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Project Gallery

Tracing ephemeral human occupation through archaeological, palaeoenvironmental and molecular proxies at Łabajowa Cave

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Confirming ephemeral human occupation is a crucial issue in cave archaeology. The project 'Tracing human presence in caves of Polish Jura' focuses on the application of molecular methods to decode the history of past human activities in cave sediments in the Kraków-Częstochowa Upland. The results will be compared with archaeological and palaeoecological proxies.

Keywords: Poland, molecular analyses, sedimentary sequence, cave occupation

Introduction

Caves have attracted people since the dawn of time and have accumulated a record of repeated human entries through many millennia. Detailed archaeological fieldwork allows us to understand many aspects of past human activities but many factors, such as the poor state of preservation of the archaeological features and observations made solely at a macroscopic scale, set limits for final interpretations. Owing to the complexity of sedimentation and post-depositional processes in cave environments, even layers containing well-preserved human occupation traces require confirmation of their original context using other proxies.

Background and process for the study

To trace human occupation, we focus on Polycyclic Aromatic Hydrocarbons (PAHs) and faecal sterols and bile acids. The former are indicators of burning events and the latter are compounds found in animal and human faeces (Figure 1). PAHs can be divided into compounds

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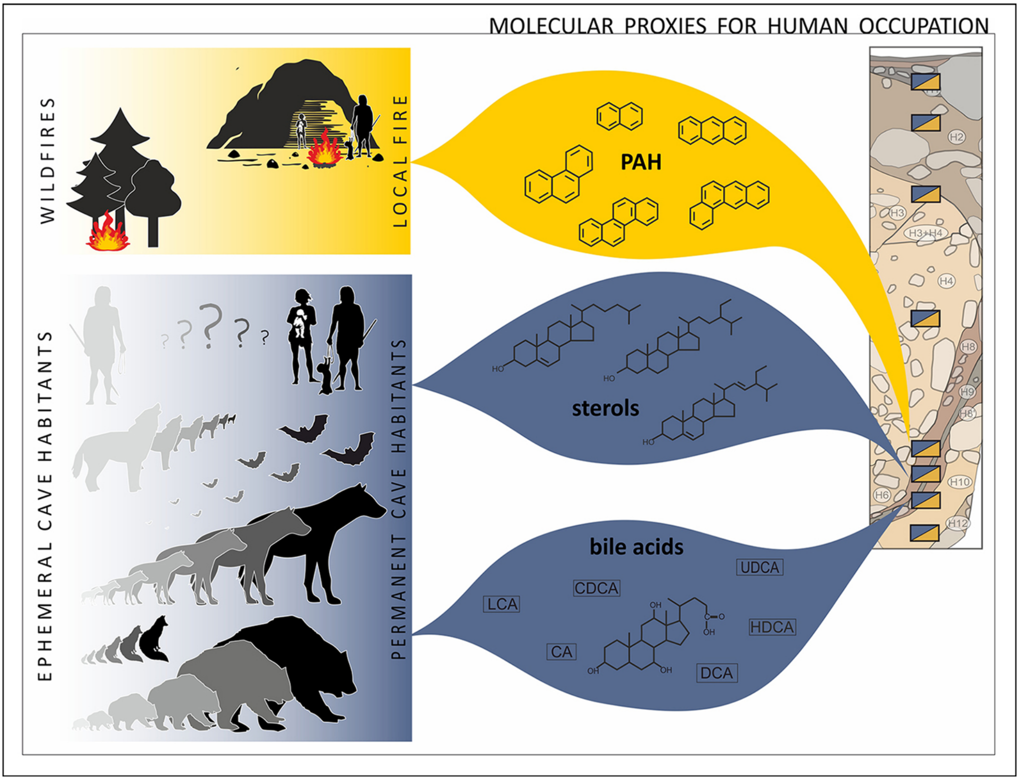

Figure 1. Tracing human presence in caves of the Polish Jura through molecular markers project (figure by the authors).

with low or high molecular weights. Studies indicate that wildfires, as opposed to wood burning in hearths, result in low production of 4-, 5-, or 6-rings PAHs and high production of 2- or 3-rings PAHs (Vergnoux *et al.* 2011). As a consequence, PAHs composition in a given sample is a marker of fire source and distance. The 2- or 3-rings PAHs correlate with distant wildfires, while the 4-, 5-, or 6-rings PAHs with local fire connected to human activity on the site (Brittingham *et al.* 2019). Therefore, PAHs provide a potential for the identification of local fire of anthropogenic origin within a specific layer.

Faecal sterols and bile acids composition in faeces depend on diet and metabolic processes of an organism. They have been successfully analysed in archaeology to recognise contamination with human faecal material and to distinguish faecal material of specific groups of animals or species (Bull *et al.* 2002; Shillito *et al.* 2020). In caves, they have been mostly analysed within layers of *fumiers*—that is, layers of dung that are connected to the use of caves as livestock-pens (Gea *et al.* 2017)—but broader approaches have been tested as well (see for instance Krajcarz *et al.* 2013). Consequently, faecal sterols and bile acids can indicate which vertebrate species, including humans, used a cave at a particular time.

This project is being conducted along with other studies focusing on archaeology, chronology and palaeoenvironment. This interdisciplinarity is necessary to assess the practicality and reliability of the molecular approach; it should confirm ephemeral human occupation

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and presence of other cave occupants and their interactions. In addition, a comparative database of sterol and bile acids composition in wild animals' faeces, whose faecal imprint could be potentially found within the caves of the Polish Jura, has been started to help interpret the results.

For testing the potential and limitations of the methods, we chose seven cave sites (Ciasna Cave, Bramka Rockshelter, Shelter in Smoleń III, Biśnik Cave, Sąspowska Zachodnia Cave, Łokietka Cave and Łabajowa Cave) located in the karstic region of the Polish Jura (Figure 2C). Before the project began, selected sediment samples collected from these sites were tested to confirm the presence of molecular markers required for the study.

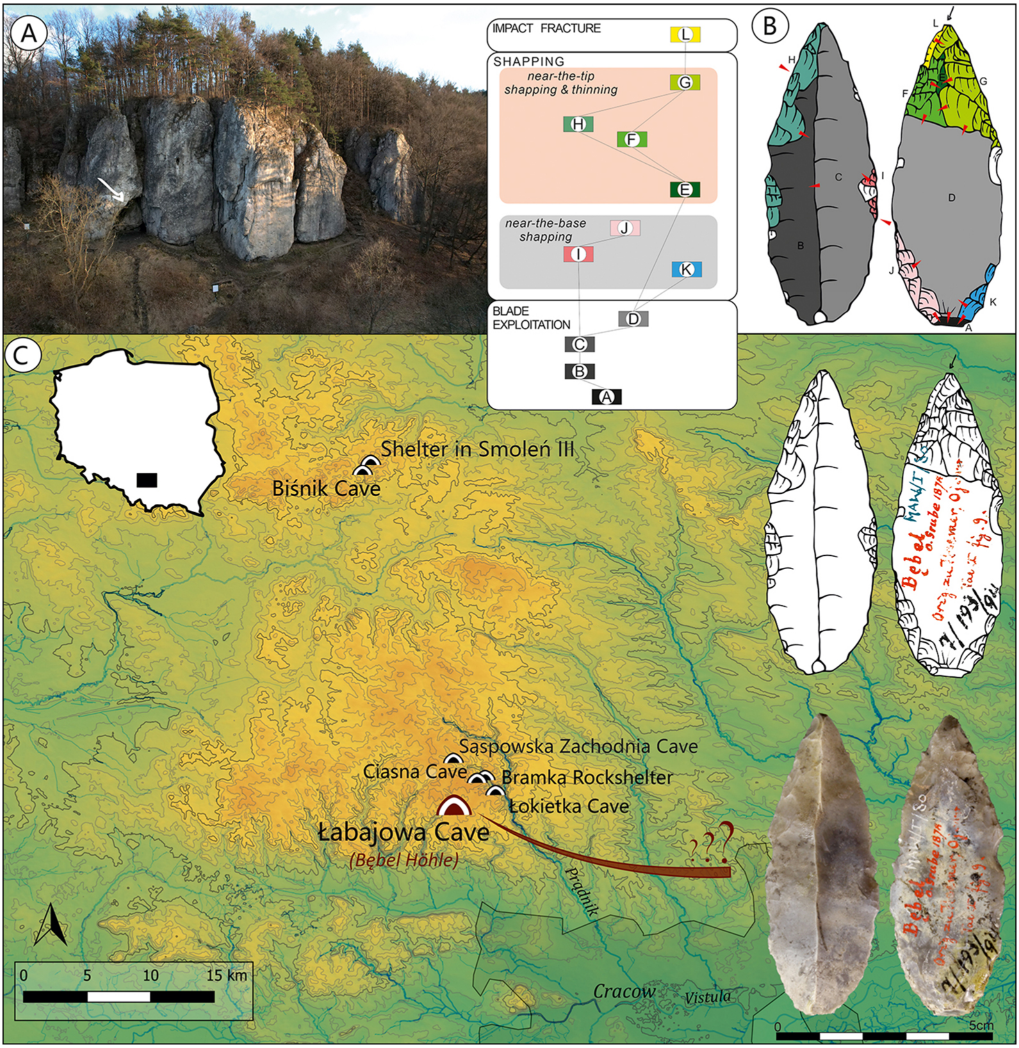

Figure 2. A) Łabajowa Cave (photograph by K. Lorek); B) leafpoint of uncertain origin found in Römer's collection and its scar pattern analysis presenting stages of tool production using a Harris matrix; C) localisation of all the sites included in the project (figure by the authors).

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Łabajowa Cave

The first phase of the project focused on Łabajowa Cave in Będkowska Valley in the southern part of the Polish Jura (Figures 2A & 2C). The site's archaeological record began when excavated by F. Römer in 1879 with an enigmatic description of combustion structures containing pottery and flint artefacts (Römer 1883, 1884). In 2018 we re-examined the F. Römer collection stored in the Archaeological Museum in Wrocław. We found that one of the Jerzmanowician leafpoints from his collection was described as coming from Bembel Höhle, the former name of Łabajowa Cave (Figure 2B). The first publication of the Römer collection (Römer 1883) indicated that the leafpoint came from Nietoperzowa Cave (eponymic Jerzmanowician site) but in the English translation of a book by Römer published in 1884 the artefact's provenance was missing.

The Jerzmanowician comprises the easternmost part of the Lincombian-Ranisian-Jerzmanowician (LRJ) complex, one of the Middle/Upper Palaeolithic transitional industries, represented by only a few cave sites in Poland (Kot *et al.* 2021). Several of them (i.e. Nietoperzowa Cave, Koziarnia Cave, Puchacza Skała, Mamutowa Cave) are near Łabajowa Cave, which makes the argument for a Jerzmanowician occupation at the site even more compelling. The scarcity of sites of the LRJ complex emphasises the question of the Bembel Höhle leafpoint's provenance and the occurrence of a related context in Łabajowa Cave.

Continuing analysis

We decided to re-excavate the site to check whether Łabajowa Cave contains traces of a Jerzmanowician occupation. In 2020, we dug a $6m^2$ trench in the middle of the old Roemer trench (Figure 3A). The sedimentary sequence consisted of the nineteenth-century trench infill (layers H1–H2) with scarce Bronze Age pottery and flint artefacts in the upper part; in the middle and bottom part, loess-like material (H3–6, H10–12) filled an erosional rill. The loess-like series was interbedded with a 250mm-thick blackish loamy layer (H8–H9) containing abundant charcoal remains (Figure 3B). The trench was excavated down to 3.5m without reaching the bedrock.

The presence of charcoal layers (H8–H9) within the sedimentary sequence can be an indicator of human occupation itself, but only a single flint chip was found within them. Based solely on archaeological materials, human occupation in Łabajowa Cave during the Palaeolithic is uncertain. Although we confirmed that Roemer's trench reached the H8–H9 layers, we need additional confirmation of possible anthropogenic inputs in the cave to confirm if the Jerzmanowician leafpoint could have been found there originally. Evidence can be obtained via PAHs analysis coupled with faecal markers. PAHs can retain details of possible causes for the formation of charcoal layers—for instance, whether the charcoal origin was anthropogenic, thereby belonging to a fireplace within the cave, or natural-environment-related, perhaps originating from wildfires outside the cave and eventually washed into the cave. Additionally, faecal markers may help us identify human presence in the cave, as shown in Krajcarz *et al.* (2013) for Biśnik Cave and in test analyses conducted for this project. Dating of the stratigraphic sequence coupled with palaeoenvironmental analysis will give us further insight into the potential Jerzmanowician attribution of the layer. The absolute chronology of the sequence will be

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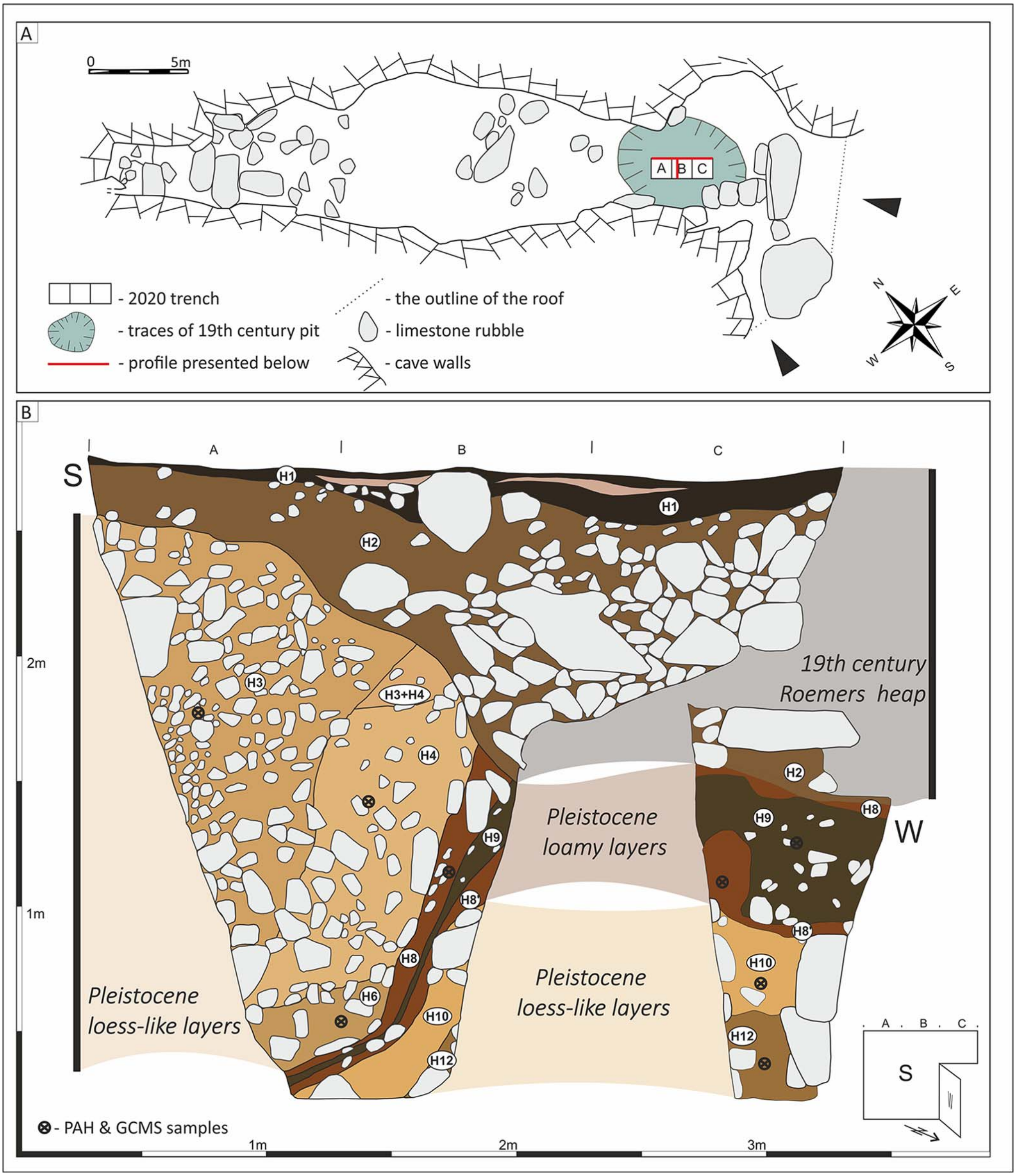

Figure 3. A) plan of Łabajowa Cave with localisation of the new trench; B) north-east profile of 2020 trench (figure by the authors).

established through optically stimulated luminescence and radiocarbon dating, which are currently taking place.

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Data availability statement

Data available within the article or its supplementary materials.

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