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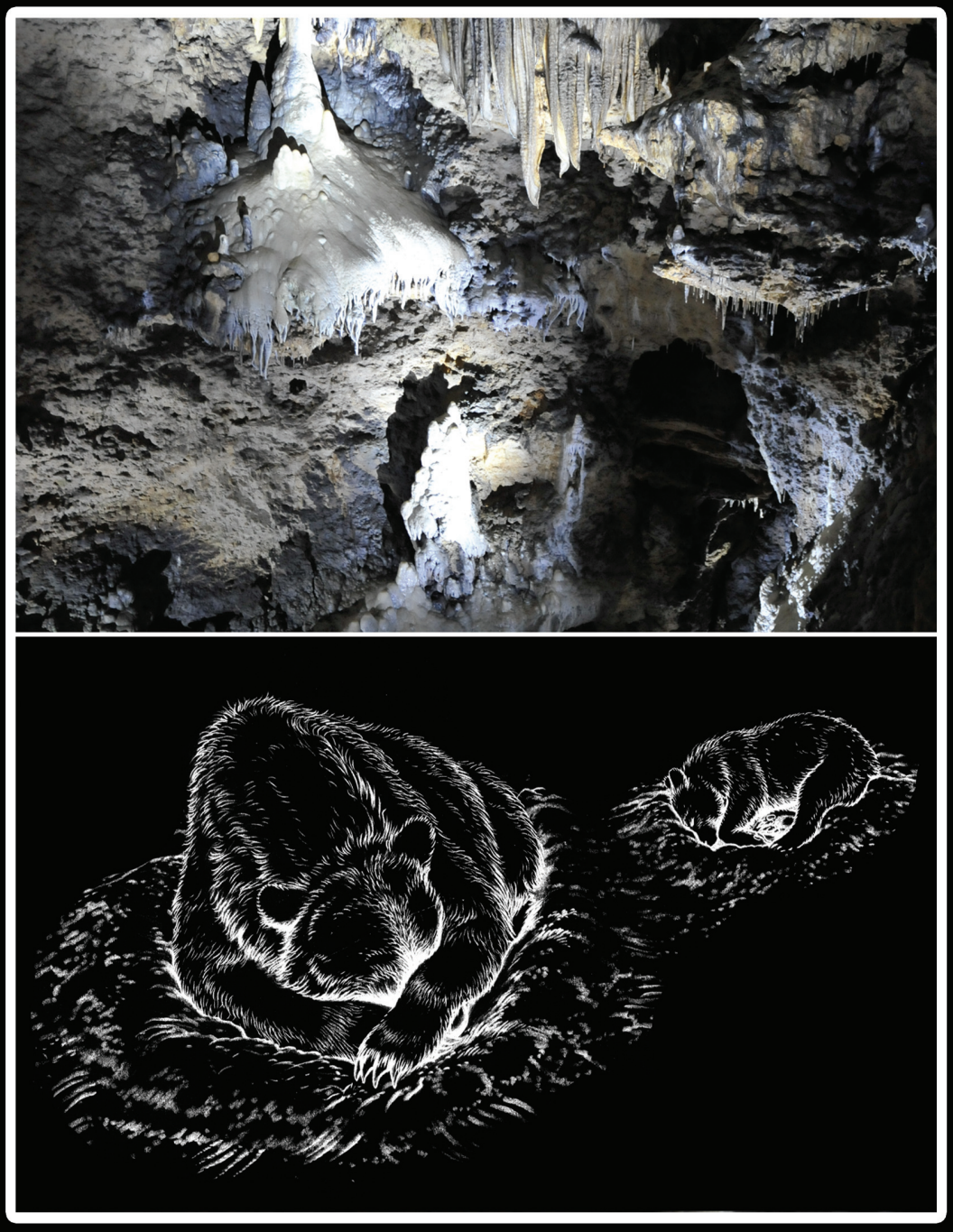
# Famous Planet Earth Caves

# Sophie's Cave (Germany)

## A Late Pleistocene Cave Bear Den

### Volume 1



Cajus G. Diedrich

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# Famous Planet Earth Caves
# Vol. 1

# Sophie's Cave (Germany) - A Late Pleistocene Cave Bear Den

**Authored By**

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## Famous Planet Earth Caves

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# FOREWORD

This book is focusing on a Late Pleistocene cave bear den in central Europe, which cave bear dens are larger cave systems, mostly filed up with ten thousands up to a half Million of cave bear bones. Herein, not only the bones of the Sophie's Cave in Upper Franconia, Bavaria southern Germany) are studied – it is the "den" and its change within 100.000 years and its interesting Wiesent valley sided position to the river terraces (or probably valley glaciers) within the Last Ice Age. These interdisciplinary sedimentological studies make the cave locally important for the geomorphology development of the past 5 Mio years and important to the questions of "glacial signs" in Upper Franconia. The cave bear research of the past 10 years has changed drastically the picture of "the cave bear" of the former Kurtén 1976 and Rabeder et al. 2000 cave bear books – which bears are indeed today splitted by DNA and osteometrical newest studies on skulls and teeth (= "cave bear clock") into several species and subspecies within the Late Pleistocene – the past 113.000 years. The cave bear ethology was for long misunderstood about European "cave bears", because all the extinct top predtors - steppe lions, Ice Age leopards, Ice Age spotted hyenas, and Ice Age wolves - the antagonists of cave bears, were not included into the "cave bear story". The predation and scavenging of cave bear carcass explained with perfect examples not only the Sophie's Cave cave bear bone taphonomy, and finally explained their deep hibernation in caves as protection against predation, such as the non-existence of "Neanderthal bone flutes", which were simply products of scavenging hyenas on cave bear cub hind leg bones. Whereas the large predators are few represented in the bone record, typical in Early/Middle Late Pleistocene middle high mountain boreal forests with nearly absence of the mammoth steppe game, quite unique in the European fossil record is a nearly complete Late Pleistocene weasel skeleton and den documentation. The herein presented Sophie's Cave and other caves of central Europe are international important furthermore due its contribution to the understanding of the "cave bear" exctinction, which can be demonstrated to be a chain reaction starting with climate change, boreal forest and food source disappearance up to the Last Glacial Maximum, and predation stress by Cromagnon humans or large carnivores. It is the first cave, where in Europe a Late Palaeolithic shamanic related reindeer antler/bone depot is proven explaining now the absence of "Ice Age cave art" in German and other western European caves. This Gravettian sanctuary falls within the main "cave bear" hunt period (Aurignacien-Gravettian) of the last and largest European cave bears.

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Former Scientific Leader Heimatmuseum Schloss Hohenlimburg,
Alter Schlossweg 30, 58119 Hagen-Hohenlimburg,
Germany

# PREFACE

The new Famous Planet Earth Caves e-book series challenges to present important caves all over the world scientifically, but somehow also popular in a mixture, that non-experts can understand their main importance. The Sophie's Cave in southern Germany belongs obviously to one of the oldest show caves in Germany and Europe and has a long Earth history starting 5 My ago with most importace for the Ice Age and its impact for the landscape reconstruction of northern Bavarian, Upper Frankonia. This is a beautiful dolomite rock and valley landscape, that became famous already in historic times. It was visited by many first and famous natural scientists from England (Buckland), France (Cuvier) and Germany (Goldfuss). The book is interdisciplinary but with a strong focus on its main importace – a Late Ice Age cave bear den within a former boreal forest environment of the medium high up to 550 a.s.l. elevated Franconia mountains. It presents a first detail scientific work after more then 150 years of non-research about the complex cave use by different cave bear species and subspecies, and their predation by lions, hyenas and wolves. It is completely different to the classical and old cave bear books, and updates much the knowledge about small and large cave bear ecology in Europe and their life and battle to survive in boreal forest mountain areas of central Europe, which was long misunderstood due to detail work lack about the top predators of Europe – the last lions and hyenas. Those specialized in mountain areas on cave bear feeding well to see at the Sophie's Cave bone material. The new systematic excavations are well documented, and are illustrated with the cave inhabiting or dwelling animals in action and "night-google vision cave view" – a new way of illustrating by a famous Ice Age artist, who painted also for the famous Beringeria Visitor Center in Youkon, Canada. From the archaeological view, the cave has another unique record, a larger reindeer antler and bone depot within the most nice speleothem decorated hall. Early modern Cromagnon humans of the Gravettian came into this cave-rich region for hunting migrating reindeeer herds in the steep valleys, but here in Upper Franconia, those did not paint or left engravings of animals mainly such as in Spanish and French caves. Here, and at other caves in Germany, shamanism was practiced by the Late Palaeolithic reindeer hunters similar as modern Scandinavian Sami people did until the Medieval times – depositions of antlers of their most important game, the reindeer at religious places. Finally the book gives a first insight about the typical modern cave animals, and postglacial use by Bronze Age, Iron Age and Medieval people, which resettled the valleys and cave entrances of Upper Franconia.

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# ACKNOWLEDGEMENTS

According to his unexpected race car accident in 2013, the book is dedicated to Mr. Wolfgang Dess. The project was supported by the cave owners Mr. W. and Mrs. S. Dess who financed the field work and science with their company Dess Grundstückverwaltungs GmbH & Co KG. Mrs. W. Wedewart gave logistic help. The cave guide Dr. T. Striebel, was responsible for further cave explorations and openings of cave branches, and supported with a new cave map ("cross section") and elevation point data. He finally curated the bones from the castle, which were rediscovered in 1998, and are now integrated in the collection of the museum. Thanks goes also to several junior and senior cavers from the speleoclubs Höhlengruppe DAV Erlangen, Speläogruppe Nordostoberfranken, Höhlenforschungsgruppe Blaustein (=HfgB) who helped in the bone cleaning and sediment sieving: S. and J. Uhl, I. and P. Heubes, N. Hedler, N. Niedling, M. and D. and K. Zistl., C. Moosdorf. M. and M. Conrad gave much help during the first and difficult "Hösch Cave" exploration and supported with cave equipment. M. Harder (speleogroup Forschergruppe Höhle und Karst Franken = FHKF) did the bat identification and supported with information on modern cave animals. Dr. H. Schabdach (also FHKF) gave personel information on the cave which allowed the rediscovery of three cave bear skulls in the Reindeer Hall; additionally, he was responsible over 15 years for the protection and study of the modern water organisms in the cave. Additonal thanks goes to Dr. H. Schabdach and R. Schoberth for the permit to use the preliminary basic cave maps. Futhermore, Mrs. R. Illmann (FHKF) send copies of the Staatsarchiv Bamberg from the years 1833-1837 concerning the historic conflicts between Graf zu Münster, Graf von Schönborn-Wiesentheit and the former inner ministery under King Ludwig. Dr. G. Schweigert from the Staatliche Museum für Naturkunde Stuttgart determined several fossils of the "Jurassic sponge reef fauna". PD Dr. G. Rösner supported with a photo of the lion jaw in the Bayerische Staatssammlung für Paläontologie und Geologie München. Pottery fragments were determined in their age and cultural relationship by Dr. W. Bleicher, who also gave information on shamanism about reindeer antler depots of the Oeger Cave (Sauerland), and from Russian historical antler deposits made by Sami. The two $C^{14}$ analyses were thankfully made by D. Hood from the Beta Analytic Laboratory, Florida, USA (www.radiocarbon.com). Final thanks go to the biologist L.T. Parker for the time-consuming spell-check proof reading and helpful comments.

## CONFLICT OF INTEREST

The author confirms that this chapter contents have no conflict of interest.

# COLLECTIONS

The Jurassic fossils, such as all Pleistocene animal bones and archaeological finds found in 2011 are housed in the Rabenstein Castle Museum (= **MBR**). Two cave bear skulls, other cave bear bones, as well as bones from a horse and woolly rhinoceros are kept in the Urweltmuseum Oberfranken in Bayreuth (= **UM-O**). A lion's lower jaw is still present in the Bayrische Staatssammlung für Paläontologie der Universität München (= **BSP**), which was figured herein. The hyena jaw is stored in the British Museum of Natural History London (= **BMNHL**). A cave bear skull and some bones taken in the 80' ies from the cave were allowed to figure from the private Mr. H. Buchhaupt collection (= **BHC**).

## CONTENT

One of the historically oldest discovered German show caves, the Sophie's Cave, in the Upper Franconia Mountains karst landscape of southern Germany (Bavaria) was opened in 1833 for visitors. The cave is reviewed in its history, geology and geomorphological valley development since Pliocene times, cave genesis and refill by sediments, and with many historical and new archaeological and palaeontological bone finds, especially cave bear remains. It is of European-scaled importance for the Late Palaeolithic cave archaeology, and Late Pleistocene palaeontology such as local climate and landscape change reconstructions. The cave supports to explain the European cave bear evolution and palaeoecology, especially the interactions between cave bears and their main antagonists – the largest top predators steppe lion prides or single leopards as bear killers deep in caves, or Ice Age spotted hyenas and wolf packs as scavengers and main carcass destructors and bone crushers. In Europe for the first time a documented weasel den was present which small carnivores used parts of the cave. Also quite rare are indirect proof (bite marks on cave bear bones) of Ice Age porcupines. Late Palaeolithic reindeer hunter humans (Gravettians) used finally a single central and by speleothems nice decorated hall area as sanctuary and deposited mainly large male shed reindeer antlers (over 100) for most probably shamanic rituals (antler $C^{14}$-dated: 30.833-30.340 cal. BP), which bone depot includes possibly even a mammoth pelvic (coxa $C^{14}$-dated: 29.340-28.600 cal. BP). Several thousands of years after a main cave ceiling collapse period and several passage or entrance blocking within the maximum glaciation (around 19.000 BP), Iron Age and Medieval humans finally used only anterior cave parts such as the yard in front of the cave and the lower cave parts. The cave is used modern by different cave dwelling or inhabiting animals (rarely bats), including small possibly endemic water related arthropods or annelids.

CHAPTER 1

# INTRODUCTION

**Abstract:** The Sophie's Cave (Bavaria, Germany), is one of the oldest show caves in Germany, and even one of the famous Late Pleistocene cave bear den caves in Europe. The cave is situated with several other famous and larger cave bear den caves, such as the Zoolithen Cave and Große Teufels Cave (latter also show cave) in one of the most cave-rich regions of Germany, the Franconia Karst especially along the Wisent and Ahorn River valleys. The confusing names of the "Rabenstein Cave" (because of its close topographic situation to the Rabenstein Castle), and later named Sophie's Cave cave parts were renamed systematically. Along the historical wooden steps and trail several sherded ceramic lamps and pottery pieces were found, which are from the "oldest cave lighting system" known in a German show cave reaching back to its discovery in 1833. After the first report of the cave by the German priest Esper in 1774, several famous European natural scientists such as Rosenmüller, Goldfuss, Graf zu Münster, Buckland and Sternberg collected or started to describe first bone finds from the first discovered cave parts, which material went partly to Prague, Bayreuth or are lost. The youngest historical finds which seem to be in connection with the visitor show cave are few militaria from the King Ludwig I (1825-1848) regentship time.

**Keywords:** Sophies's Cave (Bavaria, Germany), large cave bear den Franconia Karst, show cave, cave discovery and exploration history since 1833, renaming of cave parts, oldest German cave lightening lamps preserved, militaria finds.

## LATE PLEISTOCENE CAVE BEAR DENS IN UPPER FRANCONIA (SOUTHERN GERMANY)

Within the Late Pleistocene (116.000-24.000 BP), Millions of "cave bear" ("*Ursus spelaeus* Rosenmüller 1794" in former times) bones of about four different species and subspecies accumulated in many cave bear den caves of Europe, especially in lime-stone/dolimite rock and cave-rich regions within middle high elevated boreal forest conditions (Sauerland, Harz, Franconia, Swabian and Alpine Karst) [1 - 22]. The German localities are compiled herein in an overview map of important and larger Late Pleistocene cave bear dens of Germany (Fig. **1A**), including the herein described southern German Sophie's

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Cave of Upper Franconia, Bavaria (Fig. **1B-C**).

Along the northern Bavarian Upper Franconia Wiesent and the adjacent rivers, more than 500 small caves and a few large ones were discovered [23 - 35], but few of them contain many cave bear or other in few amounts other megafauna bones (Fig. **1C**) [7, 22, 29]. Such Pleistocene fossil bones became known in this region by initial descriptions of the German priest Esper in 1774 due to first cave bear and other bone finds of the "great deluge times" [36] or first "hyena den cave" studies in the König-Ludwig's Cave (opposite Sophie's Cave, Fig. **1C**) by the English lord Buckland in 1823 [37]. In some of the Upper Franconia cave bear den caves, cave bear traces were found [38 - 40] in the form of cave bear polished corners, scratch marks on walls or hibernation nest depressions, which latter are named ichnologically *Ursalveolus carpathicus* Diedrich 2011 [41]. Cave bear footprints, named as *Ursichnus europaeus* Diedrich 2011, are not yet described from Upper Franconia or any other German caves. The best and most preserved long overlooked cave bear nests were mapped [7] and are described and figured herein for the Sophie's Cave. Bones accumulated partly over 100.000 years (and even longer since Middle Pleistocene Elsterian/Saalian [42], *e.g.* Zoolithen Cave and Zahnloch Cave) mainly in five of the larger Upper Franconia cave bear dens (Geisloch, Zoolithen, Sophie's, Große Teufels Caves, Genther Cave) (Fig. **1C**) [7]. These caves have each delivered several thousands of cave bear bones already starting with the "Spaten-forschung" in historic times [1, 2, 8, 21, 22, 25, 35 - 37, 42 - 44]. They still contain a high amount of bones including other rarer Late Pleistocene boreal forest and very few mammoth steppe valley migratory fauna animals (less than 3% in cave bear dens of Upper Franconia, imported into hyena/wolf dens) such as documented recently for the Sophie's [7, 45] and Zoolithen caves (Fig. **1C**) [42, 44, 46, 47]. Those eight cave bear dens are the most important ones in Upper Franconia, especially concerning the Late Pleistocene megafauna, which are clues for the European megafauna distribution including the cave bears, their ecology and evolution, or climate, geomorphology, and vegetation/glacier area reconstruction models [7]. From other caves (Neideck, Wunders, König-Ludwig caves), additional bone remains are known, but in much lesser amounts, which are often not well analysed yet.

At the Upper Franconia Zoolithen Cave, the first "*Ursus spelaeus* cave bear"

holotype skull of Europe was discovered which was described first by Rosenmüller 1794 as an "extinct bear" [43, 47], it being recently revised to represent a skull of a subadult animal of the large cave bear "*Ursus ingressus*" [42]. The Zoolithen Cave bone taphonomy and several species were reviewed in the past five years with all its rediscovered Pleistocene lion, wolf, wolverine and hyena and cave bear holotype skulls [42, 44, 46, 47] which material is also important to understand the Sophie's Cave fauna and in larger scale boreal forest megafaunas of the last Ice Age in central Europe with cave bears being hunted and consumed by top predators, Ice Age wolves, Ice Age spotted hyenas and steppe lions [45].

This Zoolithen Cave is few kilometers southwest (Fig. **1C**) from the herein completely new explored, partly excavated, interdisciplinary analysed and by literature reviewed Sophie's Cave cave bear den (Fig. **1B**), of which some newer results have been published recently [7, 45]. In these Late Pleistocene middle high mountainous boreal forest region modern excavations, analyses of historical and new excavated bone material were missing for long. Also the large cave bear den Geisloch Cave (Fig. **1C**) is unstudied in a modern palaeontological/ sedimentological and cave bear find analyses [40], similar as the Große Teufels Cave, the second bone-rich show cave in Upper Franconia (Fig. **1C**). All other caves are partly unexplored or have delivered only few cave bear finds (*e.g.* Neideck Cave, Zahnloch Cave, Fig. **1C**) [7, 29].

After extensive historical "pickaxe and shovel excavations" or "cave bear bone hunts" in the Sophie's Cave and other Upper Franconia (especially Zoolithen Cave) [1, 2, 25, 35, 36, 37, 38, 42, 43] and several other European caves (e.g. Baumann's, Hermann's, Perick, Zoolithen, Mixnitz, Sloup, Sophie's caves) [1 - 22] "cave bear skeletons" were mounted in many show caves and several European museums, in all cases incorrectly or incomplete. It is known today, that those are composited of different cave bear individuals, age classes, sex and even subspecies [e.g. 14, 42] such as found still today in the Große Teufels Cave cave bear composite skeleton. Herein, for the first time, a small cave bear skeleton is arranged from the Sophie's Cave material anatomically nearly complete and correct at least using adult small cave bear subspecies material, that has included unique to Europe added to a skeleton, the nine "tongue bones" (see Chapter 3).

CHAPTER 2

# GEOLOGY OF THE CAVE ROCKS IN UPPER FRANCONIA

**Abstract:** The white-yellowish, massive Upper Jurassic dolomite reef rocks (155-150 My) of Upper Franconia are famous for climbers, because of its rich cavities, partly caused initially by burrowing marine crustaceans (= Lochkalke), partly due to rock-weathering and cave erosion. It is one of the most cave-rich regions in Europe counting several hundreds of mainly smaller caves, and few very large cave systems. Those are situated on the Upper Franconia Plateau, which is cut by the Wiesent and smaller branching river valleys. The Late Jurassic fossils (ammonite steinkerns, and metasomatic changed silified and originally calcite reef fossils) found within Pleistocene sediments of the Sophie's Cave supports reconstructing the Pliocene plateau and Pleistocene valley erosion history and geomorphological changes in the surroundings.

**Keywords:** Upper Franconia dolomite karst, European cave-rich region, Late (White) Jurassic reefs, metasomatic changed reef fossils, geomorphology change reconstruction.

## GENERAL GEOLOGY OF CAVE-RICH UPPER FRANCONIA

Upper Franconia has two different main geological regions: the western Mesozoic more or less horizontally deposited marine series ranging from Jurassic to Cretaceous, and the eastern to Czech Republic overlapping old Bohemian Massif rocks consisting of Palaeozoic sediments, but mainly of metamorphites, plutonites and vulcanites (Fig. **1**) [1 - 3]. The cave-rich-region is limited on the western part within Late Juarassic marine sediments. In most areas of Upper Franconia the morphological slope (= "Albtrauf" in German) [1 - 3] is built of those cave-rich massive Late Jurassic dolomites and thick-layered limestones [4], which were built within the 150 My old Late Jurassic (in southern Germany, = White Jurassic, Fig. **1**) [1 - 4] under a warm, tropical, shallow shelf and lagoon in Germany (Fig. **2**) [4].

**Cajus G. Diedrich**

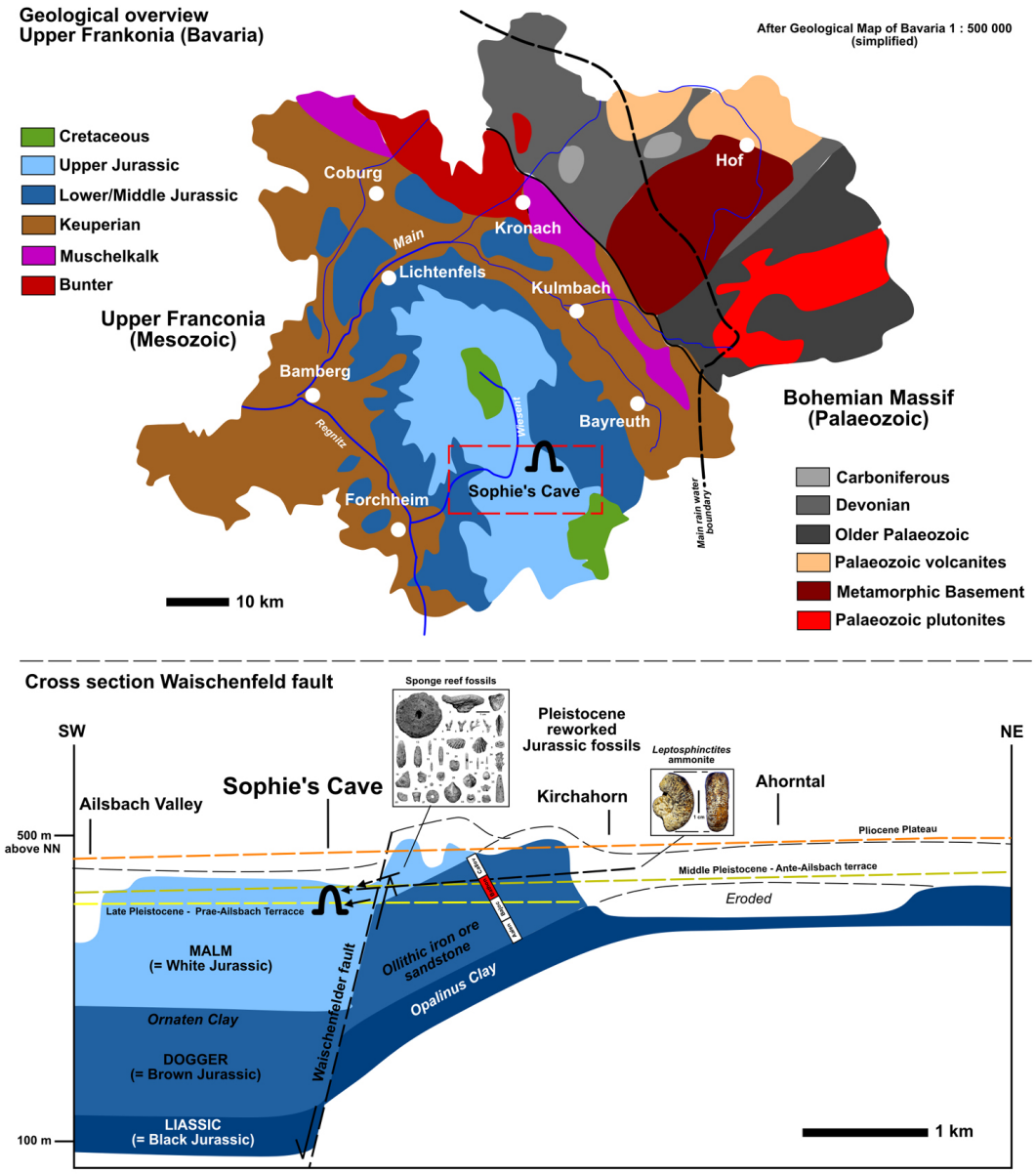


**Figure 1.** Geological overview of Upper Franconia and cross-section along the Ailsbach Valley, Ahorn Valley depression and Waischenfeld fault, and former elevations of the river terraces. The fossils found in the Middle/Late Pleistocene sediments of the Sophie's Cave are from the surrounding Brown and White Jurassic, whereas quartz pebbles are from nearby Lower Cretaceous sandstones (geology modified after [1, 2]).

The up to several decameters massive dolomites, well exposed above the Sophie's

Cave entrance (Fig. **2**), were deposited on the western margin of the Bohemian Massif. This Massif built a main land area during the Central European Jurassic Sea time, whereas during this same time period along the northern German and along the London-Brabant Massif mainland coasts large dinosaurs migrated [5].

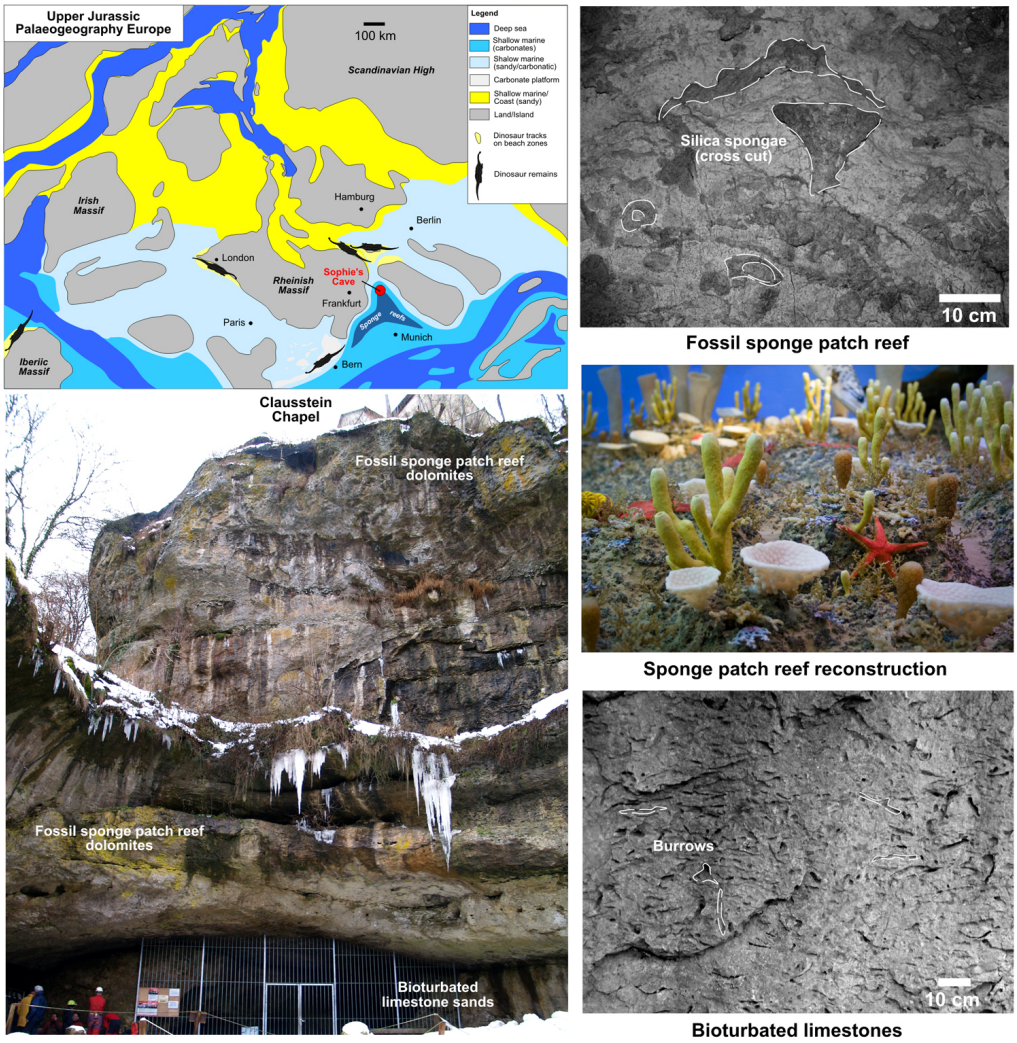


**Figure 2.** Upper Jurassic Palaeogeography, dinosaur sites and Bavarian sponge reef and lagoon facies within the northern Tethys Ocean [5]. Shrimp (such as similar to modern mud shrimp) bioturbated (= *Thalassinoides/Spongeliomorpha* burrows) in shallow marine Upper Jurassic calcareous sediments (= "Lochkalke") between the reef complexes (wall entrance Sophie's Cave), and in the cave relief-like weathered silificated spongae in the Collapse Hall, such as reconstruction of small sponge-patch reef builders (reef reconstruction, Staatliches Museum Naturkunde Stuttgart).

CHAPTER 3

# PLIO- TO MIDDLE PLEISTOCENE SEDIMENTOLOGY, CAVE GENESIS AND AILSBACH VALLEY GEOMORPHOLOGY

**Abstract:** The Sophie's Cave in southern Germany, in the middle high elevated (max 550 m a.s.l.) mountains of northern Bavaria, was formed by Pliocene subsurface ground waters of the Upper Franconia Jurassic Plateau (about 440 a.s.l.). In the ponor cave stage of Early Pliocene age, the horizontal system which started to refill partly with about 3-4 m iron-and manganese-rich clays and dolomite ash sands (= coloured series). Within the intermediate cave stage in the Early-Middle Pleistocene, the Ailsbach River valley lowered from 440 to 420 m a.s.l. In the Middle Pleistocene, fluvial sediment intruded only from the valley side into the Sophie's Cave from above the Clausstein Hall vertical shaft consisting of 8 m thick river terrace clay, sand and gravel (= "yellow series"). A first Middle Pleistocene (?Holsteinian Interglacial) speleothem generation formed on the top. Middle Pleistocene marten *Martes* sp. used some parts at minimum in the Clauststein Hall as a den and left some tracks on muds being the first known Middle Pleistocene footprints named herein *Martichnus desseri* nov. ichnogen. and ichnosp. in Europe, which were casted and preserved by the speleothem layer. These Middle Pleistocene cave sediment and speleothems eroded somehow within the late Middle Pleistocene (?Saalian) in the valley sided cave branches by intruding floods.

**Keywords:** Pliocene to Middle Pleistocene, sedimentology, Ailsbach Valley geomorphology, *Martichnus desseri* nov. ichnog. and ichnosp., marten den.

## PLIOCENE/EARLY PLEISTOCENE (5.3-1.8 MY) – CAVE GENESIS/ REFILL

The Ahorn Valley has the most dense number of caves in the Upper Franconia karst, although most of them are only small clefts or cavities [1 - 11]. The really large caves of the region, which are mostly horizontal ponor caves in their initial stages, are the König Ludwigs Cave, with its large entrance portal and one single, giant chamber (385 m a.s.l., historically also named "Kühloch" [12]). This cave is

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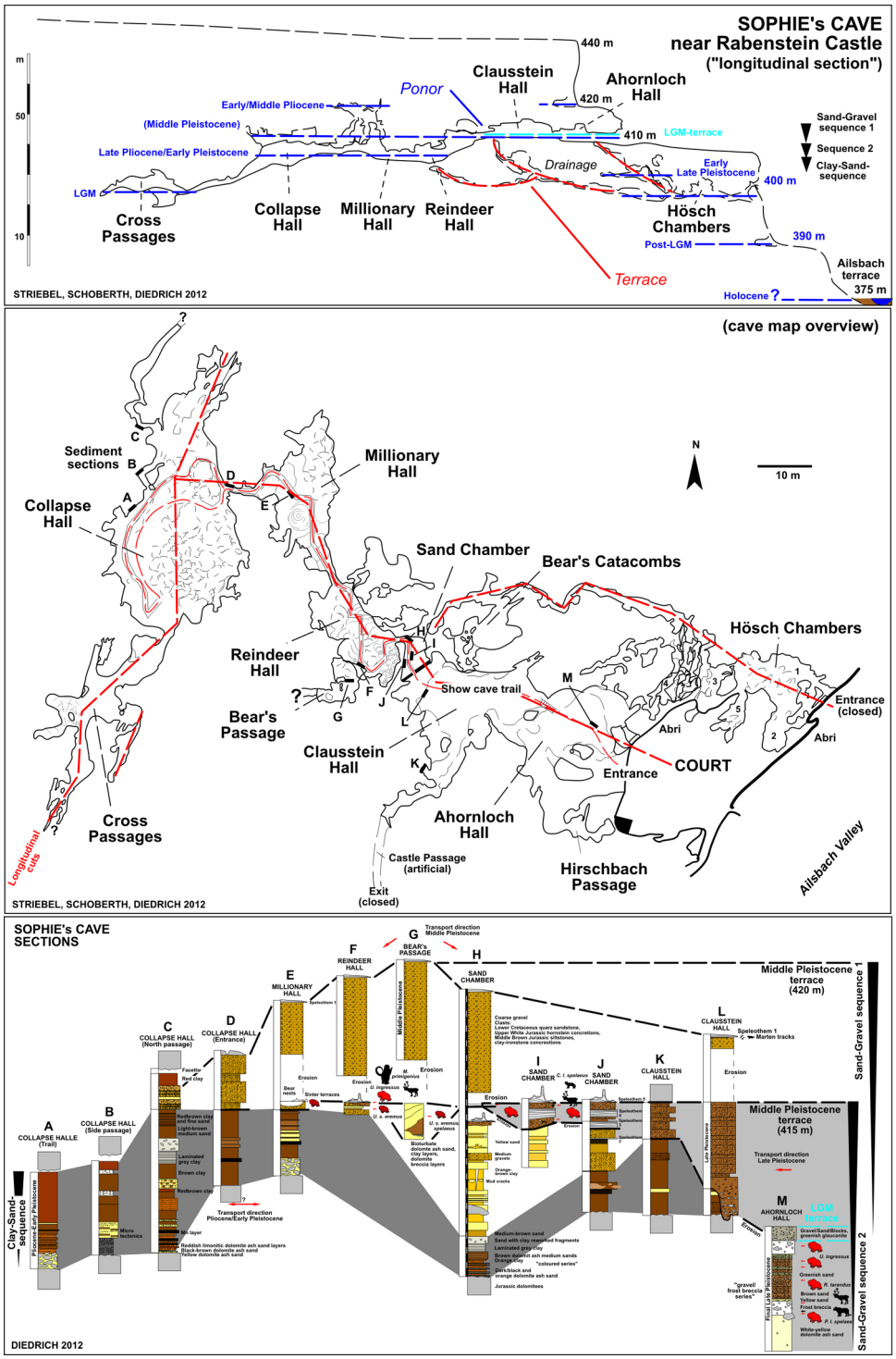
situated within the Ahorn Valley opposite the higher elevated Sophie's Cave (411 m a.s.l.). Other larger caves at different elevations between 460 to 420 m a.s.l. with Late Middle to Late Pleistocene vertebrate bone content and bonebeds are the Große Teufels Cave, Moggaster Cave, Zoolithen Cave, or Geisloch Cave such as Zahnloch Cave (see Chapter 1, Fig. **1**) [13, 14]. Smaller caves contain lesser amounts of non-studied or species determined or dated cave bear remains: Neideck Cave, Wunder Cave and Esper Cave [13].

The karstification of the dolomite reef rocks have a longer earth history record starting already in the Late Cretaceous and Palaeogene [15], which can be reconstructed in detail following classical cave genesis and filling and speleogenesis models [16 - 22] which can be transferred also to the Sophie's Cave, which will be a guide for many other similar elevated caves around 410 m a.s.l, especially of Upper Franconia (*e.g.* Große Teufels Cave). Using sediment grain sizes (clay, silt, sand, gravel), the types of sands (dolomite ash, silica sand), their different colouring (manganese - black, iron limonite – orange/red), and the presence and absence of Jurassic fossils (see Chapter 2, Fig. **3**) from different originating strata (Fig. **1**), the refill history of the cave with fluvial/(?glacial) sediments can be subdivided into three main phases [13].

The cave forming started within the groundwaters of the Pliocene plateau, along the more or less horizontal layer discordances, but also diagonally within the clefts (Fig. **1**). The Sophie's Cave eroded into the massive sponge reef dolomites of the Late Jurassic (Malm Delta), with massive rocks building the plateau and highest peaks within Upper Franconia (Chapter 2, Fig. **1** - **2**) [13 - 15]. The passages are oriented mainly on cleft systems running NNE-SSW [23]. The cave is near the Waischenfeld Fault, where the Mesozoic layers moved along a main fault (Chapter 2, Fig. **1**) [24]. The Ahorn Valley saddle structure [24] was eroded (calculated on the Sophie's Cave sediments) already by the Pliocene, but was further deepened in the Middle Pleistocene, and received its bowl-like basin structure in the Late Pleistocene (Chapter 2, Fig. **1**) [13]. The ancient Pliocene cave river (elevation about 410 m a.s.l.) cut deeper and deeper into the first pipe system and built most of the cave system known as ponor cave, similar to all the surrounding caves (*e.g.* Bing Cave [25]).


SOPHIE's CAVE
near Rabenstein Castle
("longitudinal section")
440 m
420 m
410 m
400 m
390 m
375 m
Ponor
Clausstein Hall
Ahornloch Hall
Early/Middle Pliocene
(Middle Pleistocene)
Late Pliocene/Early Pleistocene
LGM
LGM-terrace
Drainage
Early Late Pleistocene
Post-LGM
Holocene ?
Terrace
Sand-Gravel sequence 1
Sequence 2
Clay-Sand-sequence
Cross Passages
Collapse Hall
Millionary Hall
Reindeer Hall
Hösch Chambers
Ailsbach terrace
STRIEBEL, SCHOBERTH, DIEDRICH 2012
(cave map overview)
Sediment sections
Millionary Hall
Collapse Hall
Sand Chamber
Bear's Catacombs
Hösch Chambers
Reindeer Hall
Show cave trail
Bear's Passage
Clausstein Hall
Entrance (closed)
Abri
COURT
Entrance
Ahornloch Hall
Castle Passage (artificial)
Hirschbach Passage
Exit (closed)
Ailsbach Valley
Cross Passages
Longitudinal cuts
N
10 m
STRIEBEL, SCHOBERTH, DIEDRICH 2012
SOPHIE's CAVE SECTIONS
Middle Pleistocene terrace (420 m)
Middle Pleistocene terrace (415 m)
LGM terrace
Sand-Gravel sequence 1
Sand-Gravel sequence 2
Clay-Sand-sequence
DIEDRICH 2012

# CHAPTER 4

# THE EARLY/MIDDLE LATE PLEISTOCENE CAVE BEAR DEN

**Abstract:** With the beginning of the early Late Pleistocene glacial period (or even earlier: ?late Saalian/Eemian) and Ailsbach terrace elevation 415 m a.s.l., small cave bears penetrated only a side branch (Bear's Passage) the Sophie's Cave and used it as den. Nine cave bear nests *Ursalveolus carpathicus* Diedrich 2011 were documented with larger to medium-sized round-oval depressions in the deepest cave bear den part of the Millionary Hall. Autochthonous cave bear skeletal parts, especially partly connected vertebral columns were found in all den areas of the Bear's Passage, Reindeer Hall bone field and the Millionary Hall, partly being in place. A systematic excavation of the bone field, which was left in the cave *in situ* (also for visitors) demonstrate a mainly adult population within this hall. Using a combination of the skull shape morphology, P4 tooth morphology and $C^{14}$ dated teeth from other German/European cave bear dens, the small cave bears of those cave areas can be identified as small cave bears *U. spelaeus eremus/spelaeus* Rabeder *et al*. 2004. A new composite skeleton including male/female adult-senile bone material from different individuals was arranged for "*U. s. cf. eremus*" which is presented in a show case within the cave, which is anatomically nearly complete including in Europe unique for a "skeleton" all nine "tongue bones". These small cave bears also being known from the nearby Große Teufels Cave, Zoolithen Cave inhabited in Upper Franconia the Sophie's Cave and other caves between approx. 113.000-32.000 BP dated biostratigraphically with the P4 tooth morphology. With the P4 morphotypes blocking events can be coarsely estimated, whereas most primitive three-coned forms appear in the deeper Millionary/Reindeer halls and Bear's Passage. Only in the latter higher evolved forms demonstrate a longer use of this branch which was blocked to the Reindeer Hall most probably during an interstadial (possibly around 42.000 BP). At the end of the middle Late Pleistocene, finally the former still unknown entrance was also blocked, which did not allow smaller cave bears to use the cave as a den anymore.

**Keywords:** Early/Middle Late Pleistocene, sedimentology, terrace gravel infill, Ailsbach Valley geomorphology, small cave bear species/subspecies, cave bear clock, cave bear den, hibernation nests, bone taphonomy, scavengers, cave bear pathology.

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## EARLY/MIDDLE LATE PLEISTOCENE (113.000-32.000 BP, MIS 5D-3) – FIRST CAVE BEAR DEN

At the beginning of the Late Pleistocene the Ailsbach River terrace was still at a high elevation, but the first small cave bears were able to enter the cave for denning [1]. At that time, the today's entrance was still closed/non-eroded and in elevation several meters below the terrace.

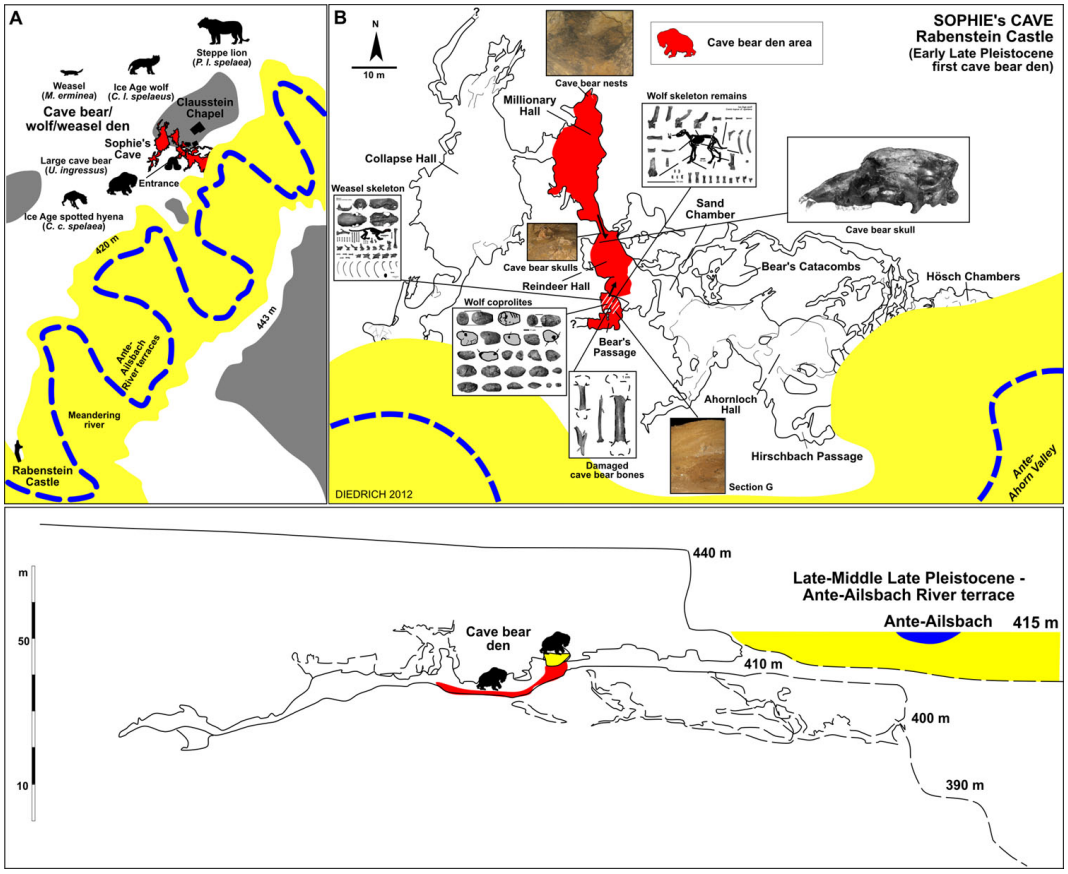


**Figure 1.** Early/Middle Late Pleistocene (113.000-32.000 BP, MIS 5d-3) – first small cave bears *Ursus spelaeus* cf. *eremus* Rabeder *et al*. 2004. The Ante-Ailsbach terrace was about 415-417 m a.s.l.. Cave bears entered the cave in what is today's blocked, former medium-sized entrance. The Reindeer and Millionary halls were used for cave bear hibernation and for the birth of their cubs (modified from [1]).

The first accessible and larger entrance for cave bears was at the "beginning" of the Bear's Passage, which entrance remains still blocked [1]. This passage was

filled with unknown in thickness (at minimum 1.5 meters thick) bone-rich sediments (= bonebed in dolomite ash sand) [1]. The early smaller cave bears were able to enter the Sophie's Cave at an elevation around 415 m a.s.l. into the Bear's Passage only, and from there, deeper through the 1,5 meter wide opening at the end of the passage deeper into the Reindeer Hall [1]. The deepest accessible area was the Millionary Hall (Passage to the Collapse Hall, Fig. **1**) [1].

**The Small Cave Bear Subspecies Composite Skeleton "Benno"**

In 2011, the historically composed "cave bear" skeleton mounted in the Reindeer Hall for visitors, which was under extremely bad condition covered by algae, was demounted and analyzed to separate its original and casted bones.

The bones (*e.g.* skull, several ribs, vertebrae, limb bones) originated from the knowledge gained of the new cave and first cave bear bone and tooth studies [1] from a European DNA-tested and well-known small cave bear subspecies of *Ursus spelaeus* cf. *eremus* Rabeder *et al*. 2004 ([2 - 9], Figs. **1** - **6**). The "Benno skelton" also incorporated the large cave bear species *U. ingressus* Rabeder *et al*. 2004 [2 - 9] (see Chapter 6) from the anterior cave areas (Ahornloch, Claustein Halls), which were mixed up with casted sternal bones and intercostal cartilage replica. The skull included two composed right lower jaw mandibles of the larger cave bear species. The newly composed skeleton (by PaleoLogic), which is based anatomically on a modern brown bear skeleton [10], has less than 25% of the formerly used "Benno skeleton" bones included and contains now only bones of grown up individuals which were found in the Bear's Passage (selected from about 1.342 bones of the "bone dump"), and a few being from the lower Reindeer Hall area (selected from few large bones of the former Rabenstein Castle collection, rediscovered in 1998).

The small cave bear *Ursus spelaeus* cf. *eremus* Rabeder *et al*. 2004 (Figs. **2** - **6**) comp-osite skeleton presented herein includes male/female bones, which postcranial bones are not well analysed yet from European sites in their proportion osteometric differences, especially postcranial bones. This composition is unique at the moment in Europe and includes, in contrast to most "cave bear" skeleton composites from Europe, the small sternal bones, sesamoid bones and "tongue

CHAPTER 5

# LION, HYENA WOLF, WEASEL AND PORCUPINE CAVE DWELLERS - CAVE BEAR KILLERS AND SCAVENGERS

**Abstract:** In the early/middle Late Pleistocene, when the small cave bears *U. s. eremus/spelaeus* Rabeder *et al*. 2004 used a part of the Sophie's Cave as den, different large and small carnivors were mainly cave dwellers or short-time occupants. With the beginning of the Late Pleistocene glacial period (113.000 BP, terrace elevation 415 m a.s.l.), Ice Age wolves used one area in the cave as a den at the end of the Bear`s Passage. *Canis lupus spelaeus* Goldfuss 1823 being represented only by grown up animal bones left larger amounts of phosphatic excrements in the cave bear bonebed especially in the Bear's Passage, but up to the Millionary Hall. A high percentage of about 26% of the cave bear bones have large predator bite damages. Mainly Ice Age wolves and Ice Age spotted hyenas scavenged the small cave bear subspecies carcasses. They produced larger bite damages on the vertebral column (inner side) proving an initial intestine/inner organ feeding. Steppe lions hunted cave bears even deeper in the cave where cave bears hibernated, whereas this can not be proven, only indirectly on large canine bite marks, which also might have resulted from those felids. Some cave area (also especially Bear's Passage) was used as a weasel *Mustela erminea* Linnaeus 1758 den, whereas the Ice Age porcupine *Hystrix* (*Acanthion*) *brachyura* Linnaeus 1758 dwelling is proven indirectly again only in the Bear's Passage with typical large rodent bite marks on two cave bear cub humeri. At the end of the middle Late Pleistocene, the former still unknown Bear's Passage entrance was blocked, which did not allow the smaller cave bears, carnivores or porcupines to penetrate the cave anymore, all inhabited/dwelled only a cave branch between approx. 113.000-32.000 BP.

**Keywords:** Late Pleistocene, sedimentology, Ailsbach Valley geomorphology, cave bear species/subspecies, cave bear clock, cave bear den, hibernation nests.

## CARCASS AND BONE TAPHONOMY OF SMALL CAVE BEARS

On more than 26% of the small cave bear subspecies bones of grown up animals (subadult to senile) of the Bear's Passage, Reindeer Hall and Millionary Hall bite

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marks and bone damage (Figs. **1** - **3**) in different stages is present in similar

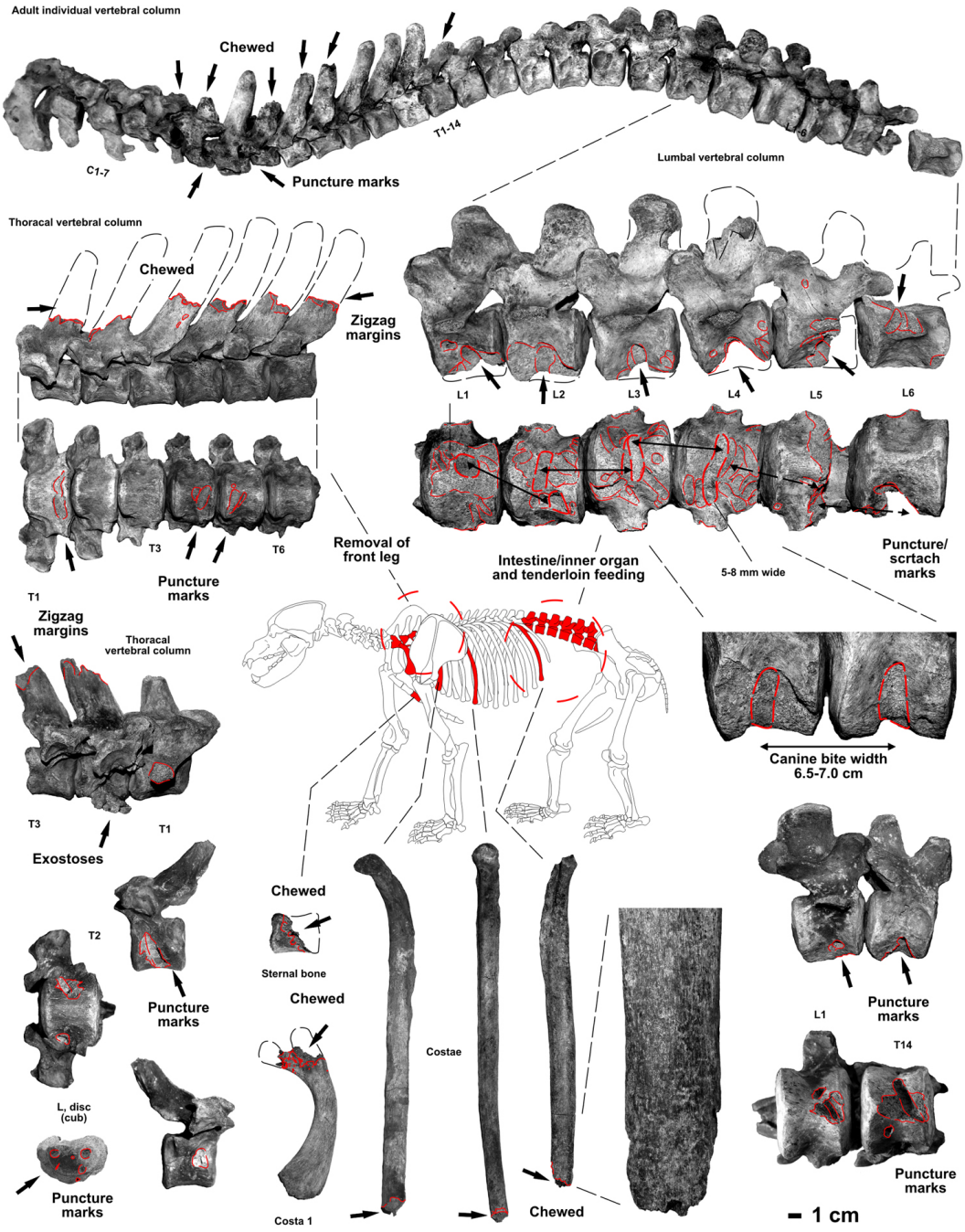

**Figure 1.** The large top predators (lions *P. l. spelaea*, hyenas *C. c. spelaea*, and wolves *C. l. spelaeus*) chewed and damaged small cave bear *U. s. eremus* vertebral columns and single bones from ther Bear's Passage, Sophie's Cave (coll. Rabenstein Castle Museum).

repeating forms. With high amounts of up to 60% of the small cave bear subspecies cub bones within the Bear's Passage and Reindeer Hall, those expose bite damage with puncture and bite marks in repeating similar forms, especially on the small longbones. First the soft distal joints and cartilage were eaten, whereas longbones were partly crushed to fragments.

The small cave bear carcasses were scavenged quite intensively, as remains are scattered (see Reindeer Hall bone field, Chapter 4, Fig. **8**), especially the skulls and legs, wheres all type of bones often have round-oval bite punctures, longbones were completely chewed on their distal joints; also vertebrae spines and costae expose chewing and stronger bite damages (Figs. **1 - 3**). The more or less articulated nearly complete cervical to lumbar vertebral column of a single small cave bear of the Reindeer Hall bone field has massive bite damage between the cervical and thoracic column (? shoulder blade region), and appears to originate from one carcass, that was initially decomposed by large top predators (see Chapter 4, Fig. **9**). If the bear had been killed there, or only the carcass had been scavenged, remains unresolved. The bones of at least six adult bear carcasses (estimated on the jaws and skulls) and possibly four older cubs between the age of six months and one year, show in many cases, bite impact marks or chewing damage on all kind of bones of different body regions (Figs. **1 - 3**).

Several articulated vertebral columns of adult cave bears (partially connected to ribs), from in total six partly articulated individual carcasses were documented from the Bear's Passage (about four lumbal vertebral columns, Fig. **1**), Reindeer Hall (one nearly complete vertebral column and some ribs in the bone field, cf. Chapter 4, Figs. **8 - 9**) and Millionary Hall (one anterior column with attached ribs within the sinter terrace, Chapter 4, Fig. **12**) prove their hibernation in those areas, and their death, naturally or caused by predators.

The vertebrae found in the Bear's Passage have deep, large bite, scratch, and puncture marks on the ventral sides in the centrum, being limited within the

CHAPTER 6

# THE FINAL LATE PLEISTOCENE CAVE BEAR AND SPORADIC CARNIVORE (HYENA AND WOLF) DEN

**Abstract:** About 32.000-26.000 BP the largest cave bears *Ursus ingressus* Rabeder *et al*. 2004 used the Sophie's Cave such as other larger cave bear dens of the Zoolithen Cave, Große Teufels Cave and Geisloch Cave and others in Upper Franconia. At this time the large portal of the today's entrance was opened. In this hall and branching areas, the cave was used for denning and birth. The Ailsbach River terrace changed first with an elevation increasing that caused periodical floods of the anterior valley oriented cave part only. Within the partly dry cave, seasonal floods cleft two more fluvial sequences, which are dominated in the first stage by sands and gravels. In the last stage, "gravel/frost brekzia/glauconite sand till series" of the latest Late Pleistocene and around the LGM (app. 32.000-16.000 BP) the floods finally transported sediment and the bones only into the Ahornloch branching halls and Passages. The large cave bears were also scavenged and predated by the three top predators (lions, hyenas and wolves) that specialized especially in boreal forests on cave bear feeding as a result of rare and disappearing valley migratory mammoth steppe game. Hyenas used the Sophie's Cave only shortly as den in the Ahornloch Hall area and imported typical for cave dens in Europe some woolly mammooth *Mammuthus primigenius* (Blumenbach 1799), woolly rhinoceros *Coelodonta antiquitatis* (Blumenbach 1799), and *Equus caballus przewalski* Poljakov 1888 horse prey remains into the cave entrance halls, which bones show typical hyena caused bite/chew damage. Already before the climatic change not later then 24.000 BP, before the Last Glacial Maximium glacier extensions in Europe (LGM, 19.000 BP), with unsolved questionable "glacial signs" (?valley glaciers) in Upper Franconia and within the Sophie's Cave, caused the extinction of the last cave bears, their top predators, and most of the boreal forest megafauna in Upper Franconia and central Europe

**Keywords:** Final Late Pleistocene, sedimentology, terrace gravel infill, Ailsbach Valley geomorphology, glacial signs, largest cave bear species, cave bear den, bone taphonomy, predators and scavengers.

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## FINAL MIDDLE LATE PLEISTOCENE (32.000–24.000 BP, MIS 3-2) – LARGEST CAVE BEARS

The sections within the Sophie's Cave (Figs. **1-2**) show first a lowering of the Pre-Ailsbach River terrace within the later Late Pleistocene (app. 32.000-24.000 BP), on a level of about 400-415 m a.s.l [1]. Again, river terrace gravels and sands were washed into the anterior parts of the cave (Ahornloch and Clausstein Halls, Sand Chamber, and Bear Catacombs), whereas the gravel components are different to those of the Middle Pleistocene terrace sequence [1]. This results from the surrounding geomorphology change due to erosion history, because the river already eroded much deeper into the softer Early (or Black) Jurassic claystone series [1] (see Chapter 2, Fig. **1**). In total, again a river terrace sequence can be well seen in the first, fine-grained, and later gravel dominated deposits, whereas two phases are subdivided [1] (Fig. **1** and Fig. **13**).

Those fluvial river terrace cold period sediments are only present in the cave as "relic sediments" within the valley and contain only the large European cave bear species of *Ursus ingressus* [2 - 14] (Figs. **2-7**), which dates those layers with the P4 and other molar tooth morphology of multiple coned forms [2 - 3] between 32.000-24.000 BP due to comparisons of other radiocarbon and P4 dated dated *U. ingressus* cave bear remains from other European caves [2 - 9].

The preserved section (= sand-gravel sequence 2 [1]) is below the "metal floor plate" in the center of the main chamber of the Ahornloch Hall (Fig. **1-2**, Chapter 3, Fig. **1**). Above yellowish-white dolomite ash sands, a first frost brekzia is present (Fig. **2**) which also contains megafauna remains found within the section of *U. ingressus* – several teeth and bones, *Panthera leo spelaea* – phalanx II and III (see Fig. **8**), *Rangifer tarandus*-phalanx I (see Fig. **11**). After this cold period, during high-floods in warmer times, primary only sands were washed into the anterior halls by the meandering Prae-Ailsbach River [1]. This also had consequences on the large cave bear species skeletons, which were decomposed completely within the cave by periodic running water, which taphonomic situation is different to the older small cave bear forms (see Chapter 5).

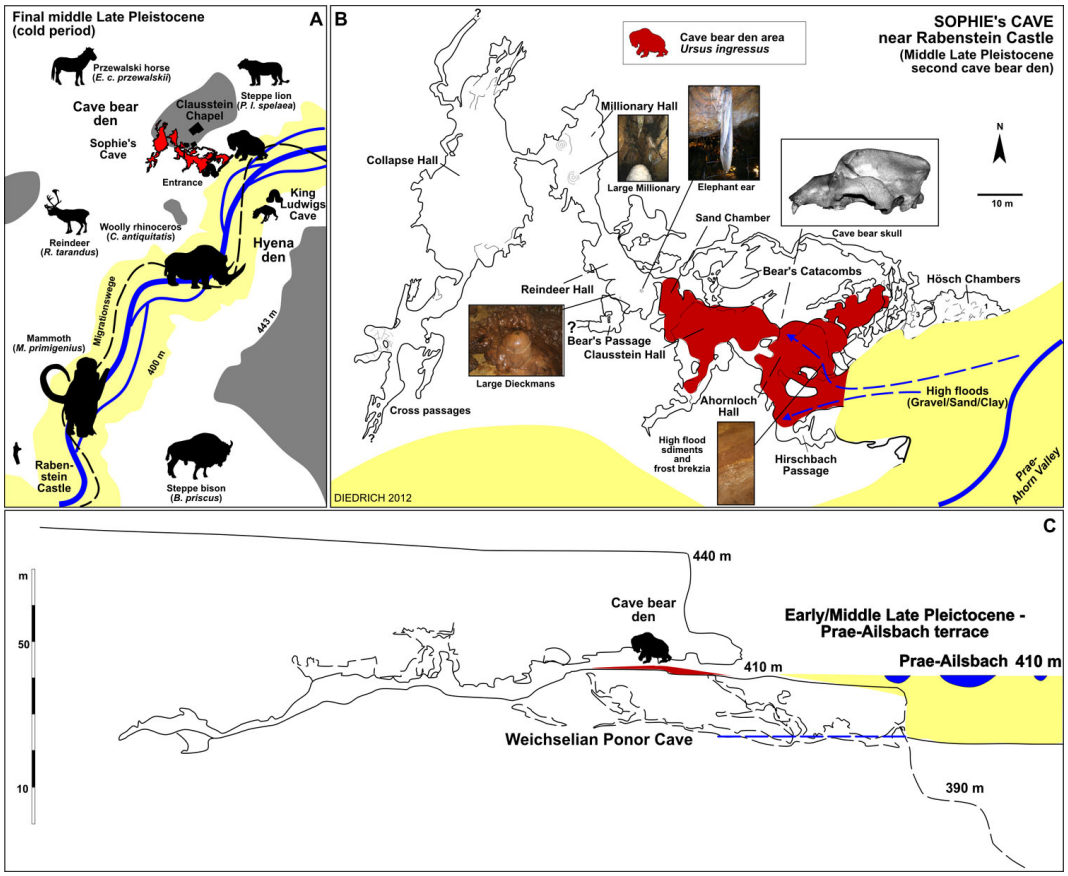


**Figure 1.** Final Middle Late Pleistocene (app. 32.000-24.000 BP, MIS 3-2) – large cave bears *Ursus ingressus* Rabeder *et al*. 2004 and Ailsbach River terrace elevation increase (modified from [1]).

The Ahornloch Hall, Clausstein Hall, and Sand Chamber of the Sophie's Cave were the den areas of the last and large cave bears of this region [1], such as the Zoolithen Cave [12], or by the author own unpublished observations, the Große Teufels Cave or Zahnloch Cave. Those largest European cave bears entered at that time what is the today's entrance, as a result of the lowered river terrace [1]. Although there must have been seasonal high floods (spring snow melting waters) the cave was still used for hibernation and as a cub raising site over some thousands of years between 32.000-24.000 BP [1], which explains larger amounts of sibling milk and not full developed cub permanent teeth (Fig. **6**) within the sands/gravels/brekzia, whereas hibernation nests were destroyed fluvially.

CHAPTER 7

# LATE PLEISTOCENE ARCHAEOLOGY

**Abstract:** The Sophie's Cave was used during the last dry cave stage just before the maximum glaciation by the first modern humans, Late Palaeolithic Early Gravettian reindeer hunters, but not as short-term hunting camp or or settlement, but as shamanic sanctuary. Those hunters seem to have deposited year after year selected larger male shed reindeer antlers (one $C^{14}$-dated 30.830-30.340 cal. BP) in only one of the deeper chambers of the cave, possibly also two mammoth pelvic halves (one $C^{14}$-dated 29.340-28.600 cal. BP) and other bones of the megafauna. Already before the Last Maximum Glaciation (= LGM, around 19.000 BP) humans and the cave bear boreal fauna disappeared in the Franconia Karst region, similar as all over Central Europe. The valley was resettled by the last reindeer hunters at the end of the glaciation by Epipalaeolithics, which left remains in other smaller cave entrances or rock shelters in lower elevations along the Wisent and Ahorn valleys.

**Keywords:** Little presence of Neanderthals, Late Palaeolithic Early Gravettian reindeer hunters, reindeer antler and bone depot, shamanic cave use of Sophie's Cave, Epipal-aeolithics.

## NEANDERTHALS IN UPPER FRANCONIA

At the same time of the cave den use by bears, and few hyenas and wolves of the Sophie's Cave and other caves in Upper Franconia (Fig. **1C**), Neanderthal humans of the Middle Paleolithic times used only a single small cavity in higher elevated rock shelter of the Hasenloch Cave near Pottenstein [1, 1C] whereas the presence of a single tooth from the cave bear den Hunas Cave ruin of Franconia [2] remains unresolved in the taphonomy, because no artifacts have been found with this single human remain. The Neanderthal cranial remain was possibly imported by hyenas, as known for several cave sites in Europe now, where Neanderthals were consumed and partly imported by carcass body parts to their cave dens [3]. Only in the Hasenloch Cave, stone tool and flake artifacts such as porcupine and other bone remains have been described [1, 4]. To date, it is unproven for Europe that Neanderthals killed and consumed the flesh of cave bears [5 - 7]. The "Nean-

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derthal caused holes in two skulls" found in the Zoolithen Cave were misidentified by Groiss [8] to have resulted from "spears", indeed, those are described with even more crania to represent non-healed wounds of battles between other cave bears or top predators (lions, hyenas) [9]. A cave bear hunt has not yet been shownin Upper Fanconia in any cave bear den cave.

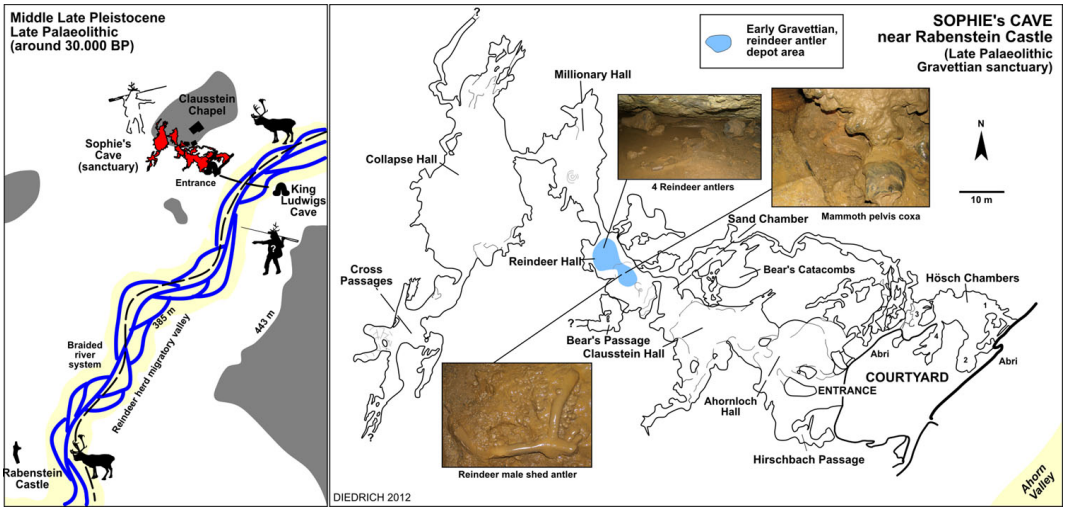


**Figure 1.** Reindeer antlers in the Reindeer Hall which were accumulated by Late Palaeolithic Early Gravettian humans. Most of the antlers which have been collected and removed are smashed from the speleothem layer, in historic times, with mainly fragments being left. One nearly complete shed antler dated ($C^{14}$ age 30.830-30.340 cal. BP) is in the center of the Hall, opposite the mammoth coxa ($C^{14}$ age 29.340-28.600 cal. BP, cf. Chapter 6, Fig. **9**) (coll. Rabenstein Castle Museum, some *in situ*).

## FIRST CAVE BEAR HUNTERS - LATE PALAEOLITHIC EARLY GRAVETTIANS (AROUND 30.000 BP)

The first secure proof of cave bear hunting by modern early Late Paleolithic Aurignacians to Gravettian humans is from the Hohle Fels Cave near Schelklingen of the Swabian Alb region [7]. There, a thoracic vertebra of an approximate 30.000 BP dated (Late Aurignacian) adult cave bear (possibly = *U. ingressus*) contains a projectile fragment [7]. Newest discoveries in the Herman's Cave in the Harz Mountains of northern Germany indicate also Aurignacien propulsor weapon hunting technique and even cave bear butchering (cut marks on cave bear bones) deeper in caves [6]. There are now some caves in Europe from Aurignacien-Gravettian times, where the cave bear hunt becomes obvious in

boreal forest cave-rich and cave bear population regions [6]. With this knowledge, the Solutréen propulsor spear point from the Große Teufels Cave, Upper Franconia [1, 4] becomes of interest. This was also found within a larger cave bear den (Fig. **1**) entrance area, and is a single find without other artifacts. Whereas in several caves of Aurignacian and Gravettian ages cave bear hunt must have taken at several European caves [6, 7], cave bear "hunting" by humans or cave bear "cult" by humans can not be observed in the Sophie's Cave, or the surrounding Upper Franconia caves, yet. Most of the sites were destroyed or partly damaged by pickaxe shovel excavations already historically in many parts and were modified especially by spelunkers and cave visitors since the 19th century. The past research did not focus on such questions about "bone taphonomy" or any bone research at all (*e.g.* Große Teufels Cave). However, there is an obvious Late Palaeolithic (Early Gravettian) non-camp site cave use of the Sophie's Cave as described below.

## Early Gravettian Shamanic Sanctuary Around 30.000 BP

In the Reindeer Hall, calculated by the historical descriptions [10, 11] and the new research and documentation of all visible antlers and new discovered fragments (Fig. **1**) approximately 100 antlers must have been present there before 1833.

After descriptions and new finds/observations, all, or most of them, must have been antler sheds. One large shed male antler (Chapter 7 Fig. **2** or Fig. **2.1**) was dated with an $C^{14}$ age of 30.830 - 30.340 cal. BP (in the laboratory of Beta Analytic Inc., USA, no. SOPHIER-EN001). This age falls into the Early Gravettian period compared to Aurignacian/ Gravettian ages *e.g.* of the southern German Geißenklösterle Cave [12]. Calcuated from the preserved remains, all of them are from large, adult male individuals (Chapter 7 Fig. **2**, Fig. **2**) with diameters of 3-4 cm (females and calves are around 2 cm [13]). From the historical descriptions, there was also a skull with attached antlers [11] and nearby, today's most complete antler (Chapter 3 Fig. 47). Most preserved specimens were left *in situ* under a large ceiling block niche in the lower part of the Reindeer Hall (Chapter 7 Fig. **1-2**).

# CHAPTER 8

# MAIN POST-LGM SPELEOTHEM PERIOD

**Abstract:** Within the climatic change after the LGM to the final Ice Age interstadials and stadials changed with humid and dryer periods. A strong "cave ceiling collapse" throughout the cave within this time frame blocked some passages up to the Collapse Hall. Most of the candle stalagmites were formed in this time between 16.000-12.000 BP with the last and main speleothem genesis, which continues since the Holocene. The cave floor was covered especially in the larger halls by falling large blocks which scattered the reindeer antlers in the Reindeer Hall, but also closed the connections of the chambers/halls in the middle part of the cave. Between those, and on those, a variety of different speleothem types formed, whereas the largest are found within the Millionary Hall. Sinter basins are also found there and in the connected Reinder Hall, only. After all sedimentological, stratigraphic, and cave bear clock dating methods, nearly the complete large "sinter decoration" of the Sophie's Cave must have build up in the middle to late Late Pleistocene covering the cave bear skulls/bones of *U. spelaeus eremus/spelaeus* and *U. ingressus* and their bonebeds all over in a second larger speleogenesis time starting in a warmer interstadial around 42.000 BP (Millionary after Chapter 3) and a third final main speleogenesis time around 16.000-12.000 BP in the Alleroed to Dryas which continued since the Holocene.

**Keywords:** Speleothem forms, ages, climate record, cave part and speleothem layer collapses, final Late Pleistocene, Post-LGM.

## CAVE COLLAPSE/SPELEOTHEMS - END OF THE LATE PLEISTOCENE (POST-LGM, MIS 1)

The few larger speleothems such as the Elefantenohr (= Elephant Ear), Bienenkorb (= Bee Basket), Kleiner und Großer Millionär (= Small and Large Millionary, Fig. **1**), grew already before the latest speleogenesis time and are much younger, as always told by cave guides: "one million years old". Those can be estimated at the moment without absolute dating only not be older than 42.000 BP (Bölling Interstadial), because they also cover the small cave bear species *U. spelaeus eremus/spelaeus* bonebed in the Reindeer and Millionary halls, which cave bear subspecies that date themselves with the "cave bear clock" into the

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early/middle Late Pleistocene (see dating by teeth: Chapter 3, Fig. **2**) [1]. However, those must have continued to grow also in the Post-LGM during the latest main speleogenesis times and continue to grow until today.

With the end of the Late Pleistocene, some thousands of years after the peak of the LGM around 19.000 BP [2], the climatic change of the warmer and colder interstadials of the Dryas to Alleröd periods caused an increase in new groundwater in Central Europe [3]. The temperature and humidity changes were responsible for a new speleothem genesis period in the Sophie's Cave, such as also documented and dated in the nearby Zoolithen Cave [4, 5].

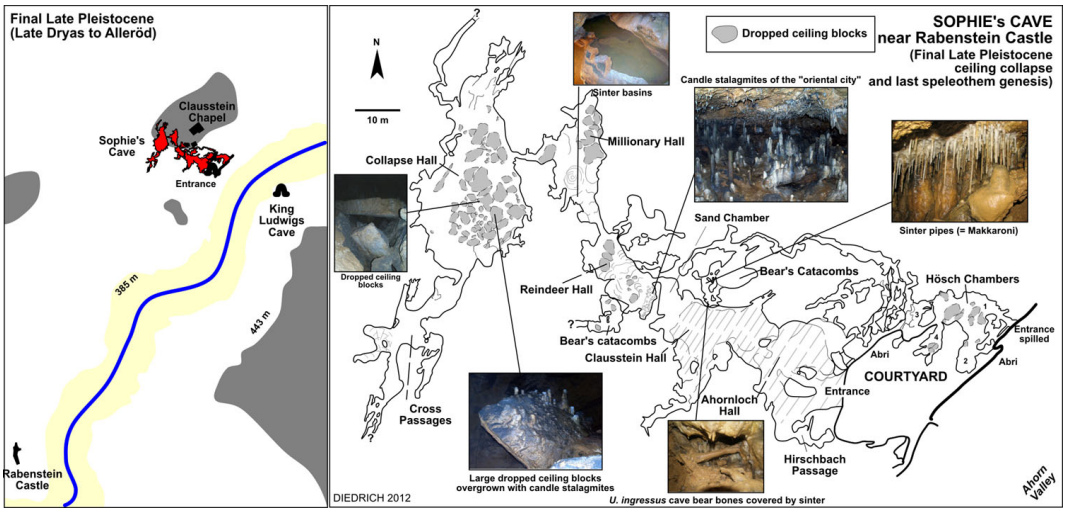


**Figure 1.** Transition final Late Pleistocene to Holocene (dry, in the Dryas to Alleröd periods, app. 16.000-14.000 BP) – main cave ceiling collapse in the third and main speleothem genesis period.

The formerly dry Sophie's Cave became wet in many parts, causing a massive ceiling collapse (Fig. **1**). The larger the halls, the more large blocks dropped from the ceilings. This is best visible on the largest block dump in the centre of the Collapse Hall (= grey coloured mapped blocks in Fig. **1**). This obviously had no effect on humans or larger animals anymore. The blocks themselves, and other places and even the cave bear bonebeds were completely covered by speleothems, especially the 5-10 cm in diameter thin candle stalagmites (Figs. **2**, **3C**), which dating is herein only correlated to other absolute dated candle-like and similar in diameter sized speleothems of Upper Franconia caves, especially to those of the

Zoolithen Cave [4]. Speleothem dates (Uranium/ Thorium) of a candle stalagmite sample of the Zoolithen Cave bone breccias gave ages on the upper and last speleothem layer of about 11.720±125 BP (older data from 1950 [6]) which is calibrated 13.720±125 BP. These seem to have built not only in the Zoolithen Cave during the latest Upper Pleistocene Alleröd climatic change to a warmer period (13.500 - 12.700 BP [4]). Also in other Upper Franconia caves those are found with absolute dating, such as the Sophie's Cave or Große Teufels Cave. The cover by the youngest speleothems all over the Sophie's Cave "floor" of the ceiling blocks, and bonebeds, some partly articulated small cave bear *U. s. eremus* skeletons (in the Reindeer and Millionary halls) or even the absolute dated reindeer antlers/mammoth coxa correlate to the dating of those as Pre-LGM deposited megafauna remains. All three main speleothem generations can be explained only with the general cave model, that includes four main cave genesis phases based on the stratigraphy, sedimentology and dated cave bears (Fig. **2**).

## Sinter Tubes (= Makkaroni)

Speleothems developed from the leachate, originating from rain waters which absorbed the $CO_2$ [7]. Within the soil they built an acid that dissolved the carbonates ($CaCO_3$), including dolomites (= $CaMgCO_3$), which the waters transport into the underground and its cavities [7, 8]. The water ran within tiny to larger clefts of the Sophie's Cave Jurassic reef and carbonate sand dolomites (Fig. **2**). During its appearance within the cavities, speleothems developed because $CO_2$ disappeared quickly due to pressure and temperature differences within the caves [7, 8]. The diffusion of the gas from the water drops caused a remineralization of the carbonate, being the initialization of the speleothem genesis [9 - 12]. Those crystals are colored by red Iron and black Manganese ions, but in some cases, white speleothems consist of 100% pure carbonate [11, 12]. The best well-known variations in speleothems and their types well known from caves all over the world [7 - 12] can be demonstrated also with the main large types in the Reindeer and Millionary halls best (Figs. **1**-**7**).

CHAPTER 9

# POSTGLACIAL ARCHAEOLOGY

**Abstract:** Postglacially, humans used the entrance throughout the Urnenfeld Bronze Age into the Hallstadt/La Tène Iron Age, which is documented by pottery shards. The lower cave entrances were occupied intensively at the Early Medival times during which the castle was built 30 meters above the cave entrance on the Jurassic dolimite plateau. From this time period, few animal and human bones such as iron/bone/stone tools and bone kitchen rubbish and several pottery shards were found on the yard infront of the today's cave entrance and the lower cave part entrance areas.

**Keywords:** Few archaeological finds, Urnenfeld Bronze Age, Hallstadt/La Tène Iron Age, pottery, Early Medival castle, cave entrance use.

## BRONZE AGE (AROUND 3.350 BP)

Bronze Age tools and ceramic fragments from the Early Bronze Age (= Hügelgräberzeit) were already mentioned in historical reports within the area of the Clausstein Hall [1, 2]. The oldest archaeological remains date into the Late Bronze Age (= Urnenfelderzeit, Hallstadt [3 - 5]). Surface finds were collected and rescued only from the Hösch Chamber 4 (Fig. **1**). From this, about 30 quartz sand tempered typical prehistoric pottery ceramic fragments (with inner side black and outer side red) were saved against future trampling. Most of the material was not taken and left "in place". Material was already "deposited" before by modern speleologists in niches to protect them against trampling destruction. A single marginal shard fragment with finger print decoration was found sticking between blocks at the end of the diagonal shaft (Figs. **1**, **2A**). This decorated shard date into the Late Bronze Age (about 3.350 BP) [1, 6]. It is a fragment from a large storage vessel, which is almost 50 cm in height [1]. In such, cereals, peas, lentils or beans were stored [1].

Another shard with slicked mud decoration and with sinter skin and rhomboidal decoration (= Dellenstrich [1]) dates into this time, too. All pottery types date

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more into the Late Bronze Age, but partly existed longer into the Iron Age [6]. When the pottery was only "daily use ceramics" possibly it was thrown into Chamber 4, from the courtyard, into the small diagonal shaft for ? sacrifices, or this part was a "storage site" to keep food fresh.

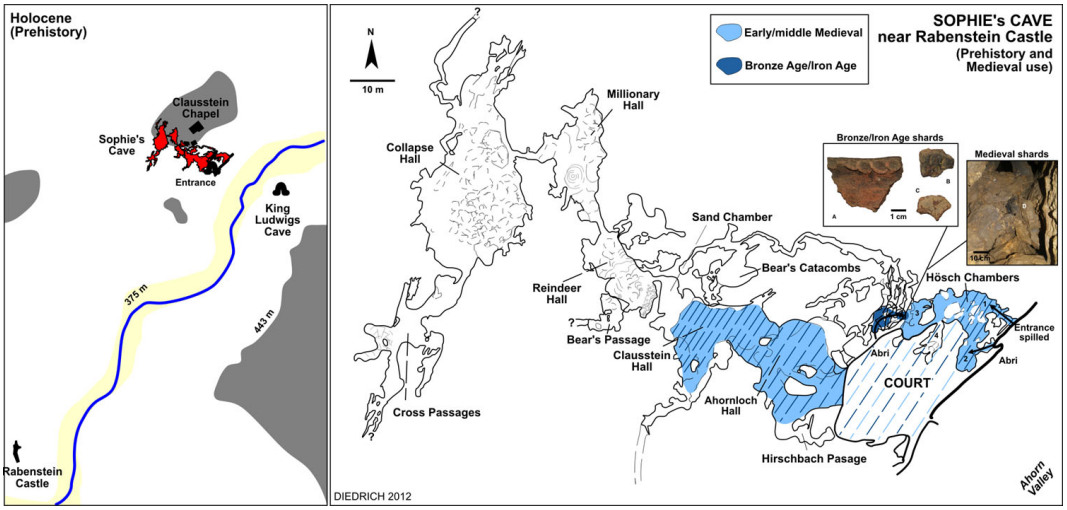


**Figure 1.** Prehistoric use and Early Medieval Age use of the Sophie's Cave areas.

## HALLSTATT/LA TÈNE IRON AGE (AROUND 2.600 BP)

Some coarse shards from the Hösch chambers 1 and 2, and possibly also from the Ahorn/Clausstein Halls, are left by people of the Early Iron Age (Hallstadt/La Tène Cultures [3 - 5] (Figs. **1**, **2**). Additionally, in 2007, shards from the archaeological trenches in the court area in front of the entrance seem to indicate the use of the anterior cave parts in prehistoric times. Secondary burials in vertical shafts are known from the nearby Esper Cave and Zoolithen Cave [7] near Burggailenreuth, although this is not proof in the Sophie's Cave. The absence of human bones or burial pottery in the Sophie's Cave supports the theory of a non-burial place of unclear use by Iron Age people.

## THE CAVE USE DURING MEDIEVAL TIMES (11-13 CENTURY)

In the courtyard of the Sophie's Cave entrance area, quite abundant remains of pottery shards, bones, and even metal tools were collected, which are typical for Early-Late Medieval castles [8]. It is unclear, if those were dropped from the

fortifications above, or are from cave use purposes. In contrast to the modern influenced archaeological horizons/cave areas, these seem to be more or less undisturbed within the Hösch Chambers 1-2. There, martens, foxes and badgers caused bioturbation and the possibility of surface finds (see Chapter 10, Fig. **1**). In the Late Medieval times (11-13 Century), the time when the Ahorn Castle existed 40 meters above the modern cave entrance [9], the Hösch Chambers and Ahornloch Hall must have been used for living, storage, animal shelter or during war times for protection of people. Metal remains are billets, door jacks, nails or knife fragments (Fig. **3A-D**). The ceramics consist of the abundant typical

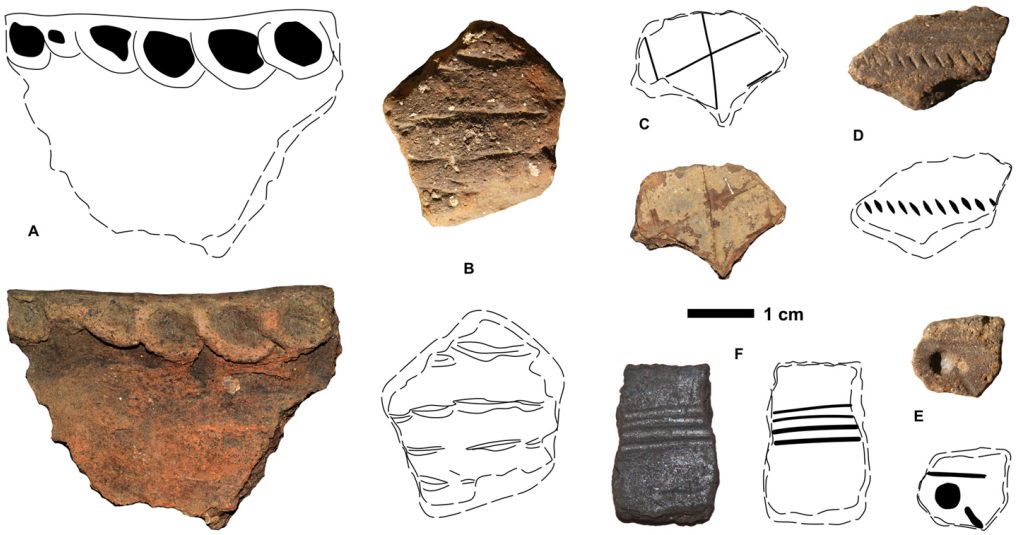


**Figure 2.** Decorated ceramic fragments from the prehistory (Bronze to Iron Ages) from the "Sophie's Cave" and mainly its courtyard. **A, D, E.** Shards with finger print decorations (Urnenfeld Bronze Age, app. 3.350 BP). **B.** Shard (La Tène Age B). **C.** Shard with feldspar temper, sinter skin and grid decoration (La Tène Age D). **F.** Shard with parallel ornamentation Hallstadt Age D3) (coll. Rabenstein Castle Museum).

"kitchen pottery", which was burned in ovens to the typical "medieval grey ware" [10 - 14]. This non-decorated and non-colored pottery types, which were tempered with fine quartz sand, are mostly cooking pots and bowls [10]. Those are represented in the cave entrance yard surface area collected materials with some marginal shard fragments (Fig. **3**). In Chamber 4, the remains of a smashed grey and burned pottery (probably lamp function) was found and left *in situ* (Fig. **1**). Other finds are a fine-sand grinder (Fig. **3E**), and typical Early Medieval wheel symbol decorated horn comb fragment [14, 15] (Fig.

CHAPTER 10

# MODERN CAVE ANIMALS AND GUESTS

**Abstract:** Today, some possibly endemic cave animals inhabit or use seasonally different parts of the cave system, which is still in use as a common fox den reaching hereby deeper cave parts of the lower cave system. Common cave spiders (*Meta menardi*) or moths (*Triphosa dubitata*) such as rare bats (*Myotis myotis*) use only the larger first two halls of the cave entrance area, whereas bats are rarely found for hibernation only deeper in the cave. In the middle part of the cave, water bodies of the speleothem terrace basins contain possibly endemic small crustaceans (*Bath-ynella*), in the mud infaunistic pigment and eye-less flatworms (*Phagocatta*) or on the water surfaces springtails (*Heteromurus*/*Onychiurus*), which species are not yet determined.

**Keywords:** Modern vertebrates and invertebrates, fox den, bat hibernation, spider and moths in anterior cave entrance halls, possibly endemic fauna, crustaceans and eyless flatworms in speleothem water basins.

## COMMON/RED FOX DEN

The Hösch Chambers of the lower cave area were used in modern times as a common (or red) fox den (Fig. **1**). Cave use is typical for *Vulpes vulpes* all over Europe [1]. Remarkably, this fox den was in use only for the past three years, reaching deep into the Hösch Chambers, and finally into the Bear's Catacombs. In Chamber 2, a fox cloak was discovered, which fresh excrements indicates use for the past years. Also several bones of domestic animals (cattle, sheep, and goat), and wild animals (roe, boar, hare) (?plus remains of a raccoon) have been imported by the medium-sized carnivore very deep and into the Bear's Catacombs, which denning behaviour is typical in fox dens [1, 2]. The modern, light-yellowish colored prey bones were accumulated only in some areas. Also the faecal areas are massive only at two points (Fig. **1**). Astonishing are the completely scratched walls along the passage between the Ahornloch Hall vertical shaft and Bear's Catacombs (Fig. **1**). Obviously a fox (?or the raccoon) was caught for a time in the Bear's Catacombs. By trying to escape it left in places 2

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meter high on the walls each 3-4 parallel and short claw scratch marks. At another place the carnivore jumped high enough (also scratch marks) through a diagonal shaft to reach the Hösch Chambers 3 and 4.

## BATS, SPIDERS, MOTHS, WORMS AND CRUSTACEANS

The Ahornloch/Clausstein Halls and Hösch Chambers contain most of the modern cave animals, especially bats, insects or snails (Fig. **1**) with about 35 different invertebrate species records [3]. This cave is one of the richest Upper Franconia cave in modern biodiversity [3].

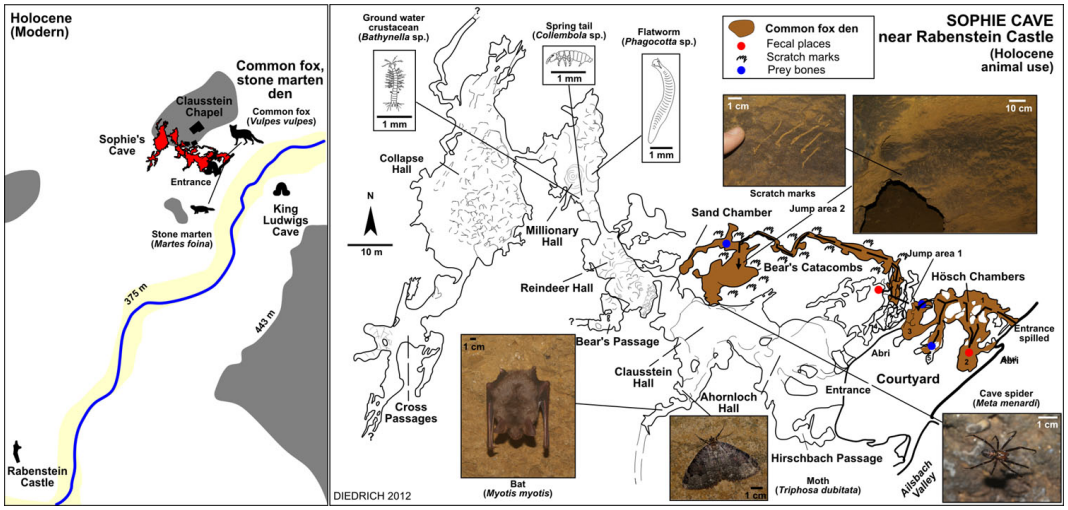


**Figure 1.** Modern bats, spiders, moths, worms, crustaceans, and common/red fox (*Vulpes vulpes*). At important crossings, foxes left faecal places for orientation. Its prey bones were enriched in some places. Interesting is the abundance of scratch marks (four parallel) on the dolomite wall of one passage to and in the Bear's Catacombs Chamber itself. At two places the foxes must have jumped up to two meters high to find an "exit" (Hösch Chambers 3 and 4 and to Bear Catacombs).

The complete Sophie's Cave is not a typical bat hibernation cave at all [3]). It is used occasionally, but only in the anterior areas, such as documented in 2011 for two specimens of *Myotis myotis*, the common European water bat [4] (Fig. **2A-B**).

In the anterior cave areas are mainly seasonal animals (= subtroglophils [3]. To this group belongs the very common cave moth *Triphosa dubitata* (Fig. **2C**) that hibernates in large amounts, starting in the late summer [3]. Another common insect is the cave spider *Meta menardi* [3] (Fig. **2D**) which hides in cavities in the


A
1 cm
B
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C
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D
1 cm
E
1 cm
F
1 cm
G
1 cm

# SUBJECT INDEX



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