

Modern geology tells us about ice-age reality

Hidden Treasures

TERESA MADEYSKA

Institute of Geological Sciences, Warszawa
Polish Academy of Sciences
tmadeysk@twarda.pan.pl

When we visit caves and admire their dripstone formations, most of us do not realize how many traces of the distant past might be found in the stalagmites and stalactites, as well as in the very sediments we are walking over

The largest Polish caves are in the Tatra Mountains, where speleologists discover new corridors and chambers every year, while Poland's most beautiful of decorative cave deposits (technically called "speleothems") are to be found in Niedźwiedzia Cave in the Sudeten Mountains or in Raj Cave in the Holy Cross Mountains. From the perspective of scientific research, however, small caves where humans or animals dwelled in the distant past are of the most precious value. The preserved small fragments of caves that were once larger, rock shelters and niches are all numerously

present in the Kraków-Częstochowa Upland and sporadically in Podhale, the southern Polish region next to the Tatra Mountains. Even though archaeologists, paleontologists, and geologists have taken an interest in Polish caves for more than 130 years and have already studied dozens of sites, spectacular discoveries do still sometimes turn up.

Traces of the presence of humans and animals can be extracted from the multiple layers of sediments accumulated on the floors of such caves. Such deposits are sometimes so plentiful that they almost reach the ceiling. Precise studies aim to collect all archeological relics and animal bones, to document in 3-D their position within the individual layers of sediment, and to trace structures attesting to processes that took place in the past. Explorations carried out in this way, supplemented by laboratory analysis, yield information about climatic changes in the past, fluctuations in the environment, and the ways in which caves were used by man.

Some 25 caves and rock shelters in the Kraków-Częstochowa Upland were excavated and studied in the latter half of the 20th century. As the geological, zoological, and



The boomerang from Oblazowa Cave



T. Madzińska

Biśnik Rock near Smoleń, with the entrance to Biśnik Cave

archeological research showed, the deposits they contain come chiefly from the latest cold period (the Vistulian glaciation) and the previous interglacial, that is from the past 120,000 years. But at Biśnik Cave near Strzegowa, sediments, fauna remains, and older Paleolithic relics were discovered from the time of the penultimate glaciation and probably the penultimate interglacial, meaning that they stretch back even as much as 200,000 years.

Stones, clay, and bones

On the one hand, geological studies of cave sediments make it possible to date their individual layers via correlation with regional sediments of known age, and on the other hand, they provide a means for identifying the environmental conditions that were present during a given period. On the basis of variations in the deposits - chiefly in the amount of chemical weathering evident in the limestone debris and the amount of clay that results from such weathering - as well as other sediment properties, we can reconstruct the climatic changes that took place while these sediments were deposited.

The present author has carried out such investigations at many Polish caves, working together with archeologists and zoologists. Such collaborative research allows to closely relate geologic results to the fluctuations in qualitative and quantitative composition of animal remains, and also to cultural artifacts. We concluded that during the latest interglacial period, the Kraków-Częstochowa Upland was first overgrown with mixed forests, later by coniferous forests, which in turn gave way to patches of vegetation of the type of cold grassland or even tundra during the short cooler periods. The presence of many species of animals is closely tied to a specific types of habitat (forest, cold grasslands, tundra), and so they constitute excellent ecological indicators. Zoologists identified bone remains belonging to some 100 species of mammals and some 80 species of birds.

The caves also contained traces of human habitation. Archeologists and the present author together ascertained that representatives of Middle Paleolithic cultures utilized Polish caves during the latest interglacial and the initial stages of the Vistulian glaciation (120,000-70,000 years ago). People of the Upper Paleolithic cultures used them up until a glacier came to cover northern Poland during the peak of the Vistulian glaciation (some 20,000 years ago). The climate then was cool and quite humid, and cold grassland vegetation prevailed with clumps of coniferous forest with birch trees and patches of tundra. Fauna studies pointed to the co-existence, in changing proportions, of species characteristic to various environmental habitats, such as reindeers and lemmings typical for tundra, steppe-inhabiting ground squirrels, and forest animals like the cervids. This was the consequence of the varied landscape in the Upland, and thus the local variations in climatic conditions (the mesoclimate).

Ritual boomerang

A truly exceptional site is to be found at Oblazowa Cave in Podhale, situated on the lower part of Oblazowa Rock, which together with the neighboring Kramnica constitute the nature reserve named the "Białka River Gorge at Krempachy." Before excavations were begun, the entranceway to this small 5-by-9 meter cave was a small opening cut out in modern ages. The lower, original opening turned out to have been completely covered over by sediments gathered in the cave and on the slope of Oblazowa Rock. During the course of several research seasons, sediments were studied down to a depth of 4.5 meters. The research was led by Prof. Paweł Valde-Nowak from the PAN Institute of Archaeology and Ethnology and Prof. Adam Nadachowski from the PAN Institute of Systematics and Evolution of Animals, in cooperation with the PAN Institute of Geological Sciences.

The deepest part of the cave was filled with coarse river gravel deposited soon after the cave itself had been shaped by the Białka River. In the sediments that accumulated in the dry cave, 10 cultural levels were discovered, including artifacts from the Middle and Upper Paleolithic and from later times. All of the sediments excavated were washed through fine sieves, producing a vast collection of bone remains of small vertebrates representing species living in various environments and various climatic conditions. A comparison of the fauna composition in the successive layers, augmented by sedimentological studies, provided a picture of climatic changes in Podhale that occurred over the past 100,000 years. Compared to the Kraków-Częstochowa Upland, Podhale experienced colder climatic conditions and a smaller degree of environmental variation, due to the close presence of the Tatra Mountains, then under glaciation.

The most interesting unique finding made at Oblazowa Cave consists a set of artifacts from the Upper Paleolithic.

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Aside from tools made of flint, this set of findings includes a boomerang made of mammoth tusk, pendants made of arctic fox teeth and *Conus* shells, and two small human bones, i.e. phalanges (finger bones). These artifacts lie within large stone encirclements, and a detailed sediment structure analysis showed that they were all located on an elevated platform, which was approached through a pit dug out near the entrance to the cave. Professor Valde-Nowak interprets this set of artifacts as the remains of a Paleolithic sanctuary, and the presence of the two human phalanges (given the lack of any other human bones) as evidence of a ritual cutting off fingers, a practice known to ethnographers and observed at other archeological sites. Under this interpretation the boomerang was not used for hunting, but was rather a cult object.

History in isotopes

More information about climatic changes in the distant past can be gleaned from speleothems, or dripstone formations in caves. Traces of uranium and thorium present in calcite, the main component of these formations, can be studied to identify how long ago they crystallized (one of the radioactive uranium isotopes on its breakdown changes into radioactive thorium at a known rate). As a result they can be used to determine the age of caves, and also – indirectly – to date various archeological discoveries. Speleothems grow during warm and humid periods conducive to the development of vegetation, and come to a standstill during dry and cold periods. On the basis of many such datings, Helena Hercman from the PAN Institute of Geological Sciences has identified periods of speleothem crystallization in various regions of Europe over the past 200,000

years. These results, correlated with the global curve for the variation of the oxygen isotope composition in the shells of oceanic foraminifers (considered to be one of the best records of world temperature changes), may be used to reconstruct climatic changes.

The oxygen and carbon isotopes present in speleothems can also be useful in cave research. Oxygen isotopes offer information about changes in the temperature present in a cave when such deposits were being formed. Carbon isotopes, in turn, to a certain extent reflect the lushness of the vegetation growing on the surface above the cave.

Geological research thus constitutes an excellent supplement to archeological and paleoecological research in caves. These natural refuges, history's first "boarding-houses," offered excellent shelter and thus played host to many guests who left traces behind, like a hotel register. Today these traces are like treasure for scientists, but also – unfortunately – for many traders and pseudo-collectors who thoughtlessly disturb the natural array of the layers of cave sediments and decorative formations, forever preventing research from being carried out. ■

Further reading:

- Valde-Nowak P., Nadachowski A., Madeyska T. (eds.) (2003). *Oblazowa Cave - Human activity, stratigraphy and palaeoenvironment*. *Wyd. Inst. Arch. Etnol. PAN*.
- Cyrek K. (ed.) (2002). *Biśnik Cave - Reconstruction of cave habitation against the backdrop of the natural environment* [in Polish]. *Wydawnictwo Uniwersytetu im. Mikołaja Kopernika w Toruniu*.
- Hercman H. (2000). Reconstruction of palaeoclimatic changes in Central Europe between 10 and 200 thousand years BP, based on analysis of growth frequency of speleothems. *Studia Quaternaria* 17, 35-70.



View from Oblazowa Rock, towards the Białka River Gorge at Krempachy

T. Madeyska