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Numerically dated palaeontological cave sites of Alpine region from Late Middle Pleistocene to Early Late Pleistocene

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SUMMARY - *Numerically dated palaeontological cave sites of Alpine region from Late Middle Pleistocene to Early Late Pleistocene* - In this paper we present an overview of all published numerically dated palaeontological cave sites in the Alpine region between OIS 5 and OIS 7. A total of eleven strata were dated from 7 sites, most of them deposited during OIS 5; the rest belonging to OIS 6 and 7. Numerically dated palaeontological sites older than OIS 7 are not known.

RIASSUNTO - *Siti paleontologici in grotta della regione alpina tra il Pleistocene medio superiore e il Pleistocene superiore inferiore* - In questo lavoro è presentata una revisione generale di tutti i siti paleontologici in grotta datati numericamente nella regione alpina compresi tra OIS 5 e OIS 7. Un totale di undici strati provenienti da sette siti è stato datato, la maggior parte dei quali si sono depositati durante l'OIS 5, mentre gli altri sono riferibili all'OIS 6 e 7. Non sono noti siti paleontologici datati numericamente più antichi dell'OIS 7.

Key words: Alpine region, TIMS-^{230}Th/U, bones, speleothem, OIS 5 – OIS 7
Parole chiave: Regione alpina, TIMS-^{230}Th/U, ossa, speleotema, OIS 5 – OIS 7

1. INTRODUCTION

Caves are terrestrial depositories that preserve a large variety of organic and inorganic remains. These may contain important Quaternary climatic and ecological information. Most of the faunal remains, however, cannot be linked to any interglacial or glacial period exclusively. Reliable dating of such remains is therefore required. Experience has, however, shown that ^{230}Th/U dating of bones is of disputable value. Only TIMS-^{230}Th/U dating of speleothems appears to yield reliable ages. Dating the bottom and top of speleothem layers permit assigning Pleistocene faunal remains to the OIS (Oxygen isotope stage) chronology if the deposition of the speleothems and the faunal remains are clearly correlated. Care must be taken to consider the depositional situation of each site before interpreting any age dates.

2. STUDY AREA AND SITE DESCRIPTION

In the following overview we therefore summarize only those Alpine region cave sites (Fig. 1) for which numeric age data covering the period MIS 5 to 7 are available. The information regarding the respective sites was taken from the cited literature. A detailed critical discussion of the dating methods and the validity of the respective dates are, however, beyond the scope of this paper.

1. Conturines-Höhle (2775 m a.s.l.), Italy

The Conturines-Höhle (nr. 1, see Fig. 1) is located at the eastern slope of Piz dles Conturines, ca. 65 km E of Bozen. The bone-bearing sands obtained by dating the bones with ^{230}Th/U are 87±5 ka und 108+8/-7 ka (Withalm 2008). Faunal remains are summarized by Rabeder (1991, see also Tab. 1).

2. Ramesch-Knochenhöhle (1960 m a.s.l.), Austria

The Ramesch-Knochenhöhle (nr. 2, see Fig. 1) is located at the north-face of the Ramesch, a peak in the Warscheneckgruppe/Totes Gebirge, ca. 75 km S of Linz. Cave bear bones from unit G (dark sediments with cave bear remains and allochthonous pebbles) yielded ^{230}Th/U dates between 117+11/-10 ka and 150+25/-19 ka (Draxler *et al*. 1986). Faunal remains of unit G only consist of *Ursus spelaeus* (Draxler *et al*. 1986).

3. Schwabenreith-Höhle (959 m a.s.l.), Austria

The Schwabenreith-Höhle (nr. 3, see Fig. 1) is located S of the farm of Schwabenreith, W of the village of Lunz/See. The basal and top (unit 2) flowstone layers yielded ^{230}Th/U ages of 116±5 ka and 78+30/-23 ka, respectively (Frank & Rabeder 1997b). The faunal remains only consist of *Ursus spelaeus* (Pacher 2000).

4. Herdengelhöhle (878 m a.s.l.), Austria

The Herdengelhöhle (nr. 4, see Fig. 1) is located SW

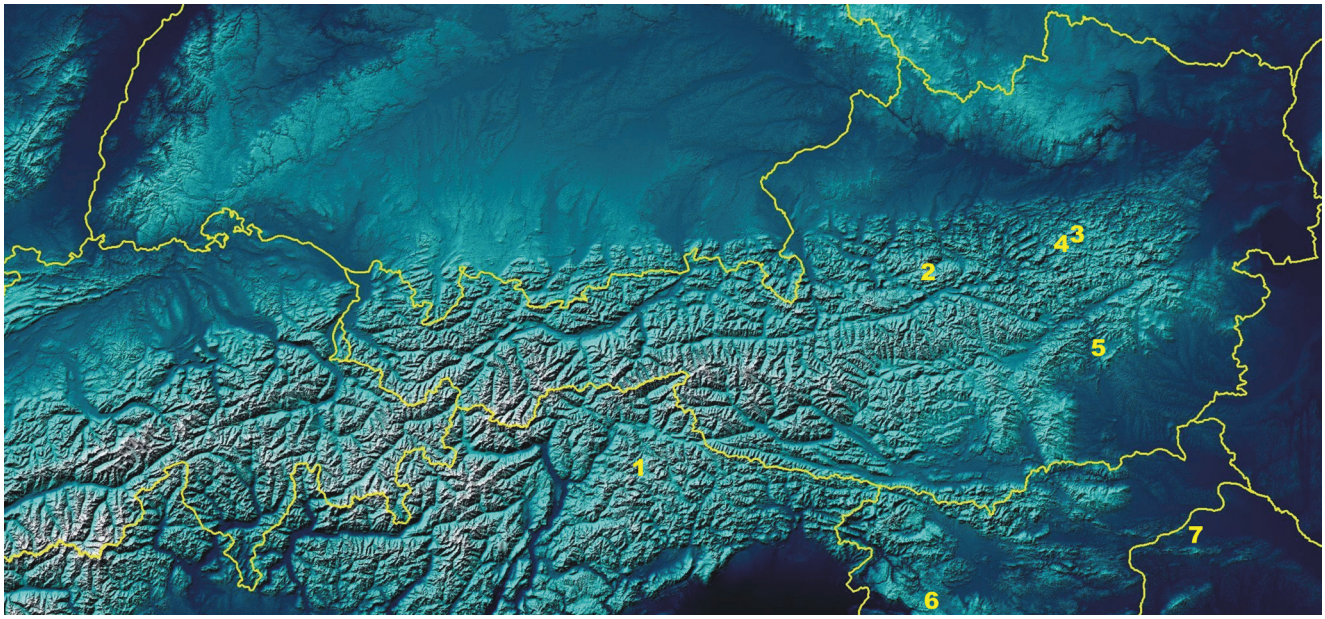

Fig. 1 - Map of the reported cave sites of the Alpine region (numbers refer to the text).
Fig. 1 - Mappa dei siti in grotta della regione alpina (per i numeri si veda il testo).

of the farm Herdengel, W of the village of Lunz/See. The flowstone layer of unit 2 was ^{230}Th/U dated to 111+11/-10 ka. The cave bear bones of unit 1 date back to the period from 135+11/-10 ka to 127±7 ka (Leitner-Wild *et al*. 1994). The faunal remains of unit 1 only consist of *Ursus spelaeus* (Frank & Rabeder 1997a).

5. Repolusthöhle (525 m a.s.l.), Austria

The Repolusthöhle (nr. 5, see Fig. 1) is located in the valley of Badl, ca. 20 km N of Graz. A cave bear bone from the lowest layers in the pit yielded a ^{230}Th/U age of 230+13/-12 ka (Fürnholzer 1997). The faunal remains of the lower rust-colored phosphate-rich sediment are summarized by Rabeder and Temmel (1997, see also Tab. 1).

6. Divje babe I (450 m a.s.l.), Slovenia

The Divje babe I site (nr. 6, see Fig. 1) is located in the Idrija valley near the village of Reka, ca. 60 km W of Ljubljana. ^{230}Th/U dating of a bear bone yielded 81±10 ka (unit 20) and 84±7 ka for unit 19 (Nelson & Ku 1997). The faunal remains from Unit 20-17 consist of *Ursus spelaeus* (Turk *et al*. 1989).

7. Vindija (275 m a.s.l.), Croatia

Vindija (nr. 7, see Fig. 1) is located on the southwest side of the Kriznjak Peak, 55 km N of Zagreb. ^{230}Th/U dates from cave bear bones of unit J range from 156±2 ka to 196+20/-15 ka and of the underlying unit K from 150 +16/-13 ka to 212 +17/-13 ka (Wild *et al*. 2001). Faunal remains are summarized by Malez & Ullrich (1982, see also Tab. 1).

3. DISCUSSION

The numerical dates of palaeontological sites in the Alpine region now available do not allow – with the exception of the Repolusthöhle – a critical discussion of their faunal assemblages as to their ecological-climatic distribution. Faunal remains of the Repolust Cave combine both Glacial and Interglacial species, i.e. *Rangifer tarandus* and *Megaloceros giganteus* occurs together with *Capreolus capreolus* and *Sus scrofa*. Thus the presence of cold climate species is in contrast to the numerical Interglacial date. But even this site is not without contradicting faunal elements and it remains doubtful if they represent either Glacial or Interglacial faunas. The flowstone dating of the sites Herdengelhöhle and Schwabenreith-Höhle yielded plausible minimal ages for their faunal elements. At the Schwabenreith-Höhle the cave bear bones are in between two dated flowstone layers. In this particularly case the fauna between these dated layers represents a certain time range and a mixing with younger and older remains can be excluded.

4. CONCLUSION

In spite of the fact that numerous palaeontologically important cave sites are known in Central Europe which may be dated into the time period MIS 5 to MIS 9 (e.g., Döppes & Rabeder 1997; Koenigswald & Heinrich, 1996, 1999), we found only seven sites from the Alpine region in the literature for which numerical dates have been published.

Palaeontological cave sites represent a rich archive that can contribute significantly to the reconstruction of the Middle and Upper Pleistocene palaeoclimate of the Alpine region, provided many additional dates can be obtained to verify results obtained from other terrestrial archives.

It will be from special interest to date the layers with different dating method (^{230}Th/U, ESR and TL) as we

Tab. 1 - Faunal remains from the cave sites Conturine-Höhle (Cu), Repolusthöhle (Re) and Vindija (Vi).
Tab. 1 - Resti faunistici dei siti in grotta di Conturine-Höhle (Cu), Repolusthöhle (Re) e Vindija (Vi).

	OIS 5b Cu	OIS 6 Vi-J	OIS 6 Vi-K	OIS 7 Re
Insectivora				
Sorex araneus				cf.
Talpa europaea				+
Chiroptera				
Myotis bechsteinii				+
Plecotus auritus				+
Lagomorpha				
Lepus sp.				+
Rodentia				
Marmota marmota	+	+		+
Spermophilus citellus				cf.
Cricetus major				+
Clethrionomys glareolus				+
Arvicola hunasensis				+
Microtus arvalis				+
Apodemus flavicollis				+
Apodemus sylvaticus				+
Hystrix cf. *vinogradovi*				+
Carnivora				
Canis lupus		+	+	?
Canis mosbachensis				+
Cuon alpinus		+		+
Vulpes vulpes				+
Ursus arctos				+
Ursus spelaeus	+	+	+	
Ursus deningeri				+
Mustela sp.				+
Mustela nivalis				+
Martes martes				+
Meles meles				+
Felis silvestris				+
Panthera leo spelaea	+	+	+	+
Panthera pardus			+	+
Lynx lynx				+
Crocuta crocuta spelaea			+	
Artiodactyla				
Sus scrofa			+	+
Cervus elaphus		+	+	+
Megaloceros giganteus			+	+
Dama dama			+	
Rangifer tarandus				+
Capreolus capreolus			+	+
Bovidae indet.		+		
Bos primigenius				+
Bison priscus				+

know from other cave sites from this time span (Rosendahl *et al*. 2007) for comparison.

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