope processes. To quantitatively assess these processes, geodetic monitoring points were established for repeated observations. The rediscovery of Lysenia Cave provides a basis for further geological, speleological, archaeological, paleoenvironmental, and geodynamic investigations of the area. It also creates opportunities to determine the nature, direction, and rate of possible present-day slope deformation and to investigate its relationship with karst, erosional, and hydrological processes in the region.

Keywords: Lysenia Cave; Cave rediscovery; Geodetic positioning; GNSS; Laser scanning; 3D modelling; Geological mapping; Karst; Slope processes; Geodynamic monitoring.

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Introduction

The karst caves of Western Podillia are important geological and geomorphological features whose formation and present-day state are controlled by the interaction of lithological, structural-tectonic, hydrogeological, and geodynamic factors. The gypsum karst of Western Ukraine, developed predominantly within Miocene (Badenian) gypsum, represents one of the world's most prominent examples of intrastratal karst formed under artesian conditions (Klimchouk, 1996; Andrejchuk & Klimchouk, 1996). Differential neotectonic movements have significantly influenced karst evolution, the configuration of the hydrographic network, and the transition of individual parts of the region between different stages of karst-system development (Klimchouk, 2012; Klimchouk & Andreychouk, 2017). An important factor controlling the formation of underground cavities is the structural heterogeneity of the gypsum sequence. Fracture systems determine the directions of cave-passage development and the spatial organization of maze caves in Western Ukraine (Klimchouk et al., 2009). Therefore, the spatial position of a cave and the orientation of its passages may provide information not only on the conditions of speleogenesis but also on the structural characteristics of the surrounding rock mass. Subsurface karst processes may also be expressed in the present-day landscape. Collapse of cave roofs and deformation of overlying strata may propagate toward the ground surface, resulting in subsidence, sinkhole formation, and localized deformation. Studies of gypsum caves in Western Ukraine have demonstrated that the development of such deformation is controlled by a combination of geological, hydrogeological, and speleogenetic factors (Klimchouk & Andrejchuk, 2002, 2005). At the same time, cave deposits of the Podillia–Bukovyna karst and speleological region constitute important natural archives of Quaternary history and environmental evolution (Ridush, 2022). Taken together, these observations demonstrate the need to consider cave systems in relation to both the geological structure and the present-day morphodynamics of the surface. Investigations of such features require the integration of geological mapping with modern geodetic and geoinformation methods. High-precision GNSS measurements provide a spatial geodetic reference framework and enable accurate control of the relative positions of survey points (Vivat et al., 2022), while UAV surveys and photogrammetric 3D modelling allow detailed documentation of topography and the spatial position of natural features (Kolb et al., 2022). Open-access digital elevation models can be used for regional terrain analysis; however, their application to local-scale geodynamic investigations requires prior assessment of their accuracy (Vivat et al., 2025). Of particular interest is Lysenia Cave, first investigated in 1965, whose precise entrance location was subsequently lost. The preserved historical geodetic data provided an opportunity to reconstruct the direction to the cave more than six decades later. For this purpose, the historical magnetic azimuth was transformed into a modern reference framework using a model of the Earth's magnetic field. The true azimuth and grid bearing were then determined, the predicted position of the cave entrance was calculated, and its location was verified in the field. Field investigations also revealed evidence of present-day slope activity. The former cave entrance was found to be completely buried by slope deposits; tilted and curved trees occur on the slope, while field observations and accounts from local residents indicate changes in the morphology of the area over recent decades. These features alone cannot unequivocally identify the mechanism responsible for the deformation. However, when considered together with the geological setting of the area and the known characteristics of gypsum-karst development, they indicate that the site is a promising location for further geodynamic monitoring.

The aim of this study is to reconstruct the location of Lysenia Cave using historical geodetic data, determine its present-day spatial position, analyze the geological and geomorphological characteristics of the surrounding area, and provide a rationale for establishing a geodetic network for the future monitoring of potential slope deformations.

Results

The main result of the 2026 field investigations was the rediscovery of the entrance to Lysenia Cave, whose precise location had been lost over the preceding decades. The cave was investigated in 1965; however, the surviving records contained only limited information on its spatial reference. After preliminary delineation of the search area, a detailed field survey of the slope was conducted. The

presumed location of the entrance was found to be completely buried by slope deposits. Following the removal of these deposits, the entrance to an underground cavity was exposed and subsequently confirmed as Lysenia Cave (Figure 1). Lysenia Cave is located near the village of Kolyndiany, Chortkiv District, Ternopil Region, on the left bank of the Nichlava River, on the southern slope of a small ravine. The geodetic coordinates of the cave entrance in the WGS 84 reference system are 48.978766° N, 25.942855° E. The ellipsoidal height determined from GNSS observations is 303 m, whereas the normal height in the Baltic Height System is 270 m. In the USK-2000 coordinate system (Zone 5), the entrance coordinates are X = 5,427,922.56 m and Y = 5,422,733.70 m. The difference between the ellipsoidal and normal heights is attributable to the quasigeoid height in the study area. The condition of the entrance area and the considerable accumulation of slope material explain the difficulty of relocating the cave more than six decades after its initial investigation. At the same time, the burial of the entrance by slope deposits provides evidence of active downslope movement of surficial material and warrants further investigation in conjunction with other geomorphological and geodynamic features of the area.

Figure 1. *Participants of the field investigations at the rediscovered and cleared entrance to Lysenia Cave, August 2026*

To confirm the identification of the rediscovered underground cavity, spatial scanning was carried out and a modern 3D model of the cave was created. The resulting model was compared with the topographic plan of Lysenia Cave produced during the 1965 survey. The comparison revealed a clear correspondence in the overall cave configuration, including the arrangement of the main passages, enlargements, and internal features (Figure 2). This spatial agreement provides independent confirmation that the rediscovered underground cavity is Lysenia Cave, originally investigated in 1965.

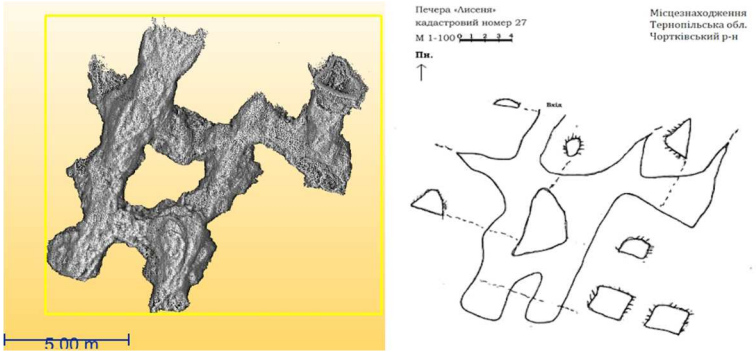

Figure 2*. Comparison of the modern 3D model of Lysenia Cave obtained by laser scanning (left) with the 1965 topographic plan of the cave (right)*

The condition of the entrance area and the accumulation of a considerable amount of slope material explain the difficulty of relocating the cave after more than six decades. At the same time, the complete burial of the entrance by deposits indicates the movement of surficial material on the slope and requires further investigation in conjunction with other geomorphological features of the area. The reconstruction of the precise location of Lysenia Cave made it possible to relate its spatial position to the geological structure of the region. According to the geological map compiled by A. Bubniak, the cave is located within the Neogene sedimentary succession of Western Podillia (Figure 3). At the

regional scale, the Neogene deposits are spatially associated with exposures of older Cretaceous and Devonian formations, reflecting the complex geological structure of the area.

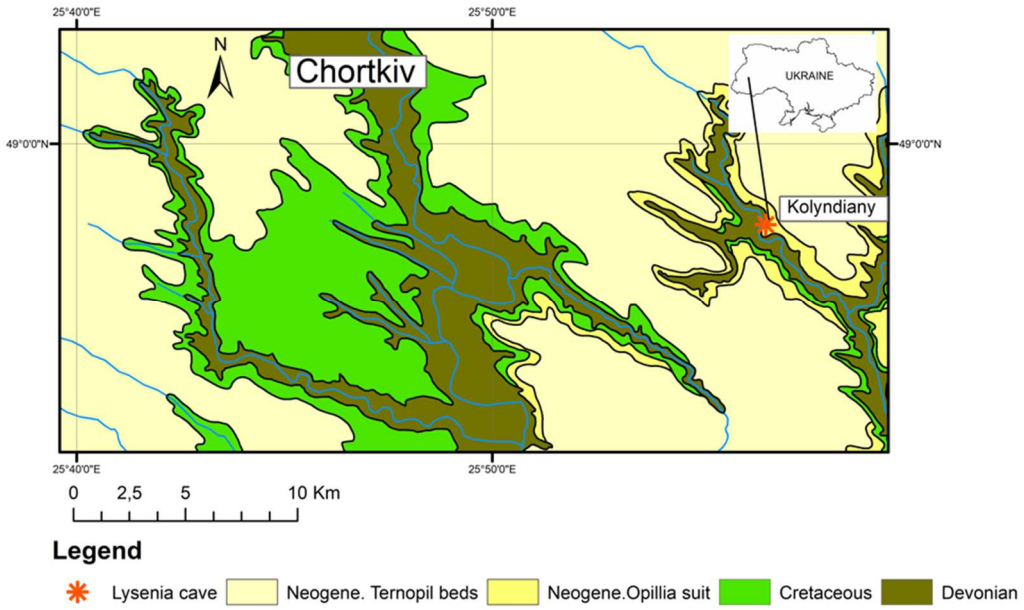

Figure 3. *Geological map of the Lysenia Cave area (based on materials provided by I. Bubniak)*

Establishing the precise location of the cave provides an opportunity for a more detailed investigation of the geological factors controlling its formation. A promising direction for further research is to compare the orientation of passages derived from the 3D model with the orientation of fractures and other structural elements of the rock mass. This will make it possible to assess the potential structural control on cave development and to refine the interpretation of its speleogenesis.

Of particular interest are the present-day processes affecting the adjacent slope. The complete burial of the historical entrance by slope deposits, relief deformation, and other field evidence require an integrated geological, geomorphological, and geodetic analysis. Repeated measurements at the established geodetic monitoring points should make it possible to determine the presence, direction, and magnitude of present-day slope movements and to distinguish them from changes associated with erosional, karst, and hydrological processes.

The rediscovery of the cave may also be of archaeological significance. The prolonged inaccessibility of its inner sections and the presence of cave sediments provide a basis for specialized archaeological and paleoenvironmental investigations. However, conclusions regarding the presence or age of any potential archaeological materials can only be drawn after appropriate specialist investigations have been conducted.

Conclusions

As a result of the integrated analysis of historical records and field investigations conducted in 2026, the location of Lysenia Cave was successfully reconstructed. The entrance, which had been buried by slope deposits, was cleared and reopened for further investigation. The identification of the rediscovered cave was confirmed by laser scanning and the construction of a 3D model. Comparison of the modern model with the 1965 topographic plan revealed a clear correspondence in the configuration of the main cave passages.

Reconstruction of the spatial position of Lysenia Cave made it possible to relate the cave to the modern geological map of the area and provided a basis for further analysis of the lithological and structural controls on its formation. The rediscovery of the cave also opens new opportunities for more detailed speleological, geological, and archaeological investigations.

The burial of the historical entrance, the characteristics of the present-day relief, and morphological evidence of slope deformation observed in the field indicate ongoing slope processes. To determine

their nature, direction, and rate, geodetic monitoring points were established for repeated observations and long-term geodynamic monitoring of the area.

References

Andrejchuk, V., & Klimchouk, A. (1996). Gypsum karst of the Eastern-European Plain. *International Journal of Speleology, 25*(3–4), 251–261. https://doi.org/10.5038/1827-806X.25.3.19

Klimchouk, A. (1996). Gypsum karst in the Western Ukraine. *International Journal of Speleology, 25*(3–4), 263–278. https://doi.org/10.5038/1827-806X.25.3.20

Klimchouk, A. (2012). Gypsum caves and karst in the Western Ukraine: Speleogenetic and typological significance. In W. B. White & D. C. Culver (Eds.), *Encyclopedia of caves* (2nd ed., pp. 31–46). Academic Press. https://doi.org/10.1016/B978-0-12-383832-2.00051-7

Klimchouk, A., & Andreychouk, V. (2017). Gypsum karst in the southwest outskirts of the Eastern European Platform (Western Ukraine): A type region of artesian transverse speleogenesis. In A. Klimchouk, A. N. Palmer, J. De Waele, A. S. Auler, & P. Audra (Eds.), *Hypogene karst regions and caves of the world* (pp. 363–385). Springer. https://doi.org/10.1007/978-3-319-53348-3_23

Klimchouk, A., Andreychouk, V., & Turchinov, I. (2009). *The structural prerequisites of speleogenesis in gypsum in the Western Ukraine* (2nd rev. ed.). University of Silesia & Ukrainian Institute of Speleology and Karstology.

Klimchouk, A., & Andrejchuk, V. (2002). Karst breakdown mechanisms from observations in the gypsum caves of the Western Ukraine: Implications for subsidence hazard assessment. *International Journal of Speleology, 31*(1–4), 55–88. https://doi.org/10.5038/1827-806X.31.1.4

Klimchouk, A., & Andrejchuk, V. (2005). Karst breakdown mechanisms from observations in the gypsum caves of the Western Ukraine: Implications for subsidence hazard assessment. *Environmental Geology, 48*, 336–359. https://doi.org/10.1007/s00254-005-1279-1

Ridush, B. (2022). The Quaternary vertebrate fauna of cave deposits of the Podillia-Bukovynian Karst-Speleological Area (Western Ukraine). *Stratigraphy & Timescales, 7*, 157–219. https://doi.org/10.1016/bs.sats.2022.10.002

Klimchouk, A. (1996). Speleogenesis in gypsum. *International Journal of Speleology, 25*(3–4), 61–82. https://doi.org/10.5038/1827-806X.25.3.5

Vivat, A., Tretyak, K., Savchyn, I., Navodych, M., & Lano, O. (2022). Investigation of determining the accuracy of spatial vectors by the satellite method in a real time mode. *Journal of Applied Geodesy, 16*(4), 351–360. https://doi.org/10.1515/jag-2022-0003

Kolb, I., Vivat, A., Nazarchuk, N., Zhyvchuk, V. L., & Pashchetnyk, O. (2022). Methodology of 3D modeling based on aerial images from a drone with simplified geodetic reference. In *16th International Conference Monitoring of Geological Processes and Ecological Condition of the Environment, Monitoring 2022* (pp. 1–5). European Association of Geoscientists & Engineers.

Vivat, A., Bubniak, A. M., Bubniak, I. M., Boretskyy, P., Boiko, K. O., & Bochko, O. (2025). Accuracy assessment of open digital elevation models (DEM) for the territory of Ukraine and prospects for their improvement. In *18th International Scientific Conference Monitoring of Geological Processes and Ecological Condition of the Environment, Monitoring 2025*. European Association of Geoscientists & Engineers.