Preistoria Alpina	v. 39 (2003)	pp. 115-127	Museo Tridentino di Scienze Naturali	Trento 2003	ISSN 0393-0157

Upper Pleistocene cave assemblages at alpine sites in Austria and adjacent regions

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ABSTRACT – The paper summarizes general characteristics of Upper Pleistocene cave assemblages of Austria and neighbouring regions. Special emphasis is given to large mammal remains and evidence of Palaeolithic humans. Radiometric dates obtained on cave bear bones are presented.

Key words: Upper Pleistocene, large mammal, Austria, Palaeolithic, alpine cave sites.
Parole chiave: Pleistocene superiore, Macromammiferi, Austria, Paleolitico, Siti alpini in grotta.

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1. INTRODUCTION

Numerous important archaeological and palaeontological cave sites of the Late Middle and Upper Pleistocene are known in Austria and neighbouring regions. The majority of alpine caves mentioned in this summary belong to the geological unit of the Northern Calcareous Alps. It comprises the largest area of karstified rocks in Austria. Caves are mainly developed in Triassic and Jurassic limestones. Some regions, like the Totes Gebirge or the Dachstein, have a long scientific history concerning Pleistocene cave sites. The latter area comprises numerous impressive cave systems and sites of mainly palaeontological importance. The former is one of the best investigated regions (see DÖPPES & RABEDER, 1997a). Furthermore single caves, revealing additional information concerning the characteristics of alpine sites are included in this paper. Few caves belong to the geological unit of the Southern Calcareous Alps. Among them is Conturines cave, the cave bear site at the highest elevation known so far, or Potočka zijalka one of the richest site in the Eastern Alps. Caves in alpine regions are found at low elevations and up to 2800m a.s.l. Sites at altitudes of more than 1500m are summarised under the term "High alpine sites".

2. HISTORY OF INVESTIGATION

The history of scientific investigations in caves, however, began at easier accessible karst-systems. In Austria, sites along the valleys of two source rivers of the river Krems in Lower Austria (GALIK, 1997; NEUGEBAUER-MARESCH, 1993) or numerous caves in the Central Styrian karst area, north of the city of Graz (FLADERER, 2000), have to be mentioned. In this area the oldest Palaeolithic artefacts of Austria are assumed at Repolusthöhle (MOTTL, 1949), although a necessary modern examination of the total assemblage is still missing (FUCHS *et al.*, 1999). First archaeological surveys at these sites date back into the late 19th century and the beginning of the 20th century. Important archaeological and palaeontological discoveries were already reported during this first phase of investigation.

On the other hand, many caves have probably been known to local people throughout times. These caves reveal finds from various prehistoric and historic periods up to the Romans and to the Middle Ages (FUCHS, 1993; GALIK, 1997). Furthermore, evidence of fossil bones in caves let to tales about mythical creatures. Especially cave bear bones were regarded as remains of dragons. Bones and teeth were collected by special "bone-diggers" and sold as medicine against a

variety of diseases - a fact well documented in case of the Drachenhöhle ("Dragoncave") near Mixnitz (f.e. ABEL, 1926; KUSCH & KUSCH, 1998).

Between the two World Wars a special program was established in order to produce fertilizer out of cave sediments. Several caves were surveyed for sediments enriched with phosphates, but industrial mining took only place in the Drachenhöhle near Mixnitz. Palaeontologists and archaeologists accompanied the mining activities and documented a rich cave bear fauna and Palaeolithic remains (ABEL & KYRLE, 1931).

At the beginning of the 20th century E. BÄCHLER (1940) discovered cave bear remains and Palaeolithic artefacts in three high alpine caves in Switzerland. His discoveries were a scientific sensation at that time. PENCK & BRÜCKNER (1909) had already established their classical subdivision of the Pleistocene into four glacial and three interglacial periods. The Alps had been regarded as frozen waste, hostile to life, during glaciations. Better living conditions were only assumed during warm periods. Thus, leaving the last Interglacial (Riss-Würm or Eemian) as time in which cave bear and man may have occupied high alpine caves. *Homo sapiens neanderthalensis* was proven in Europe during the Eemian, and the "primitive" impression given by the majority of artefacts found at these sites seemed to confirm the idea of Neanderthal man visiting or even living in high-altitude caves.

The hypotheses of a specialized cave bear hunting culture in the Alps during the late Middle Pleistocene was established. The assumptions of a subsistence based on cave bear hunting, of bone tools manufactured from cave bear bones and a ritual worship of cave bear remains stayed controversial but let to an increased focus on alpine sites (see discussion in JÈQUIER, 1975; MOTTL, 1975; PACHER, 1997, 2001a).

Bächler's discoveries also influenced research and interpretation of finds in Austrian caves. Among others, the Salzofenhöhle and the Drachenhöhle near Mixnitz were discussed as sites of cave bear hunters. After the recovery of Early Upper Palaeolithic artefacts in alpine caves, such as Potočka zijalka in Slovenia (BRODAR & BRODAR, 1983), cave bear hunting groups were assumed among Neanderthals as well as among Early Upper Palaeolithic people.

An increased knowledge on stratigraphy in caves let to the discarding of many ideas such as a mass occurrence of cave bears or specialized cave bear hunting groups. The development of a more fine-scaled chronology and a better knowledge of climatic oscillations during glaciations placed alpine sites now into a warmer period (Interstadial) of the early Wuerm (f. e. SCHMID, 1957). This chronology still did correspond to the alleged evidence of Neanderthal man or Early Upper Palaeolithic remains at various sites.

It was not before the late 1970s that a new period of cave exploring was introduced in Austria. Excavations in the Teufelsrast-Knochenfuge in the valley of the river Krems (NEUGEBAUER-MARESCH, 1993), the Große Badlhöhle in the Central Styrian karst area (FUCHS, 1989) or the Ramesch-Knochenhöhle in the high Alps (HILLE & RABEDER, 1986) marked the beginning of detailed multidisciplinary approaches. The co-operation of various disciplines revealed new insights into climatology, chronology, site-formation processes, the evidence of Palaeolithic man, man-animal relationship and evolutionary trends in cave bears.

Since a few years special emphasize is given to detailed taphonomic analyses of cave assemblages. This approach revealed the complexity of cave sites and the problems of time resolution. It provides further information concerning the taphonomic history of finds as well a possible bias of data (KUNST, 1992; KÜHTREIBER & KUNST, 1995; PACHER, 2000). Further new aspects concerning palaeobiology and phylogeny of Pleistocene animals can be expected by the recently applied ancient DNA analyses on remains from alpine cave sites (HOFREITER *et al.*, 2002).

3. GENERAL CHARACTERISTICS OF CAVE SITES

In general, caves provide shelter for animals and man, and caves favour the preservation of fossils (RENTZEL, 1993; LOWE & WALKER, 1997; PACHER, 2000). Depending on the morphology of caves two facies areas are distinguished. The entrance part is influenced by external climatic conditions and is therefore subject to the freeze-defreeze cycle throughout a year. The input of organic material and exotic sediments is evident and results in a complex stratigraphy. Remains of Palaeolithic resting places are normally restricted to the entrance part and the fore-cave area.

The interior passage of caves is relatively protected from daily and seasonal changes in weather and climate. Thus, temperature remains constant throughout the year. These deep parts of a cave are mainly restricted to remains of cave bears and "associated" fauna elements.

Sediment sequence in caves characterizes by several hiatuses and facies variation inside a cave (RENTZEL, 1993). Especially at the entrance part remains of different periods are preserved producing mixed assemblages or palimpsests (KÜHTREIBER & KUNST, 1995; STINER, 1996). Younger finds are incorporated into stratigraphical older sediments. Older remains, mainly cave bears, are often reworked but can still represent the most abundant fauna element.

Different taphonomic agents and processes may

contribute to the total assemblage. The composition of taphocoenoses depends mainly on the geographical position of a cave and its topographic characteristics. Following the classification of ZAPFE (1954) five types of cave sites are differentiated. He distinguishes cave bear sites, hyena dens, small carnivore sites and Palaeolithic resting places. As a special case he refers to pit falls and shafts that function as natural traps either as part of a larger cave system or as separate karst phenomenon. In one region several types of sites are evident, and the same cave may serve for various functions either contemporaneously or at different times. The following summary focuses mainly on cave bear sites and Palaeolithic remains of the Totes Gebirge and other caves in the Northern Calcareous Alps of Austria as well as on few sites in adjacent regions. For details about cave sites in the valley of the river Krems and the Central Styrian karst area the reader is referred to NEUGEBAUER-MARESCH (1993), FLADERER (2000) and DÖPPES & RABEDER (1997).

4. TOTES GEBIRGE (Fig. 1)

The Totes Gebirge is the largest karst plateau of the Alps. This massif covers an area of 600 km^2 north and south to the border between the federal states of Upper Austria and Styria. The plateau and its highest elevations are mainly developed in Triassic and Jurassic limestone (RABEDER, 1999). The highest peaks reach more than 2000m a.s.l..

Archaeological surveys date back into the 1920s. Until now seven Pleistocene sites are known (Fig.1, Tab. 4). Remains of cave bears are most abundant. The entrance part of these caves often reveals a mixed assemblage consisting of Ungulate remains, few artefacts, middle to small-sized carnivores and cave bear bones. Furthermore small mammals and other vertebrates, molluscs and pollen are determined (see sites in DÖPPES & RABEDER, 1997). Four of these caves, Liegloch, Gamssulzenhöhle, Ramesch-Knochenhöhle and Salzofenhöhle, revealed also evidence of Palaeolithic man. In general, the caves of the Totes Gebirge show a variety of characteristics that seem to be typical for alpine caves sites:

4.1. *Palaeolithic evidence*

Evidence of Palaeolithic man is proven at several alpine sites but the chronological position of the majority of remains is rather uncertain. With exception of Potočka zijalka, the number of artefacts recovered is relatively low. Finds are often described as untypical pieces or stone tools of a more "primitive", Mousterian like character. An own cultural tradition in the alpine region was assumed therefore, termed "alpine Palaeolithic" after (BÄCHLER, 1940), whereas caves with untypical Early Upper Palaeolithic remains in combination with bone points were classified as "Olschewien" (BAYER, 1929). Both definitions were dismissed later on, because they summarize cave sites of several periods and various typological traditions. Differences in assemblage composition are then ra-

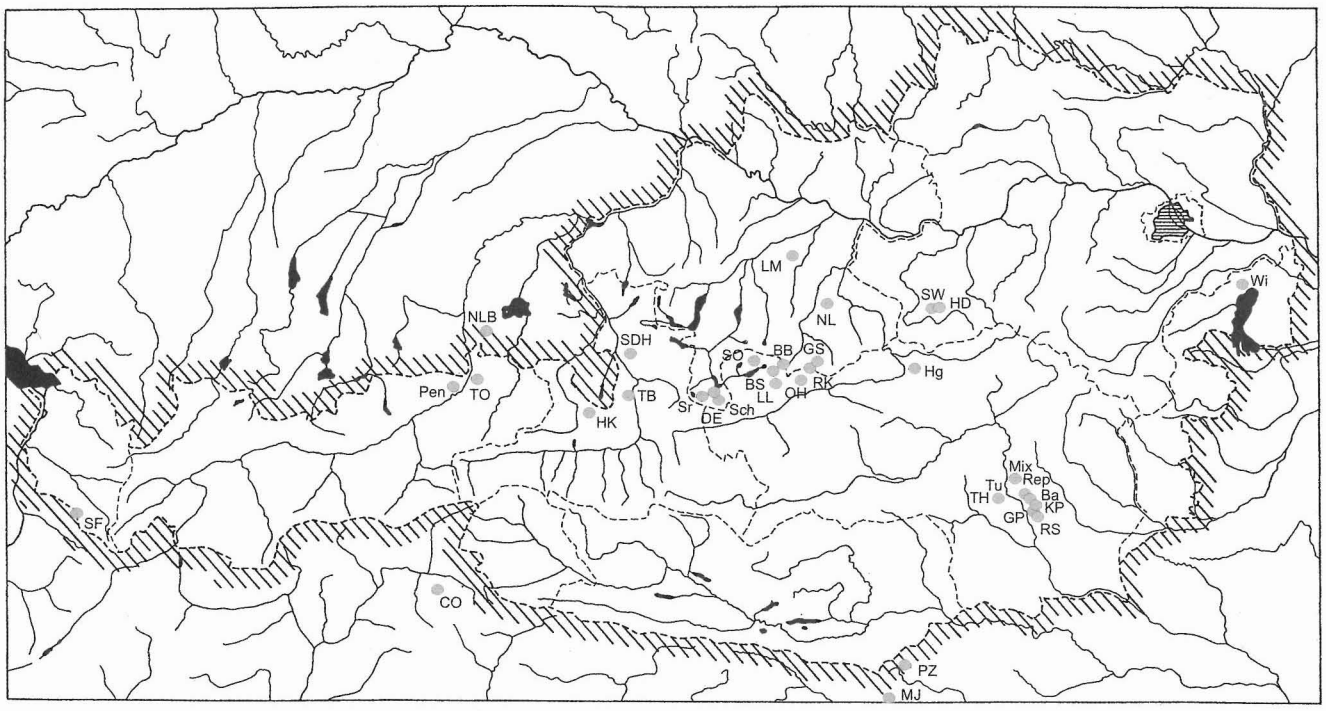

Fig.1 - Upper Pleistocene cave sites of the alpine region and other caves mentioned in this summary (Abbrevations as in Tab. 1 and 2).

ther ascribed to various functions of sites (see discussion in JÈQUIER, 1975; MOTTL, 1975; HAHN, 1977). Recently the term "Olschewien" is discussed as regional tradition in Slovenia and Croatia by MONTET-WHITE (1996) and KARAVANIĆ (2000).

The caves of the Totes Gebirge clarify the scientific history regarding alpine Palaeolithic sites. Salzofenhöhle and Lieglloch represent the first period. Hearts, cultural layers, few artefacts and modified cave bear bones are described (KÖRBER, 1939; MOTTL, 1950a; EHRENBERG, 1958/59). Following the scientific tradition at that time artefacts and faunal remains were placed into the last Interglacial or an Early Würm Interstadial. The cave assemblage was more or less regarded as single complex of finds. At least all large mammal remains were ascribed to human hunting activity. At Salzofenhöhle proposed evidences of ritual deposited cave bear bones were reported (see summary in PACHER, 1997).

Concerning lithic artefacts, Lieglloch revealed few atypical flakes and one stone artefact attributed to a Middle Palaeolithic tradition (MOTTL, 1950b). Besides pseudo-bone tools a fragment of a bone point is determined as evidence of Early Upper Palaeolithic, respectively Olschewien tradition (MOTTL, 1950b, 1975). Among the eight stone tools recovered in the Salzofenhöhle only one is determined as artefact. This piece is described as convergent (side) scraper but is not enough to determine a Moustèrien tradition (MOTTL, 1950a). In 1983 another artefact was recovered and again described as side scraper of the Middle Palaeolithic (PITTIONI, 1984).

Hearths and "cultural layers" reported at both sites are interpreted with caution. Chemical analysis proved the proposed "cultural layers" at Salzofenhöhle as inorganic depositions (EHRENBERG, 1941: 330). Scattered pieces of charcoal were incorporated within sediments (SCHMID, 1957). One sample was measured by conventional radiocarbon method and produced an age of 34.000+/-3000a BP (Gro-761). A bone derived from the alleged "cultural layer" was beyond the limits of radiocarbon method and resulted in an age >44.5000a BP, respectively >54.000a BP. Pollen and plant remains revealed an age of 31.200+/-1.100a BP (DÖPPES *et al.*, 1997). A cave bear bone, collected at the entrance part in 1999 yielded again an age beyond the limits of radiocarbon dating with >49.000a BP (DÖPPES 2001: 25).

Problems in distinguishing Palaeolithic hearths from charcoal remains of natural or modern fires are also evident at other alpine sites. At the Swiss Drachenloch-cave (LEUZINGER-PICCAND *et al.*, 1999) one date obtained on charcoal produced a very recent age of 5.730+/-35a BP (GrN-12277). Dating of charcoal from a second proposed Palaeolithic fireplace resulted in a minimum age of >49.000a BP (GrN-1432) and >53.000a BP (GrN-1477). It has to be noted, that Drachenloch-cave reveals no certain evidence of Palaeolithic man (TENSORER, 1993). At Potočka zijalka on the other hand, Palaeolithic hearths, modern fireplaces and probably charcoal concentrations from natural fires are documented but undated (BRODAR & BRODAR, 1983).

Ramesch-Knochenhöhle marked to some extent the beginning of modern investigations at alpine caves (see 4.2). During excavation five stone artefacts were recovered. One artefact is an outstanding evidence of the Levallois-technique (PITTIONI, 1986) and surprisingly unique at alpine sites.

The best investigated cave of the four Palaeolithic sites of the Totes Gebirge is certainly Gamssulzenhöhle. Excavation area 1 at the entrance part yielded a mixed assemblage of late glacial remains embedded into older sediments with cave bear bones. Specific samples for radiometric age determination proved the palimpsest character of layers as already assumed because of thorough taphonomic investigations of artefacts and fauna remains (KÜHTREIBER & KUNST, 1995). 45 stone artefacts and 2 bone points give evidence of a short-term hunting station of late Palaeolithic people. Despite the relative large assemblage of artefacts and a number of typological identifiable pieces the exact chronological position was determined by radiometric dating of associated fauna elements (KÜHTREIBER & KUNST, 1995:94). Taphonomic approaches and spatial distribution analyses of artefacts and bones proved a correlation between these types of finds.

Outside the Totes Gebirge, more or less the same results had already been obtained at Nixloch-cave near Losenstein in Upper Austria. At this site seven lithic artefacts and one bone point are ascribed to late Palaeolithic and probably Mesolithic tradition. Determination was derived from radiocarbon data of fauna remains and to a lesser degree from the morphology of the retrieved artefacts (KÜHTREIBER, 1992).

Two other alpine cave sites of the Northern Calcareous Alps revealed artefacts, too. A single specimen is reported from Herdengelhöhle. The lower entrance of this cave lies at 878m above sea-level but the characteristics of the total assemblage of finds classifies this site as typical alpine cave bear site. The lithic artefact retrieved is attributed to a Moustèrien tradition (FRANK & RABEDER, 1997a). Another site at lower altitude is Tischoferhöhle in Tyrol. From this cave six bone points are reported and traditionally determined as Olschewien remains (ZOTZ, 1964/65).

An extraordinary rich Palaeolithic assemblage is recovered at Potočka zijalka in the southern Alps. 80 lithic artefacts and 130 bone points are described (BRODAR & BRODAR, 1983; BRODAR, 1994; PACHER, 2001). The majority of remains is attributed to the Early Upper Palaeolithic. BAYER (1929) introduced the "Olschewien" as distinct Early Upper Palaeolithic facies, on behalf of certain characteristics of the Palaeolithic assemblage at

Potočka zijalka. The nearby Mokriška jama revealed far less Palaeolithic remains. Due to evidence of several bone points the site is also placed into Aurignacien or Olschewien tradition (Brodar, 1960, Montet-White, 1996). The evidence of younger, probably Epipalaeolithic remains is discussed (Brodar, 1960).

Bone points were regarded as type fossil of the Olschewien tradition after Bayer (1929) but the described specimen reveal a high variability (Albrecht *et al.*, 1972; Mottl, 1975; Turk, 2002) and a longer chronological time range (Patzelt *et al.*, 2002). Furthermore bone points are mainly distinguished at their basis, making it even more difficult to determine fragments (Albrecht *et al.,* 1972; Kühtreiber & Kunst, 1995). As with lithic artefacts from alpine caves the majority of remains is non stratified.

Few other alpine caves yielded only a variety of pseudo bone-tools. In tradition of a cave bear hunting culture several types of bone fragments were described as artefacts (f.e. Ehrenberg, 1976). Among them, the most controversial types are so-called "flutes" manufactured from cave bear bones (see Albrecht *et al.*, 1998; Turk, 1997).

4.2. *Cave bears (Fig.2 & Tab.1)*

First of all, caves of the Totes Gebirge and many other sites are classified as alpine cave bear sites. *Ursus spelaeus* may contribute with up to 99% to the total faunal assemblage.

Cave bears are regarded as completely herbivorous and these animals used caves to hibernate (Rabeder *et al.* 2000: 31-38). Finds of neonates prove caves as nursery places. At least the majority of cave bear bones recovered at cave sites are remains from bears that died during hibernation period. Evidences of human hunting activities or exploitation of cave bears are rare and mostly controversial. Recently Münzel & Langguth (2001) and Tillet & Bernard-Guelle (1998) published traces of human produced modifications on cave bear bones.

Gnawing marks are evident on cave bear bones at many alpine sites. Depending on the intensity of damage, the modifications are primarily attributed to the activity of wolves or cave bears (Pacher, 2000).

If bears used caves to hibernate one would assume the deposition of whole carcasses. Despite this assumptions articulated skeletal parts are rare. More or less complete skeletons are only encountered at special protected places, such as narrow passages or as part of a shaft-fauna (see Pacher, 2000: 57). Disarticulation of skeletons is attributed to the activity of carnivores, other cave bears and physical transport processes.

Previous, traditionally based chronologies, placed cave bear remains at alpine sites into the last Interglacial or an early Interstadial of the Würm (Bächler, 1940; Ehrenberg, 1941). A first series of radiometric data obtained at Ramesch-Knochenhöhle refuted this assumption. Surprisingly, the majority of data obtained range from 65000 to 30000a BP

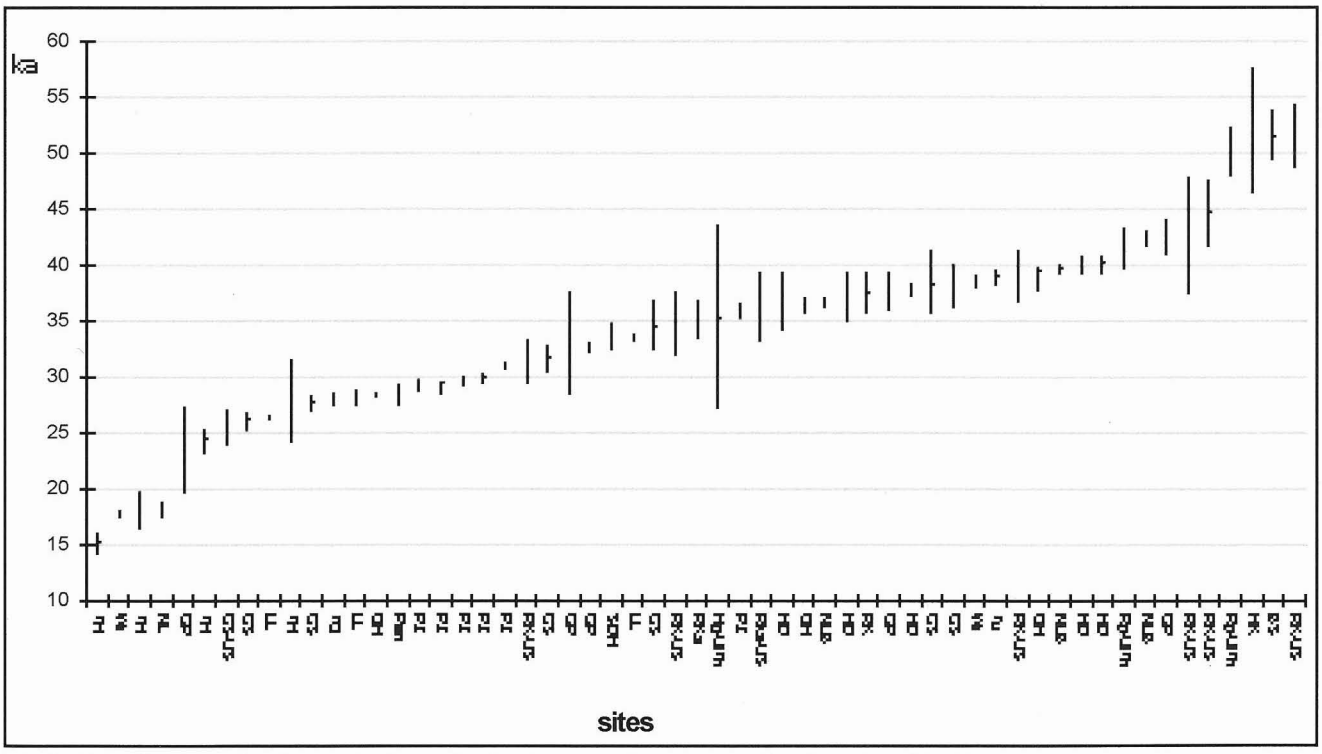

Fig.2 - Distribution of radiometric dates obtained on cave bear bones (database in table 1)

	site	laboratory	date (BP)	method	reference
TH	Tropfsteinhöhle	Hv-16895	15.000+/-865	conv	Fladerer, 2000
Wi	Windener Bärenhöhle	VRI-1029	17.680+/-238	conv	Döppes & Rabeder, 1997b
TH	Tropfsteinhöhle	Hv-16894	17.900+1870/-1400	conv	Fladerer, 2000
NL	Nixloch bei Losenstein	VRI-1030	18.130+/-580	conv	Frank & Rabeder, 1997
GP	Große Peggauerwandhöhle	VRI-1310	22.600+4500/-2900	conv	Fladerer, 2000
TH	Tropfsteinhöhle	VRI-1256	24.200+/-900	conv	Fladerer, 2000
GS	Gamssulzenhöhle	VRI-GS II	25.400+/-1500	US	Frank & Rabeder, 1997
GS	Gamssulzenhöhle	Hv-16893	25.965+/-780	conv	Kühtreiber & Kunst, 1995
LL	Lieglloch	VERA-2184	26.390+/-110	AMS	unpublished
TH	Tropfsteinhöhle	VRI-1350	27.000+4500/-2900	conv	Fladerer, 2000
GS	Gamssulzenhöhle	Hv-16892	27.520+/-645	conv	Kühtreiber & Kunst,1995
TO	Tischoferhöhle	Hv-5441	27.875+/-485	conv	Patzelt et al., 2002
LL	Lieglloch	Ua-15978	28.130+/-600	conv	
OH	Ochsenhalt-Höhle	VERA-2191	28.370+/-140	AMS	unpublished
Pen	Pendling Höhle	Hv-4850	28.370+/-905	conv	Patzelt et al., 2002
PZ	Potocka zijalka	GrN-23501	29.130+570/-530	conv	Pacher, 2001
PZ	Potocka zijalka	VERA-0659	29.310+750/-250	AMS	Pacher, 2001
PZ	Potocka zijalka	GrN-23500	29.600+/-290	conv	Pacher, 2001
PZ	Potocka zijalka	VERA-0661	29.810+/-270	AMS	Pacher, 2001
PZ	Potocka zijalka	VERA-0660	30.980+330/-310	AMS	Pacher, 2001
RK	Ramesch-Knochenhöhle	RK81-D1-nr.1	31.300+1900/-1800	US	Hille & Rabeder, 1986
GS	Gamssulzenhöhle	VRI-1226	31.500+1300/-1100	conv	Kühtreiber & kunst, 1995
GP	Große Peggauerwandhöhle	VRI-1311	31.800+5600/-3300	conv	Fladerer, 2000
GP	Große Peggauerwandhöhle	ETH-9656	32.600+/-400	conv	Fladerer, 2000
SDH	Schlenkendurchgangshöhle		33.415+1150/-1050	conv	Frank & Rabeder, 1997
LL	Lieglloch	VERA-2185	33.500+/-240	AMS	Unpublished
GS	Gamssulzenhöhle	VRI-1228	34.300+2400/-1900	conv	Kühtreiber & Kunst, 1995
RK	Ramesch-Knochenhöhle	RK83-L11-nr.1	34.600+2800/-2700	US	Hille & Rabeder, 1986
RK	Ramesch-Knochenhöhle	VRI-776	34.900+1800/1500	conv	Hille & Rabeder, 1986
Hg	Bärenhöhle im Hartlesgraben		35.000+8400/-7700	U/Th	Rabeder, 1997
PZ	Potocka zijalka	GrN-22335	35.720+650/-600	conv	Pacher, 2001
RK	Ramesch-Knochenhöhle	RK80-D7-nr.2	36.100+3000/-2800	US	Hille & Rabeder 1986
HD	Herdengelhöhle	VRI-1506	36.200+2900/-2100	conv	Frank & Rabeder, 1997
OH	Ochsenhalthöhle	VERA-1601	36.240+670/-620	AMS	Rabeder, 2001
NLB	Neue Laubenstein-Bärenhöhle	GrA-13380	36.610+320/-300	AMS	Rosendahl & Grupe, 2002
HD	Herdengelhöhle	VRI-1506	36.800+2300/-1800	conv	Frank & Rabeder, 1997
RK	Ramesch-Knochenhöhle	VRI-792	37.200+1900/-1600	conv	Hille & Rabeder, 1986
GP	Große Peggauerwandhöhle	GrN-22338	37.400+1800/-1500	conv	Fladerer, 2000
HD	Herdengelhöhle	ETH-11567	37.670+/-590	AMS	Frank & Rabeder,1997
GS	Gamssulzenhöhle	VRI-1227	38.000+3300/-2300	conv	Kühtreiber & Kunst, 1995
GS	Gamssulzenhöhle	VRI-1326	38.000+2000/-1900	conv	Frank & Rabeder, 1997
Wi	Windener Bärenhöhle	VERA-0062	38.500+430/-450	AMS	unpublished
Tu	Tunnelhöhle	ETH-9657	38.810+/-680	conv	Fladerer, 2000
RK	Ramesch-Knochenhöhle	RK80-D7-nr.3	38.900+2300/-2200	US	Hille & Rabeder, 1986
OH	Ochsenhalthöhle	VERA-2190	39.260+500/-470	AMS	unpublished
NLB	Neue Laubenstein-Bärenhöhle	GrA-13378	39.520+440/-410	AMS	Rosendahl & Grupe, 2002
HD	Herdengelhöhle	ETH-11568	40.030+/-740	AMS	Frank & Rabeder, 1997
HD	Herdengelhöhle	ETH-11568	40.030+/-740	AMS	Frank & Rabeder,1997
Rep	Repolusthöhle	Uh1267	41.400+/-1700	U/Th	Fuchs et al., 1999
NLB	Neue Laubenstein-Bärenhöhle	GrA-13382	42.360+590/-550	AMS	Rosendahl & Grupe, 2002
GP	Große Peggauerwandhöhle	ETH-10406	42.400+/-1500	conv	Fladerer, 2000
RK	Ramesch-Knochenhöhle	RK80-D7-nr.1	42.400+5300/-4900	US	Hille & Rabeder, 1986
RK	Ramesch-Knochenhöhle	RK82-U17-nr.1	44.500+2900/-2800	US	Hille & Rabeder, 1986
Rep	Repolusthöhle	Uh1265	50.100+/-2100	U/Th	Fuchs et al., 1999
HK	Äußere Hennenkopfhöhle	GrN-22361	50.200+7200/-3700	AMS	Cech et al., 1997

BS	Brettsteinbärenhöhle	VERA-2186	51.300+2300/-1800	AMS	unpublished
RK	Ramesch-Knochenhöhle	RK81-D8-nr.3	51.300+2800/-2700	US	Hille & Rabeder, 1986
RK	Ramesch-Knochenhöhle	RK83-L11-nr.3	52.000+4700/-4500	US	Hille & Rabeder, 1986
SW	Schwabenreith-Höhle	VERA-0061	52.500+1900/-2500	AMS	Pacher, 2000

Tab. 1 - List of radiometric dates of *Ursus spelaeus* at cave sites from Austria and adjacent region. The list serves as database for figure 2.

	site	**laboratory**	**Date (BP)**	**method**	**reference**
Ba	Badlhöhle	VRI-1398	>34000	conv	Fladerer, 2000
BS	Brettsteinbärenhöhle	GrN-23502	>37600	conv	Döppes, 2001
BS	Brettsteinbärenhöhle	GrA-9428	>44000	AMS	Döppes, 2001
BS	Brettsteinbärenhöhle	GrN-23503	>41100	conv	Döppes, 2001
CO	Conturineshöhle		>39000	conv	Rabeder, 1991
HK	Äußere Hennenkopfhöhle		>43900	AMS	Cech et al., 1997
KP	Kleine Peggauerwandhöhle	VRI-1389	>27000	conv	Fladerer, 2000
LM	Lettenmayerhöhle	VERA-0058	>54000	AMS	unpublished
RS	Rittersaal	VRI-1394	>29600	conv	Fladerer, 2000
RS	Rittersaal	VRI-1395	>34500	conv	Fladerer, 2000
RK	Ramesch-Knochenhöhle	VRI-793	>40700	conv	Hille & Rabeder, 1986
SO	Salzofenhöhle	VERA-1285	>49100	AMS	unpublished
SDH	Schlenkendurchgangshöhle		>42735	conv	Frank & Rabeder, 1997d
Sr	Schreiberwandhöhle	GrA-9429	>49000	AMS	unpublished
SW	Schwabenreith-Höhle	VERA-1600	>48100	AMS	unpublished
TB	Torrener Bärenhöhle	VERA-1293	>48500	AMS	unpublished
RK	Ramesch-Knochenhöhle	RK83-L11-nr.2	62.100+4.100/-3.900	US	Hille & Rabeder, 1986
RK	Ramesch-Knochenhöhle	RK82-U16-nr.1	64.000+5.400/-5.100	US	Hille & Rabeder, 1986
HD	Herdengelhöhle	VRI B	65.800+/-2.300	US	Frank & Rabeder, 1997a
HD	Herdengelhöhle	VRI C	66.400+/-3.000	US	Frank & Rabeder, 1997a
Rep	Repolusthöhle	Uh1266	85.800+/-2.800	U/Th	Fuchs et al., 1999
RK	Ramesch-Knochenhöhle	RK82-U16-nr.2	117.400+11.300/-10.000	US	Hille & Rabeder, 1986
RK	Ramesch-Knochenhöhle	RK82-U16-nr.2	117.500+20.100/-16.000	US	Hille & Rabeder, 1986
HD	Herdengelhöhle	VRI E	126.900+7.000/-6.700	US	Frank & Rabeder, 1997a
RK	Ramesch-Knochenhöhle	RK81-D8-nr.4	150.400+24.700/-19.000	US	Hille & Rabeder, 1986
Rep	Repolusthöhle	Uh1268	223.600+13.400/-11.800	U/Th	Fuchs et al., 1999
Rep	Repolusthöhle	Uh1269	>330000	U/Th	Fuchs et al., 1999

Tab. 2 - List of additional radiometric dates obtained on cave bear bones.

(Hille & Rabeder, 1986). As a consequence of this series of dates a discussion concerning climatic condition during the Middle Wuermian period arose (Draxler *et al.*, 1986). The main question of the dispute is, if cave bears lived in the surrounding of high alpine caves throughout a year. Pollen of herbs and various ontogenetic stages of cave bears are stated as arguments in favour of this assumptions. Climatic conditions in the Alps must have enabled a large herbivorous species to live at these altitudes, therefore even Interglacial conditions ("Ramesch-Interglazial") are proposed (Draxler *et al.* 1986; Rabeder, 1993).

Meanwhile, numerous radiometric data are derived from cave bear samples of various alpine sites (Tab.1, Fig. 2). In combination with absolute dating methods, a chronology of cave bear sites is undertaken by means of morphodynamic analyses of evolutionary trends in teeth and metapodials (Leitner-Wild *et al.*, 1994; Rabeder, 1997a; Rabeder & Nagel, 1997; Withalm, 2001). The database available (Tab.1) is completed by radiocarbon dates from four caves of the Central Styrian karst area (Fladerer, 2001; Fuchs *et al.*, 1999) and the Windener Bärenhöhle in Lower Austria (Döppes & Rabeder, 1997b). The majority of dates obtained range from 24000a BP to 45000a BP (Fig. 2). Cave bears were therefore abundant at alpine sites during the younger period of marine isotopic stage 3. OIS 3 characterizes by rapid climatic fluctuations, which make it impossible to further subdivide this stage using astronomical parameters (Weissmüller, 1997). Few samples from the Central Styrian karst area prove cave bears at lower elevations during the Middle Wuermian, too.

species	site	Lab	Method	data (BP)	reference
*Ursus arctos?**	GS	VRI-GS I	US	10.800+800/-250	Frank & Rabeder, 1997
Ursus arctos	NLB	GrA-13379	AMS	10.140+/-50	Rosendahl & Grupe, 2001
Ursus arctos	NLB	GrA-13383	AMS	>50.000	Rosendahl & Grupe, 2001
Capra ibex	GS	VRI-1327	conv. 14C	10.180+/-160	Kühtreiber & Kunst, 1995
Capra ibex	NLB	GrA-13377	AMS	11.350+/-50	Rosendahl & Grupe, 2001

* brown bear and not cave bear is assumed

Tab. 3 - Radiometric data for *Ursus arctos* and *Capra ibex* from two alpine cave sites.

Conventional radiocarbon dates, AMS dates, U/Th dates as well Uran-series dates (Mais *et al.*, 1982) are included in table 1 and 2. In general US-dates reveal a high standard deviation (+/-1500a and more) including the aberrant result from Hartlesgrabenhöhle (Hg). Nonetheless, one sample of Ramesch-Knochenhöhle yielded nearly identical age if dated by conventional radiocarbon method (RKa) and US-method (RKa-US). Seriously deviant are mainly dates obtained from samples close to the limits of radiocarbon method (BS, SW, HK) and three dates from caves of the Central Styrian karst region (TH, GP). Standard deviation exceeds +/-1400 up to +/-7500a (Tab. 2). The database must further be interpreted in the light, that conventional 14C-dates may be misleading with errors increasing strongly at ages older than 30.000a BP (Jöris & Weninger, 2000: 14) and, that radiocarbon dates listed in table 1 and 2 are uncalibrated.

Four dates obtained, suggest cave bears might have survived the Last Glacial Maximum. The two dates from Tropfsteinhöhle (TH) must be interpreted with caution. According to Fladerer (2001), contamination cannot be excluded. At Winden (Wi) it is uncertain whether the date was obtained on a bone from brown or cave bear (Döppes & Rabeder, 1997b). The only reliable date seems to be the result from Nixloch-cave (Kunst, 1992). This cave is the only site dated close to the Pleniglacial in the alpine region of Austria.

Several samples from alpine caves and four dates obtained on cave bears from the Central Styrian karst (Ba, KP, RS) resulted in minimum ages, because samples are beyond the limits of radiocarbon (conventional and AMS) method or contaminated. U/Th and US-dates of cave bear bones and flowstone also indicate older cave bear remains of the Early Wuermian (SW, HD, RK, Rep) or even Eem (HD, RK). Two samples from Repolust cave in the Central Styrian karst area result in a Middle Pleistocene age of bears. Up to now few reliable data for these older periods are available. The ongoing project on dating speleothems by the improved TIMS-U/Th method (Spötl *et al.*, 2000) confirmed speleothem deposition in alpine caves f. e. during the Eemian and OIS 3. A combination of proxy data from cave bear sites and speleothems will certainly contribute to the reconstruction of alpine environmental conditions.

4.3. *Large mammal fauna diversity*

Besides cave bears several other taphonomic components contribute to the total assemblage of alpine caves (Kühtreiber & Kunst, 1995). The fauna record is relatively uniform with cave bear being the main component. Remains of other species are often rare. Compared to caves at lower altitudes species diversity is lower.

4.3.1. *Carnivores*

Large and middle sized carnivores (*Panthera spelaea, Canis lupus, Gulo gulo*) are regarded as "associated" fauna elements of the cave bear taphocoenoses. Cave lion and wolverine (Döppes, 2001) are certainly Pleistocene fauna elements and more or less regularly determined at alpine caves (Tab. 4). At some sites a correlation of *Panthera spelaea* and cave bears on primary deposition is clearly proved (f.e. Schmid, 1977; Kunst, 1993). Furthermore, yet unpublished radiometric data confirm the evidence of cave bear and cave lion at Gamssulzenhöhle at the same period (pers. comm. Nagel). Wolverine at Salzofenhöhle yielded an age of 33.200+/-400a BP (Döppes, 2003) whereas the one cave bear sample yielded only a minimum age.

The chronologically position of wolf is slightly more controversial. *Canis lupus* is probably responsible for intensive gnawing marks on cave bear remains at several sites (Pacher, 2001; Rabeder, 1997c) and sometimes the only additional species determined at cave bear sites. On the other hand, remains of wolf are documented in layers with slightly reworked cave bear bones (Schmid, 1977) and *Canis lupus*, most likely, contributed to the late glacial ungulate taphocoenoses at alpine sites as well (Kühtreiber & Kunst, 1995; Kunst, 1993).

Crocuta crocuta misses at higher alpine regions and is only determined at Tischoferhöhle. Other middle and small sized-carnivores, like Mustela, Martes, foxes or Felidae are either recovered at remote parts of caves (Kunst, 1993) as part of the cave bear taphocoenoses (Pacher, 2001) or at higher stratigraphical levels (Schmid, 1977; Kühtreiber & Kunst, 1995).

Concerning the taphonomic origin of carnivore remains all of these species, especially Canidae and

site	altitude	Paeol.	Can.	Alo.	Vul.	Uar.	Usp.	Mus.	Mar.	Gul.	Cro.	Fel.	Lyn.	Pan.	Sus	Ran.	Cer.	Alc.	Cap.	Cib.	Rup.	Ovi.	ind.
BB	1960m		+				++														+		
BS	1660m		+				++			+				+	+		+			+	+		
GS	1300m	LP	+		+	+	++	+	+				+	+				+		+			
LL	1290m	UP	+				++										+			+			
OH	1650m						++																
RK	1960m	MP	+			+	++							+						+			
SO	2005m	MP	+		+	+	++		+	+				+			+		+	+			
Hg	1230m						++			+				+						+			
Sr	2250m		+				+																Ung.
Sch	1980m		?				+																
SDH	1590m	?	+			+	++	+	+					+			+		+	+	+		
DE	1421m		+				+																
HK	2070m						++																
PZ	1700m	MP, UP	+		+	+	++	+		+							+		+		+	+	Ung.
MJ	1500m	UP, EP?	+				++							+						+			
CO	2800m						++							+									
SF	2200m		+			+	++			+													
NLB	1300m					+	++													+			
HD	878m	MP	+		+	+	++	+						+		+				+			Bov.
SW	959m						++	+	+														
TB	810m		?				++																
NL	770m	LP, MS?	+	+	+	+	+	+	+			+		(+)		+				+	+		Bov.
TO	598m	UP	+		+		++				+			+		+				+	+		

Abbreviation: LP: Late Palaeolithic, UP: Upper Palaeolithic, MP: Middle Palaeolithic, EP: Epipalaeolithic, MS: Meoslithic; Ung: Ungulates, Bov: Bovidae, Can: Canis lupus, Vul: Vulpes vulpes, Alo: Alopex lagopus, Uar: Ursus arctos, Usp: Ursus spelaeus, Mus: Mustelidae, Mar: Martes, Gul: Gulo gulo, Lyn: Lynx lynx, Pan: Panthera spelaea, Sus: Sus sp., Cer: Cervus elaphus, Alc: Alces alces, Cap: Capreolus capreolus, Cib: Capra ibex, Rup: Rupicapra rupicapra, Ovi: Ovibos moschatus, ind: undetermined specimen
Sites not included in table 2: BB: Brieglersberghöhle, DE: Dachstein-Rieseneishöhle, MJ: Mokriska jama, SF: Sulzfluh-Höhlen

Tab. 4 - Large mammal fauna diversity at various alpine sites

Mustelidae, are known to use caves as shelter or den. Remains of small sized carnivores might also be determined as hunting prey of large raptors. At Nixloch-cave foxes were probably introduced by large owls whereas the preservation pattern of Martes suggest a different taphonomic origin (KUNST, 1992). At Potočka zijalka, Mustela is part of the micro-mammal assemblage whereas remains of Martes are recovered within cave bear layers (BRODAR & BRODAR, 1983).

Another bear, *Ursus arctos*, is sometimes determined at alpine sites. In most caves the remains of these species are restricted to upper stratigraphical layers (BRODAR & BRODAR, 1983; SCHMID, 1977, KÜHTREIBER & KUNST, 1995) and radiometric data confirm brown bear as late glacial/Holocene element of alpine cave assemblages (tab. 3). Brown bears as part of Upper Pleistocene assemblages are mainly reported from open air sites or from caves at lower altitudes (DÖPPES & RABEDER, 1997b; THENIUS, 1956). Surprisingly a humerus of *Ursus arctos* at Neue Laubensteinbärenhöhle lies beyond the limits of radiocarbon method and contributes to the discussion of a co-existence of cave and brown bear (ROSENDAHL & GRUPE, 2001).

4.3.2. *Ungulata remains*

Remains of ungulates at alpine sites are mostly rare, mainly restricted to the entrance parts and often heavily fragmented. Not much attention has been paid to these components of alpine cave sites. The importance of these components was recognized by a detailed taphonomic analyses of stratigraphically documented finds. Ungulate remains are part of the Late Glacial complex at Gamssulzenhöhle. Spatial distribution analyses of bones and artefacts suggest *Capra ibex* as human hunting prey (KÜHTREIBER & KUNST, 1995). A radiocarbon date gives an age of 10180+/-160a BP (KÜHTREIBER & KUNST, 1995) and corresponds well to a date from Neue Laubensteinbärenhöhle in Bavaria (ROSENDAHL & GRUPE, 2001). At Nixloch-cave ungulates probably also correlate with the human visit of this site although an input by carnivores is also possible, because of severe gnawing damage (KUNST, 1992). Probably ungulates of other alpine caves, too (Tab. 4) are mainly of late glacial or Holocene age.

Caves at lower altitudes, like Nixloch, Herdengelhöhle and Tischoferhöhle reveal few additional ungulate species. *Rangifer tarandus* is evident as artic element of rather open areas, that misses at higher alpine sites. Another unusual arctic element, *Ovibos moschatus,* is reported from Potočka zijalka (RAKOVEC, 1938). It is discussed whether muskox was a native or imported element of the cave assemblage from Potočka zijalka (see FLADERER, 2001). Few remains of Bos/Bison at Nixloch and Herdengelhöhle are recovered.

5. IMPLICATIONS

Concerning old excavated assemblages it will be necessary to gather and analyse all possible information available from previous publications and documentations concerning stratigraphy and spatial distribution of finds. More radiometric dating should be undertaken on well chosen samples in order to contribute to distinct questions such as site formation processes or man–animal relationships. Special emphasize must be given to the analyses of ungulate taphoconoeses and to a critical revision of Palaeolithic artefacts.

At this state of investigations the most important question concerning characteristics of alpine cave sites are those regarding taphonomic origin and possible correlation of finds. Furthermore chronology and fine-scaled time resolution needs to be improved in order to better understand the importance of the alpine region as biosphere for Palaeolithic man and animals during Middle and Upper Pleistocene. Multidisciplinary approaches and recent advances in methods applied, promise new insights concerning environmental and chronological aspects as well as palaeobiology and phylogeny of species.

ACKNOWLEDGEMENTS

I am especially grateful to Thierry Tillet for inviting me to the round table and to Stefano Grimaldi for the opportunity to contribute on this volume. Special thanks go to Alfred Galik, who read and commented the manuscript and to Paul Gleirscher, who helped with the Italian summary. The work was financed by the Austrian Academy of Sciences - Commission for Quarternary Sciences under G. Rabeder.

SUMMARY - This paper gives a summary on large mammal assemblages and evidences of Palaeolithic humans at alpine caves in Austria and neighbouring regions. A broad database on radiometric dates obtained on cave bear bones is included. In general, two chronological groups of finds are distinguished. During the Middle Wurmian cave bears are abundant, accompanied by few additional fauna elements. Proposed human evidences during these periods have to be interpreted with caution in the light of un-stratified, traditionally determined artefacts. After a hiatus, Late Glacial remains are evident. This complex of finds consists of micro-mammal remains, other small vertebrates, middle to small sized carnivores, ungulate remains and artefacts. Short-term visits of Late Palaeolithic and probably Mesolithic people are proven at two sites. Various taphonomic groups contribute to site formation processes in alpine caves. A more fine-scaled time resolution is hence necessary at many sites and may be undertaken by specific radiometric dating and detailed taphonomic analyses.

RIASSUNTO – Vengono descritte le raccolte dei macromammiferi e le evidenze della presenza umana paleolitica nelle grotte alpine in Austria e regioni limitrofe. Il lavoro include anche un ampio spettro di datazioni radiometriche ottenute su ossa di orso delle caverne. In generale, da un punto di vista cronologico si distinguono due gruppi di ritrovamenti. Durante il Wurm medio, gli orsi delle caverne sono abbondanti e accompagnati da resti di poche ulteriori specie animali. Le attuali evidenze di presenza umana durante questo periodo devono essere interpretate con cautela in quanto si tratta di manufatti fuori contesto stratigrafico e interpretati in modo tradizionale. Dopo uno iato cronologico, si conoscono reperti del tardiglaciale. Questi consistono di resti di micromammiferi, altri piccoli vertebrati, carnivori di media-piccola taglia, ungulati e manufatti. In due siti sono testimoniate brevi frequentazioni da parte di gruppi umani del Paleolitico finale e, probabilmente, del Mesolitico Dversi gruppi tafonomici contribuiscono ai processi di formazione dei siti nelle grotte alpine. Si rivela necessaria in molti siti una scala cronologica di maggiore risoluzione ottenibile da ulteriori datazioni radiometriche così come da dettagliate analisi tafonomiche.

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