

## New radiometric datings of different cave bear sites in Germany - results and interpretations

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### ABSTRACT

New radiometric dates from seven cave bear sites in Germany were achieved during the last two years. The dates were obtained for four sites from bone samples, for one site from two stalagmites and from another site from charcoal and bones. The bones and the charcoal have been dated with the AMS <sup>14</sup>C-method and the stalagmites with the TIMS-U/Th-method. Sites are briefly described and all dates with their analytic values are presented and discussed in methodological and paleoclimatic context. Radiocarbon ages were calibrated using calPal2004 ([www.calPal.de](http://www.calPal.de)) and paleoclimatic interpretation was made by correlation with the GISP2 ice core  $\delta^{18}\text{O}$ -curve (Stuiver & Grootes, 2000), GI = Greenland Interstadial of the GIPS2 ice core.

### RÉSUMÉ

De nouvelles dates radiométriques ont été obtenues pour sept gisements d'Allemagne au cours des deux dernières années. Pour quatre sites, les dates ont été obtenues sur ossements, pour un site sur deux stalagmites et pour un dernier sur charbons de bois et os. Les ossements et les charbons de bois ont été datés par AMS C<sup>14</sup> et les stalagmites par TIMS-U/Th. Les gisements sont brièvement décrits et l'ensemble des dates et leurs valeurs brutes sont discutés dans une perspective méthodologique et paléoclimatique. Les âges radiocarbone ont été calibrés avec calPal2004 ([www.calPal.de](http://www.calPal.de)) et les interprétations paléoclimatiques ont été corrélées avec la courbe  $\delta^{18}\text{O}$  de la séquence glaciaire GISP2 (Stuiver & Grootes, 2000). GI = Greenland Interstadial de cette carotte glaciaire.

### INTRODUCTION

Around 14 % of the geological surface of Germany is build by karstic rocks and about 12 000 caves are documented in these areas (Rosendahl & Krause, 1996). More than hundred of these caves yield Pleistocene deposits with bones, often from cave bear. The chronological position or geological age of these remains is mostly unknown. To close this gap, we started to date some interesting sites within research projects and through private funding. During 2003 and 2004 radiometric dates from seven cave bear sites in Germany were achieved.

The dates were obtained for four sites from bone samples, for one site from two stalagmites and from another site from charcoal and bones. The bones and the charcoal have been dated with the <sup>14</sup>C-method (1 sample with conventional <sup>14</sup>C and 6 samples with AMS) and the stalagmites with the

TIMS-U/Th-method. The sites are briefly described and all dates with their analytic values are presented (Tab. 1) and discussed in methodological and palaeoclimatic context.

Radiocarbon ages were calibrated using calPal2004\_SFCP ([www.calPal.de](http://www.calPal.de)) and palaeoclimatic interpretation was made by correlation with the GISP2 ice core  $\delta^{18}\text{O}$ -curve (Stuiver & Grootes, 2000).

### SITES

#### 1. Baumanns Cave, Rübeland, Harz Mountains /Saxony-Anhalt

The Baumanns Cave is located about 130 km SE from Hannover (Fig.1) and developed in Devonian limestone. The cave entrance opens at 378 m a. s. l.

Site	Lab-code	Material	Method	Taxon	$\delta^{13}\text{C}$ -value
Baumanns Cave	Erl-6209	bone collagen	AMS 14C	<i>Panther leo spelaea</i>	-19.3 ‰
Baumanns Cave	Erl-6745	bone collagen	AMS 14C	<i>Ursus spelaeus</i>	-21.7 ‰
Baumanns Cave	Erl-6746	bone collagen	AMS 14C	<i>Rangifer tarandus</i>	-20.2 ‰
Hermanns Cave	Erl-6050	bone collagen	AMS 14C	<i>Ursus spelaeus</i>	-20.3 ‰
Unicorn Cave	KIA 22754	charcoal	AMS 14C	-	-22.23 ‰
Unicorn Cave	Erl-6046	bone carbonate	AMS 14C	<i>Ursus spelaeus</i>	-26.1 ‰
Unicorn Cave	Erl-6047	bone carbonate	AMS 14C	<i>Ursus spelaeus</i>	-26.1 ‰
Unicorn Cave	Erl-6048	bone carbonate	AMS 14C	<i>Ursus spelaeus</i>	-24.6 ‰
Unicorn Cave	Erl-6049	bone carbonate	AMS 14C	<i>Ursus spelaeus</i>	-24.8 ‰
Malachitdom	Hv-24417	bone collagen	Conventional 14C	<i>Equus</i> sp.	-21.0 ‰
Heinrichs Cave	Hv-24414	bone collagen	Conventional 14C	<i>Ursus spelaeus</i>	-25.8 ‰
Sybillen Cave	Erl-6051	bone collagen	AMS 14C	<i>Ursus spelaeus</i>	-19.9 ‰
Hunas	HUsi2u	stalagmite top	TIMS-U/Th	-	-
Hunas	HUsi2u	stalagmite base	TIMS-U/Th	-	-

Site	yr BP	yr calBP	yr calBC	GI	Pos. Fig. 1
Baumanns Cave	34,645 ± 365	40,594 ± 738	38,644 ± 738	9	F
Baumanns Cave	43,106 ± 814	46,136 ± 1,496	44,186 ± 1,496	13	B
Baumanns Cave	35,499 ± 436	41,185 ± 645	39,235 ± 645	10	E
Hermanns Cave	30,761 ± 315	35,931 ± 322	33,981 ± 322	8	H
Unicorn Cave	42,520 +1,200/-1,040	45,544 ± 1,258	43,594 ± 1,258	12	C
Unicorn Cave	11,410 ± 134	-	-	-	-
Unicorn Cave	24,052 ± 494	-	-	-	-
Unicorn Cave	21,506 ± 411	-	-	-	-
Unicorn Cave	15,316 ± 566	-	-	-	-
Malachitdom	31,130 ± 2,155	36,417 ± 2,637	34,467 ± 2,637	6 bis 8	G
Heinrichs Cave	28,670 ± 1,060	-	-	-	-
Sybillen Cave	35,952 ± 521	41,734 ± 302	39,784 ± 302	10	D
Hunas	76,872 ± 9,686	n.a.	n.a.	-	A
Hunas	79,373 ± 8,237	n.a.	n.a.	-	-

Table 1 : Analytic values and calibrations from the reported cave bear sites.

The so-called “old part” of the cave is known since the middle of the 16<sup>th</sup> century and its fossil remains were mostly removed. The “new part” was discovered in 1888. Excavation campaigns by Blasius lasted from 1890 to 1901 (i.e. Blasius, 1894, 1898, 1902). The rich fauna material was divided after Schütt (1969) in a so-called older “Diluvialfauna” and a younger “Glacialfauna”.

From the older “Diluvialfauna” assemblage two samples were taken. Sample one, a cave lion bone, yielded an age of 34,645 ± 365 yr BP. The calibrated age of 40,594 ± 738 yr calBP can be correlate with the GI 9 (GI = Greenland Interstadial) of the GIPS2 ice core (Fig. 7).

The second sample was taken from a cave bear bone (Fig. 2). The age of 43,106 ± 814 yr BP (calBP 46,136 ± 1,496) can be correlated with the GI 13 (Fig. 7).

A reindeer bone from the younger “Glacialfauna” was

sampled for a third date and yielded an age of 35,499 ± 436 yr BP (41,185 ± 645 yr calBP).

The  $\delta^{13}\text{C}$ -value of all three samples (Tab. 1) supports the validity of the dates.

## 2. Hermanns Cave, Rübeland, Harz Mountains /Saxony-Anhalt

The Hermanns Cave is located opposite from the Baumanns Cave and is also developed in Devonian limestone. The cave entrance opens at the same level as the Baumanns cave.

In 1866 the cave was discovered during road constructions. Excavations of the rich cave bear fauna (Fig. 3) were started by Grotrian in 1875/76 (Grotrian, 1878), followed by Kloos & Blasius from 1887 to 1897 (Kloos & Müller, 1889; Blasius, 1898) and U. Steiner in 1962 (Steiner & Steiner, 1969).

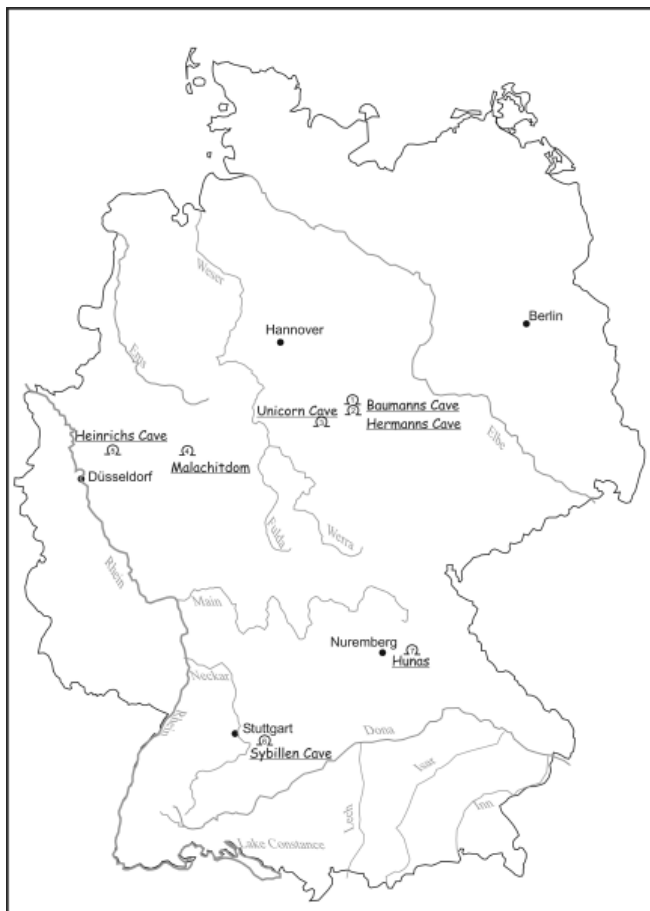


Fig.1 : Geographical position of the studies cave bear sites.  
(Graphic D. Döppes).

The sampled cave bear bone yields an age of  $30,761 \pm 315$  yr BP. The  $\delta^{13}\text{C}$ -value (Tab.1) supports the validity of the date and the calibrated age of  $35,931 \pm 322$  yr calBP correlates with GI 8 (Fig. 7).

### 3. Unicorn Cave, Scharzfeld, Harz Mountains/Lower Saxony

The Unicorn Cave is located about 108 km SE from Hannover (Fig. 1) and is developed in Permian limestone. The cave entrance opens at 380 m a. s. l.

The cave was mentioned first in 1541. In 1872 Virchow started the excavations (Virchow, 1872), followed from 1881-1884 by Struckmann (Struckmann, 1883, 1884), 1888-1933 by Alten (Alten 1907a,b), 1905-1908 by Windhausen & Favreau (Favreau, 1907; Windhausen & Hahne, 1908), 1925/26 by Jacob-Friesen (Jacob-Friesen, 1926), 1956 - 1959 by Meischner (Meischner, 2001), 1968 by Duphorn (Duphorn, 1969), 1984 by Vladi (Vladi, 1984) and 1984-1988 by Nielbock (Nielbock, 2002).

Several cave bear bones from the excavation site "Jakob-Friesengang" (Fig. 4) were dated. The results can not be used to determine the age of the fauna, because collagen was

not preserved in any of the bones and the strongly negative  $\delta^{13}\text{C}$  value of the bone carbonate indicate a contamination of the samples with modern carbon (Tab. 1).

During new geological investigations in 2003, a charcoal sample from the layer above the cave bear bearing sediments (organic silt with a small mammal forest fauna) of the Jacob-Friesen-Gang was dated. Therefore the date ( $42,520 \pm 1,200/-1,040$  yr BP, Baier et al., 2005) constrains a minimum age for the layers below. The  $\delta^{13}\text{C}$  value supports the validity of the date and the calibrated age of  $45,544 \pm 1,258$  yr calBP correlates with the GI 12 (Fig. 7).

### 4. Malachitdom-Kreiselhalle, Brilon-Bleiwäsche, Sauerland/North Rhine-Westphalia

The cave system Malachitdom-Kreiselhalle is located about 165 km E from Düsseldorf (Fig.1) and developed in Devonian limestone. The cave entrance opens at 425 m a. s. l.

The cave system was discovered in 1987 in a limestone quarry. A small pleistocene faunal assemblage was found during surface collections short after the discovery (Niemeier & Schudelski, 1992) and excavations in 1992 and 1993 (Rosendahl, 1993).

The dated sample, a horse bone, yielded an age of  $31,130 \pm 2,155$  yr BP. The  $\delta^{13}\text{C}$ -value (Tab.1) supports the validity of the date and the calibrated age of  $36,417 \pm 2,637$  yr calBP correlates with the GI 6 to GI 8 (Fig.7).

### 5. Heinrichs Cave, Hemer, Sauerland/North Rhine-Westphalia

The Heinrichs Cave is located about 84 km NE from Düsseldorf (Fig. 1) and is developed in Devonian limestone. The cave entrance opens at 220 m a. s. l.

The cave was first mentioned in 1771. Excavations were started by different palaeontologist in the 19<sup>th</sup> and 20<sup>th</sup> Century, i.e. Nöggerath and Goldfuss (Weber, 1997). During 1903 - 1905 the cave expanded to a show cave.

A cave bear bone sample was dated in Hannover with conv.  $^{14}\text{C}$  and yield an age of  $28,670 \pm 1,060$  yr BP. The strongly negative  $\delta^{13}\text{C}$ -value (Tab.1) indicates a contamination by modern carbon and the date can therefore not be used to determine the age of the fauna.

### 6. Sybillen Cave, Kirchheim-Teck, Swabian Alb/Baden-Wuerttemberg

The Sybillen Cave is located about 42 km S from Stuttgart (Fig. 1) and developed in Upper Jurassic limestone. The cave entrance lies directly below the castle "Burg Teck" at 760 m a.s.l.

According to the Sybillen-legend, a well-known regional fairy-tale, the Sybillen Cave is known for a long time. First and final excavations (Fig. 5) were done by E. Fraas in 1898 (Fraas, 1899).

The sampled cave bear tooth yielded an age of  $35,952 \pm$





Fig. 2: Cave bear skull in the Baumanns Cave found during historical excavations (Photo S. Wielert).



Fig. 3: Calcite covered cave bear bones in the Hermanns Cave. (Photo S. Wielert)



Fig. 4: Sediment profile of the excavation in the Unicorn Cave (Jacob-Friesen-Gang). The darker brown layer above the hand of the person is the dated horizon, reported in the article. (Photo R. Nielbock)



Fig. 5: Cave bear skull found in the Sybillen Cave during the excavation by E. Fraas in 1898. (Photo W. Rosendahl)

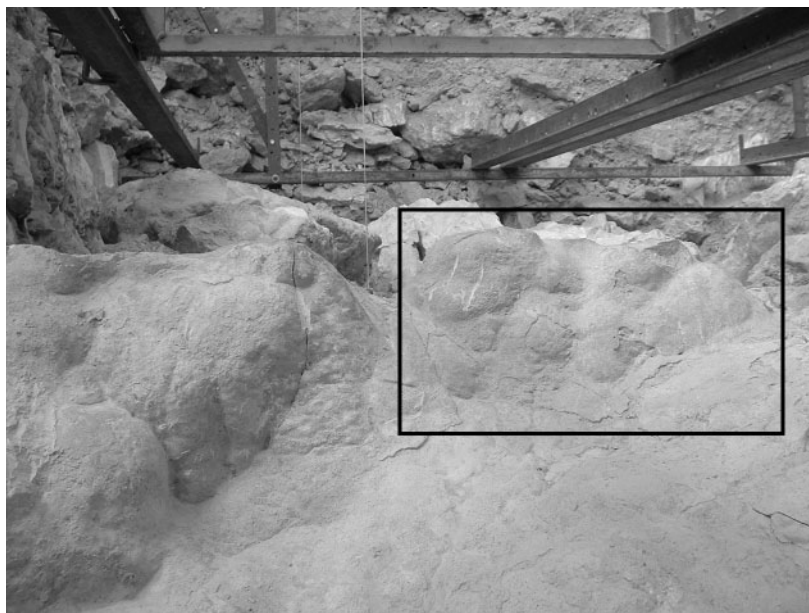


Fig. 6: Dated speleothem layer at the base of the recent excavation. (Photo W. Rosendahl)

521 yr BP. The  $\delta^{13}\text{C}$ -value (Tab. 1) supports the validity of the date and the calibrated age of  $41,734 \pm 302$  yr calBP correlates with GI 10 (Fig. 7).

### 7. Hunas, Hartmannshof, Franconian Alb/Bavaria

Hunas is located about 40 km E from Nuremberg (Fig. 1) and developed in Upper Jurassic dolomite. The excavation site opens at 520 m a.s.l.

The cave ruin was discovered in 1956 in a limestone/dolomite quarry. The entirely sediment-filled cave ruin was excavated in the so-called Heller-excavation between 1956 and 1963 and in the adjacent so-called New-excavation since 1983 (i.e. Heller, 1983, Kaulich et al., 2002).

The first speleothem-dating in Hunas was carried out in 1979. The dated sample supposedly originated from a flowstone layer, which was recognized in a test profile below Heller's excavations. However, detailed sample documentation does not exist. This sample was dated using the conventional U/Th-method by G.J. Hennig at the University of Cologne. Three different ages (230 kyr,  $221 +52/-34$  kyr and  $260 +60/-40$  kyr) are reported in the literature (Hennig, 1979 ; Hennig et al., 1983 ; Brunnacker, 1983), and were used as an important chronostratigraphical argument for a Middle Pleistocene age of the site.

In 2002, another flowstone layer could be identified at the base of the New-excavation (Fig. 6). This layer is in contact with the sediment series above without showing an obvious hiatus. A stalagmite (HUSi2u) from that layer was now dated by the TIMS-U/Th-method and yielded an Early Würmian age. The stalagmite base yielded an age of  $79,373 \pm 8,237$  yr BP and the top dated to  $76,872 \pm 9,686$  yr BP

(Rosendahl et al., 2004 ; 2005a). This age was confirmed by replicate analyses on the same layer.

### CONCLUSION

Since the first excavations a separation of two faunal assemblages (so-called older "Diluvialfauna" and younger "Glacialfauna") are discussed for the Baumanns Cave. According to our new dates a separation in the faunal assemblages as done before is not possible. The fauna of the Baumanns Cave does not reflect two different climate phases with in a longer time span of the Last Glacial. On the contrary the fauna reflects one short-term climate fluctuation in the OIS 3 within a maximum timespan of 10 ky years.

The dating result from the Hermanns Cave confirms the attribution of a typical bone point, discovered in the cave (Toepfer, 1967), to the Aurignacian. It also correlates well with the age of bone points from the Potocka Cave in Slovenia (Rabeder & Pohar, 2004)

The charcoal age from the profile in the Jacob-Friesengang of the Unicorn Cave gives not only a minimum age for the layers below but allows also for the first time a correlation with a tempered climate phase during OIS 3 (GI 12). Prior to our new geological investigations the typical tempered wood fauna assemblage was supposed to have been deposited during the Late Weichselian or Holocene (Nielbock, 1989 ; Paul & Vladi, 2003).

The cave bear remains from the Sibyllen Cave are well-known in the older literature as *Ursus spelaeus sibyllinus* (Fraas, 1898) ; based on the presence of small-grown individuals. The study of Weinstock (2000) and the new date proof finally that the cave bear from the Sibyllen Cave falls within



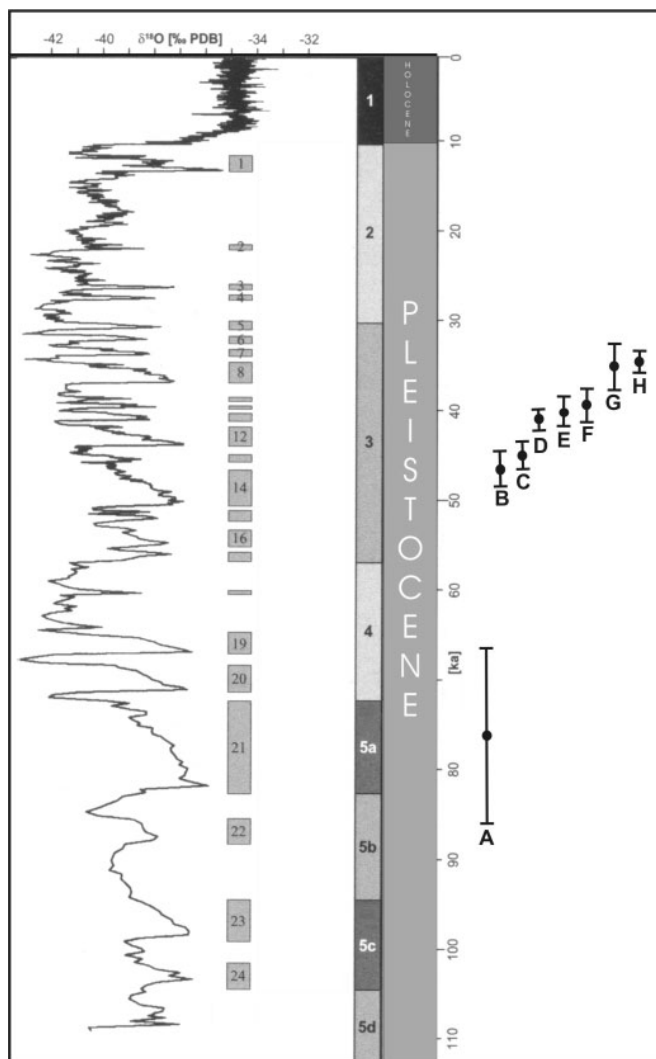


Fig. 7: GISP 2 ice core results for the last Glacial and the Holocene (after Stuiver & Grootes, 2000), the capital letters A - H (site names see Tab. 1) indicate the locality for all reported dates. (Graphic W. Rosendahl)

the morphological and geochronological range of the Last Glacial cave bear.

The flowstone layer, found in 2002, at the base of the New-excavation in Hunas is in contact with the sediment series above, without showing an obvious hiatus and yielded an Early Würmian age. These new U/Th-TIMS dates indicate a maximum age of around 88 ka for the base of the Hunas section. The minimum age of the site is constrained by the presence of typical Middle Palaeolithic artefacts within the top layer of the section. Therefore the whole sediment stack was deposited within a maximum time span of around 50 ka (OIS 5b till OIS 3; Rosendahl et al., 2005b).

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