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Site formation processes of a Mesolithic rockshelter at Galgenbühel / Dos de la Forca (Adige Valley, South Tyrol, Italy)[1]

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SUMMARY - *Site Formation Processes of a Mesolithic Rockshelter at Galgenbühel/Dos de la Forca (Adige Valley, South Tyrol, Italy)* - Archaeological excavations at the rockshelter Galgenbühel/Dos de la Forca, located in the Adige Valley at Salurn (Bozen/Bolzano, Italy), allowed us to investigate a site occupied from 9.2 to 8.5 ka BP by Mesolithic Sauveterrian groups. The site was used mainly for the exploitation of freshwater fish and other aquatic resources. The aim of the paper is to reconstruct the palaeo-environmental setting, the site formation processes and the stratigraphic architecture. The interdisciplinary approach was carried out through geomorphological, stratigraphic, sedimentological and micromorphological analyses. The site is located under a rockshelter inside a debris *talus*. The roughly 2.5 m thick stratigraphic sequence is made up of coarse grained debris interfingered with anthropic layers. Hearths and pits are present, usually located in proximity of the overhang. The excavation of these features caused an accumulation of reworked mixed sediments. The site was most probably abandoned when the sedimentation reached the top of the shelter.

RIASSUNTO - *Processi di formazione del sito mesolitico Galgenbühel/Dos de la Forca (Valle dell'Adige, Bolzano, Italia)* - Lo scavo del sito Galgenbühel/Dos de la Forca, ubicato nel fondovalle del Fiume Adige a Salorno (Provincia di Bolzano), ha permesso lo studio di un sito frequentato tra 9.200 e 8.500 anni BP da gruppi mesolitici sauveterriani, principalmente per lo sfruttamento dell'ittiofauna e di altre risorse acquatiche. Lo scopo del lavoro è la ricostruzione dell'evoluzione paleoambientale, dei processi di formazione del sito e dell'assetto stratigrafico. A tale scopo è stato seguito un approccio interdisciplinare con analisi geomorfologiche, stratigrafiche, sedimentologiche e micromorfologiche. Il sito è ubicato al di sotto di un riparo roccioso in corrispondenza di un *talus* detritico. La sequenza, spessa circa 2,5 m, è costituita da detriti grossolani alternati a depositi antropici. Questi comprendono focolari e buche situate in corrispondenza del tetto del riparo. La realizzazione di tali strutture ha comportato l'accumulo dei materiali di risulta verso l'esterno. Molto probabilmente il sito fu abbandonato quando la sedimentazione colmò il riparo.

Key words: Alps, Sauveterrian, geomorphology, stratigraphy, micromorphology, hearth features
Parole chiave: Alpi, Sauveterriano, geomorfologia, stratigrafia, micromorfologia, focolari

1. INTRODUCTION

The Mesolithic rockshelter of Galgenbühel/Dos de la Forca was discovered in 1995 inside a gravel quarry at Salurn/Salorno, in Southern Tyrol (Italy), about 20 km south of Bozen/Bolzano. The site was damaged during the quarrying activities that destroyed large part of the deposits; unauthorized excavations caused further damage of the site. Archaeological excavations were undertaken by the Bozen Archaeological Heritage Office from 1999 to 2002 and supervised by M. Bazzanella and U. Wierer (Bazzanella & Wierer 2001); M. Coltorti and P. Pieruccini carried out geomorphological, stratigraphical, sedimentological and micromorphological analyses.

The shelter was occupied during the Early Mesolithic, as indicated by the radiocarbon dates and the typo-technological aspects of the Sauveterrian industry (Wierer 2007, 2008). The occupation occurred in a quite short time interval, between 9265±70 and 8560±65 yrs BP (8425-8089 cal BC and 7705-7478 cal BC). Faunal remains highlight differentiated subsistence strategies with evidence for fishing, collecting molluscs, hunting forest ungulates and wetland mammals (Bazzanella *et al*. 2004, 2007; Wierer & Boscato 2006). The site belongs to a regional settlement

[1] The paragraph 1. INTRODUCTION was written by M. Bazzanella and U. Wierer; 2. METHODS by M. Coltorti, P. Pieruccini, M. Bazzanella and U. Wierer; 3. GEOLOGICAL AND GEOMORPHOLOGICAL SETTING by M. Coltorti and P. Pieruccini; 4. STRATIGRAPHY by M. Coltorti, P. Pieruccini, M. Bazzanella and U. Wierer; 5. CHRONOLOGY by U. Wierer; 6. MICROMORPHOLOGY by P. Pieruccini; 7. PRELIMINARY REMARKS ABOUT THE HEARTHS by U. Wierer; 8. DISCUSSION AND CONCLUSIONS by M. Coltorti, P. Pieruccini, M. Bazzanella and U. Wierer. PROJECT COORDINATOR: U. Wierer

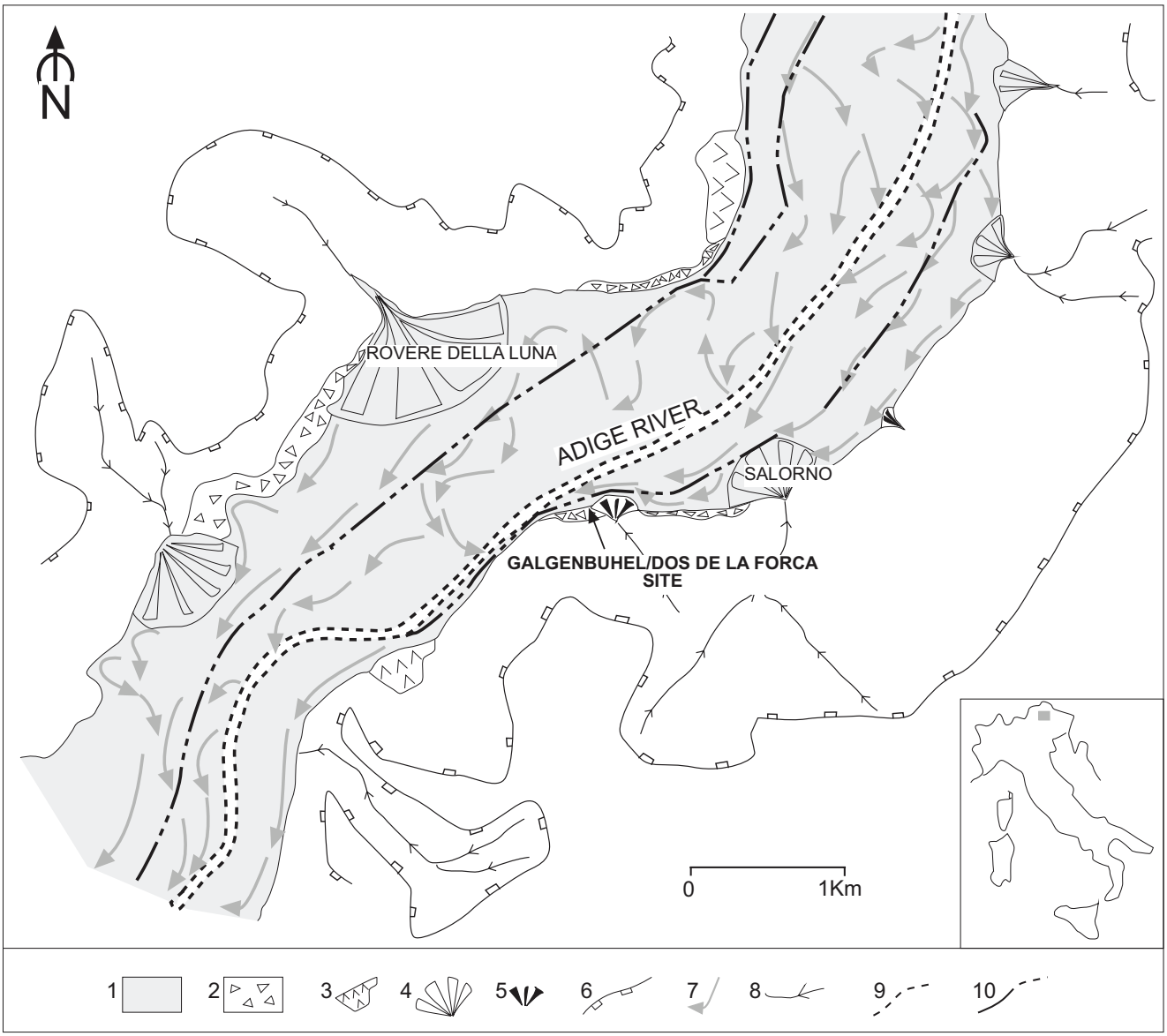

Fig. 1 - Geomorphological sketch of the Galgenbühel/Dos de la Forca area. 1. alluvial deposits; 2. slope waste deposits; 3. landslides; 4. alluvial fans; 5. debris cones; 6. main polygenic escarpments bordering the valley; 7. paleochannels; 8. streams; 9. artificial levees; 10. artificial channels (drawn by M. Coltorti and P. Pieruccini, digital elaboration by P. Pieruccini).
Fig. 1 - Schema geomorfologico dell'area di Galgenbühel/Dos de la Forca. 1. depositi alluvionali; 2. depositi detritici di versante; 3. frane; 4. conoidi alluvionali; 5. coni di detrito; 6. principali scarpate di erosione poligenica che delimitano la valle; 7. paleoalvei; 8. torrenti; 9. argini artificiali; 10. canali artificiali (disegno di M. Coltorti e P. Pieruccini con elaborazione digitale di P. Pieruccini).

system on behalf of Early Mesolithic hunter-gatherers, which exploited both the valley bottoms and the mountain areas above timberline (Broglio & Lanzinger 1990).

The aim of the present paper is to place the archaeological evidences discovered at Galgenbühel into its geomorphological and palaeoenvironmental context and to highlight the site formation processes and their relationships with the settlement modalities during the Mesolithic.

2. METHODS

The stratigraphic excavation, carried out over an area of at most 18 m^2, was made with the application of three-dimensional spatial coordinates. The minimum excavation unit of the horizontal grid was 0.5x0.5 m. Stratigraphic units (SU) were documented with profile and plan drawings in 1:10 scale. The entire anthropic sediment was wet sieved with 1 mm meshes and finds were hand-collected. Sediments and charcoals were systematically sampled. A geomorphological survey was carried out firstly with aerial photos at a scale of ca. 1:33,000 and later in the field, describing and mapping the landforms and related processes. A detailed stratigraphic and sedimentological analysis was performed during the excavation and complemented with a micromorphological analysis of selected samples from the anthropic layers. The micromorphological description was carried out following Bullock *et al*. (1985) and Stoops (2003).

Fig. 2 - View of the rockshelter on top of the remaining *talus* debris (centre). The black arrows indicate the original height of the *talus*; the white arrow indicates the overhang that continues to the left of the site (photo by U. Wierer).
Fig. 2 - Panoramica del riparo alla sommità dei depositi di falda detritica ancora preservati (centro). Le frecce nere indicano l'altezza originale del talus*; la freccia bianca indica il riparo che prosegue sulla sinistra del sito (foto U. Wierer).*

3. GEOLOGICAL AND GEOMORPHOLOGICAL SETTING

The site is located on the left-hand side of the Etsch/Adige Valley between Bozen and Trento, at an elevation of 225 m a.s.l., ca. 20 m above the present day valley bottom (Fig. 1). It is one of the major valleys dissecting the Alpine chain from north to south and constituted one of the easiest pathways to cross the Alps. The valley bottom is occupied by a large alluvial plain, that is fed by a series of alluvial fans. The valley is bordered by steep and vertical walls modelled in limestones and dolomites, sometimes dissected by narrow canyons in correspondence of the major tributaries. The modelling of the valley is the result of glacial underscoring during the major advances of the Pleistocene glaciers interfering with the progressive tectonic uplifting of the Alpine chain. During the Last Glaciation underscoring created a depression up to 300 m below the surface of the plain (Felber *et al*. 1998). As glacial retreat progressed, fluvial erosion dissected the glacial and fluvioglacial deposits. However, frost shattering and gravitational processes continued to operate during the Late Glacial and the beginning of the Holocene, creating a series of *talus* and debris cones that hosted various Mesolithic sites (Bartolomei 1974; Broglio 1990, 1992). At Galgenbühel/Dos de la Forca the occupation layers are located inside a sequence of debris *talus* in correspondence with a narrow rock shelter (Fig. 2). The shelter was created by selective erosion of thick limestone layers overlying thinner layers with marly intercalations.

During the Early Holocene the debris sedimentation was reduced following the progressive colonization of the slope by vegetation (Coltorti & Dal Ri 1985). This reduction of solid load also led to a general stabilisation of the alluvial fans. A new widespread phase of debris and alluvial fan deposition is documented during the Bronze and Iron age and later in Medieval times, possibly as a consequence of widespread deforestation and the interference with the social history (Coltorti 1987, 1990, 1994). In the Dos de la Forca site, the Mesolithic layers were buried under ca. 12 m of sediments. Unfortunately this record is missing due to quarrying activity.

The Early Holocene landscape, after the glacial retreat, was characterized by a series of lakes in the valley bottom, also generated by the damming of the valley due to the frontal moraines in the Po Valley (Venzo 1957, 1961; Cremaschi 1987). The elevation of the valley bottom during the Mesolithic is unknown because of the strong sedimentation that occurred in later times. For instance, at Vadena-Laimburg, ca. 17 km upvalley, up to 10 m of sediments were deposited after the Late Bronze Age (Coltorti & Dal Ri 1985).

The river was bordered by artificial levees at the beginning of the XIX century. The previous meandering pattern was reported in the original map of the Austrian engineers (Novak-Map). Many paleochannels are still recognizable, as they often correspond to the limits of municipalities and private properties. Abandoned meanders are also traceable in aerial photos due to the different texture of the sediments. The lateral erosion caused by meander migration across the plain is responsible for the reduced thickness and locally for the complete destruction of the *talus* at the feet of the escarpments. A large meander has been recognized

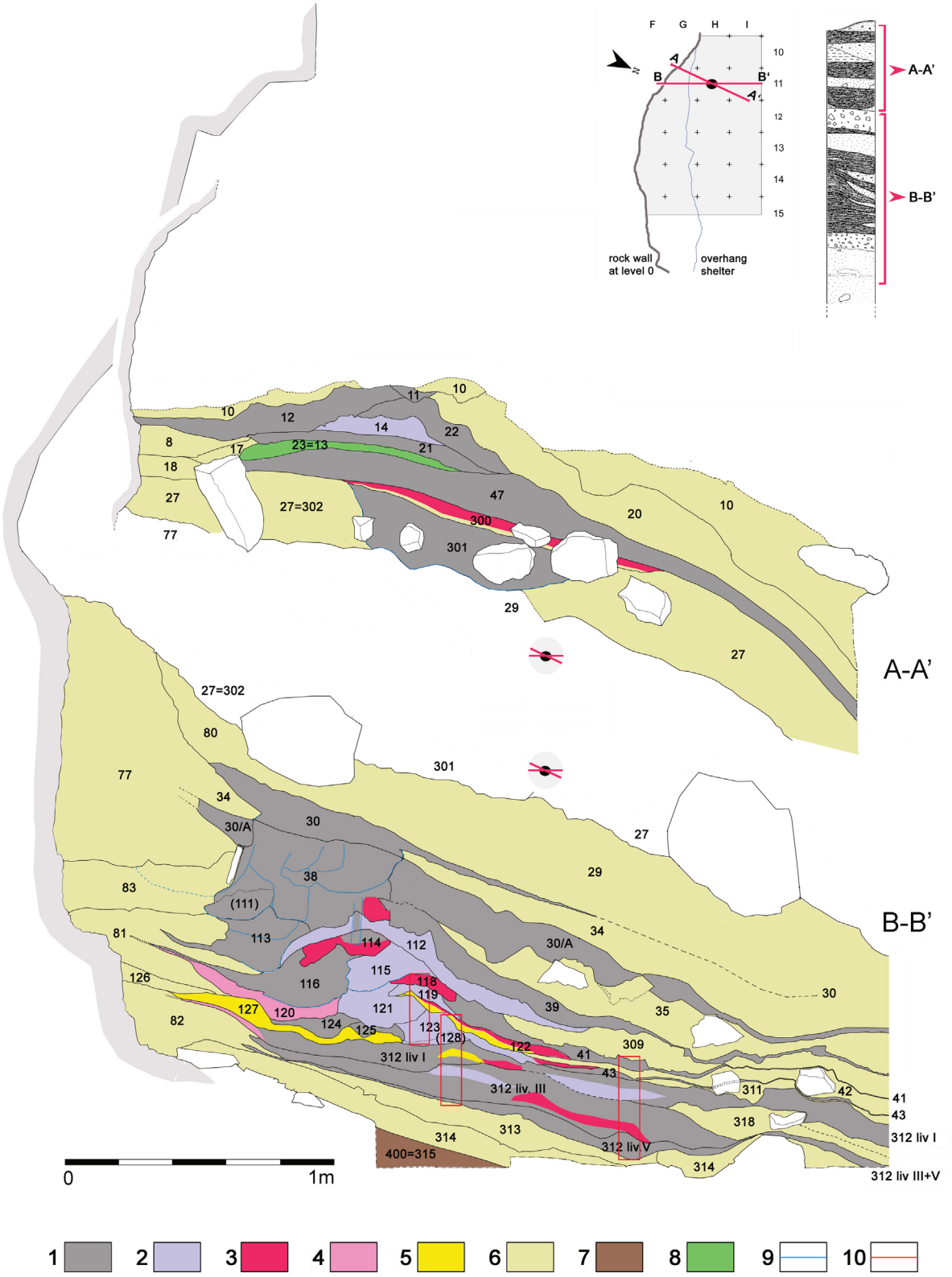

Fig. 3 - Sections A-A' and B-B' with excavation area and stratigraphic column. The numbers represent the SSUU. 1. sediment composed by charcoal, debris, ash, faunal remains and lithic artefacts; 2. ash; 3. *in situ* burnt sediment; 4. reworked burnt sediment; 5. alluvial fine sand (human transported); 6. debris; 7. debris with silty matrix; 8. clayey-sandy sediment; 9. anthropogenic feature; 10. sample for micromorphology (drawings by A. Bernardi - SRA, M. Coltorti, M. Decarli - SRA and U. Wierer; digital elaboration by U. Wierer).

Fig. 3 - Sezioni A-A' e B-B' con riferimento all'area scavata e colonna stratigrafica. I numeri rappresentano le UUSS. 1. sedimenti composti da carboni, detriti, ceneri, resti faunistici e manufatti litici; 2. cenere; 3. concotto; 4. concotto rimaneggiato; 5. sabbia di origine fluviale (di apporto antropico); 6. detriti; 7. detriti in matrice siltosa; 8. sedimenti argilloso-sabbiosi; 9. strutture antropiche; 10. ubicazione dei campioni per la micromorfologia (disegno di A. Bernardi - SRA, M. Coltorti, M. Decarli-SRA e U. Wierer; elaborazione digitale di U. Wierer).

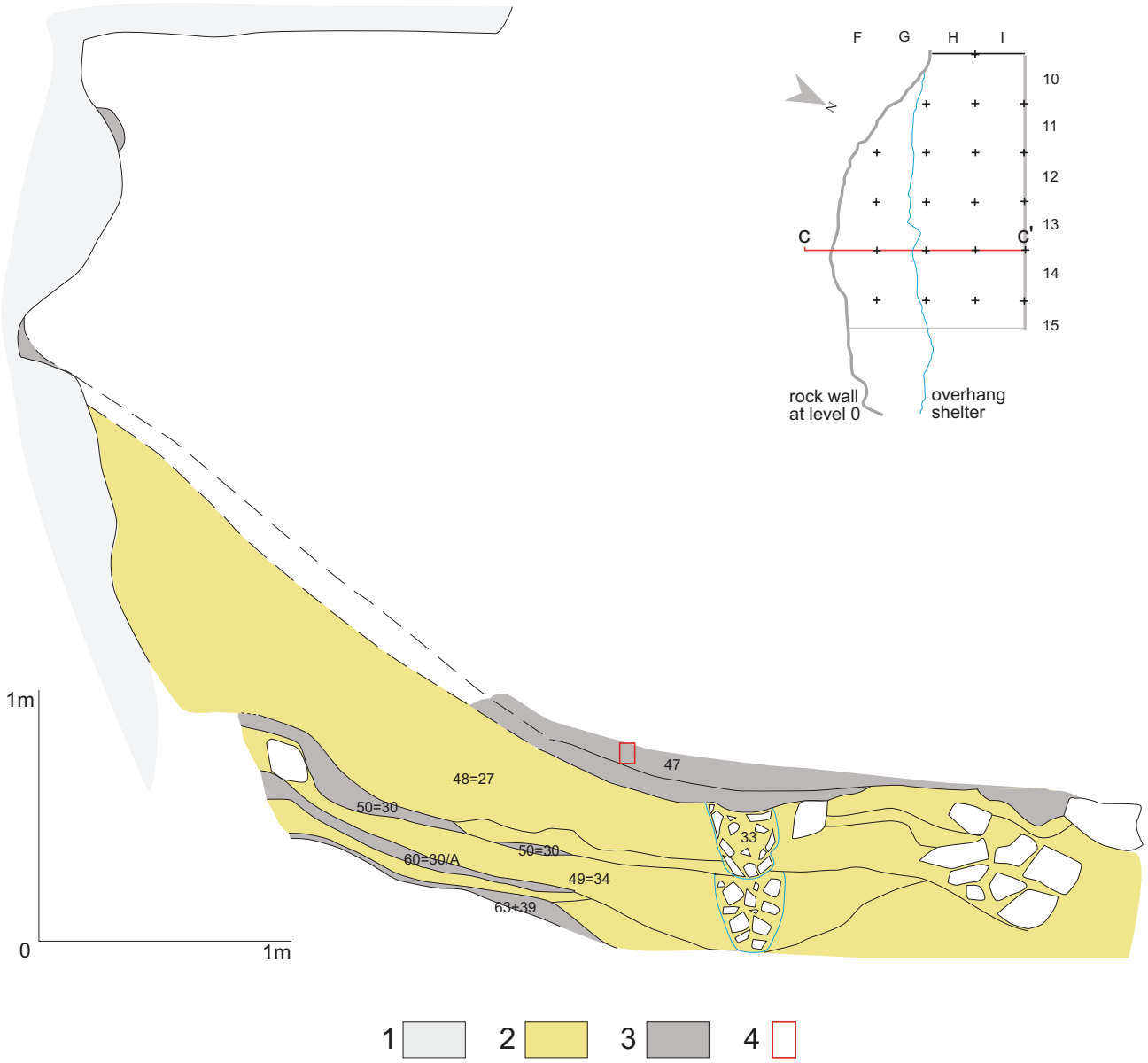

Fig. 4 - Section C-C' with excavation area. The numbers represent the SSUU. SU 47 has been partially damaged by unauthorized excavations. 1. rock face; 2. debris; 3. sediment composed by charcoal, debris, ash, faunal remains and lithic artefacts; 4. sample for micromorphology (drawn by M. Coltorti; digital elaboration by P. Pieruccini).
Fig. 4 - Sezione C-C' con riferimento all'area scavata. I numeri rappresentano le UUSS. US 47 è stata parzialmente rimaneggiata da scavi abusivi. 1. parete rocciosa; 2. detriti; 3. sedimenti composti da carboni, detriti, ceneri, resti faunistici e manufatti litici; 4. ubicazione dei campioni per la micromorfologia (disegno di M. Coltorti; elaborazione digitale di P. Pieruccini).

up and downvalley of the site. Upvalley it runs inside a large depression between the shelter and Salorno. A few hundreds of metres down-valley a large meander reached the left side of the valley where no *talus* is actually preserved.

4. STRATIGRAPHY

The investigated sequence of Galgenbühel evidences a total thickness of about 2.5 m. Although the top of the deposit was destroyed by quarrying activities, rare remains of anthropogenic sediments were preserved on the rear rock face of the shelter. These indicate that the archaeological deposit had originally an overall thickness of at least 4 m reaching almost the overhang (Fig. 4). The original extension of the anthropogenic layers, which exceed the excavated area both to the north and to the east, cannot be reconstructed anymore.

The sections A-A' and B-B' show the main stratigraphical and sedimentological setting (Fig. 3). *Talus* deposition prevails in the outer part of the shelter and close to the rear face, indicating the synsedimentary occurrence of physical weathering. It is dominated by unsorted debris of different mean size. The fabric varies from open work to matrix supported layers. The higher amount of sandy-silty matrix is usually associated to more intense slope washing,

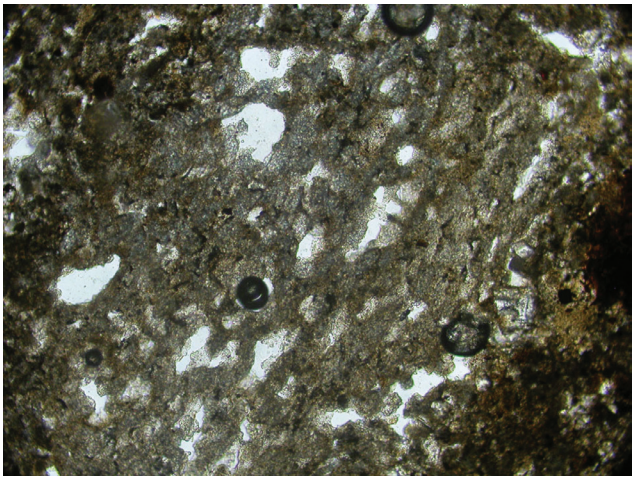

Fig. 5 - Microphoto PPL, frame 1 mm. The microfacies rich in ash, is made of micrite and opaline cystholits, with typical vesicles caused by the trapping of air bubbles due to burning (photo by P. Pieruccini).
Fig. 5 - Microfoto PPL, lato lungo 1 mm. La microfacies, ricca di ceneri, è costituita da micrite e cistoliti opalini con tipici vuoti vesicolari formatisi dall'intrappolamento di bolle d'aria generate dalla combustione (foto P. Pieruccini).

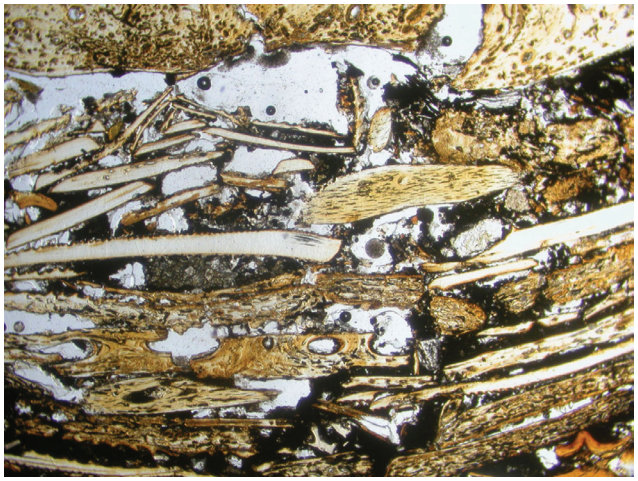

Fig. 6 - Microphoto PPL, frame 1,5 mm. Strong concentration of bones and shells burnt at different degree. Their parallel layering indicates the compaction of the surface (photo by P. Pieruccini).
Fig. 6 - Microfoto PPL, lato lungo 1,5 mm. Forte concentrazione di ossa e conchiglie più o meno intensamente bruciate. La stratificazione parallela è dovuta alla compattazione della superficie (foto P. Pieruccini).

being the coarser fraction concentrated close to the wall. The centimetre thick layers, generally dipping towards the valley bottom, suggest the occurrence of long lasting frost shattering and gravity processes, although rock fall of single blocks up to 30-50 cm in size occurred in places. In the central part of the sections a convex-up architecture of the anthropogenic layers was generated during human occupation. They are made of the following elements: 1. a mixture of charcoals, unsorted debris, ash, faunal remains and lithic artefacts; 2. ashes mixed with a low amount of debris, charcoal and bone fragments; 3. *in situ* burnt reddened sediments; 4. slightly reworked burnt reddened sediments; 5. thin layers of human transported alluvial fine sands.

The first weak evidence of human occupation[2] is represented by an almost regular layer of silty matrix debris containing very rare charcoal fragments and sporadic archaeological finds (SU 400, section B-B'). The overlying debris (SSUU 314 and 313) without anthropic components could be associated with a period of site abandonment or of the lateral shifting of the campsite. An almost continuous growth of anthropogenic layers is recorded upward. At first, humans occupied the more external area of the shelter (SU 312, levels I-III-V), as shown by a series of almost planar lenses of fire-related sediments. Moving upward, the occupation progressively shifted closer to the rock wall. This part of the stratigraphy is characterized by a series of different sized fire pits. The excavations of these pits resulted in the vertical growth of the more external layers. The vertical hole in SU 112 (probably caused by a small peg or stake) could be related to the use of the nearby hearth. When the fires moved inwards, debris accumulation prevailed in the external part.

Thick layers of debris and some large boulders in a sandy matrix (SU 29, 27= 302) indicate an interruption of the local human occupation, splitting the sequence into two main periods.

The base of section A-A' is formed by a hearth feature deepened among big boulders (SU 301). It is covered with debris and a reddish burnt layer. The upper part of the sequence, preserved on a very limited surface, shows the growth of convex-up reworked layers, maybe resulting from nearby digging activities. Furthermore a clayey-sandy layer (SU 23= 13) containing a large amount of charcoal, fish bones and lithics has been distinguished.

In section C-C' (Fig. 4), a clear lateral variation of the sedimentological characteristics can be recognized. In fact, the main occupation layers are bounded towards the slope by one or two superimposed pits. These could represent holes of posts placed against the edge of the overhang. In the external part coarse to very coarse debris and boulders prevail, containing few charcoals. Close to the wall there is a colluvial wedge. Thin patches of occupation layers are preserved close to the top of the shelter.

5. CHRONOLOGY

Seven charcoal samples have been dated with the AMS method by the ETH Laboratory of Zurich. Dendrochronological calibration was carried out with the programme CalibETH (Niklaus *et al*. 1992). The sequence of the resulting dates is coherent with the succession of the layers, except for ETH-22089 (Tab. 1).

The investigated part of the site was frequented from

[2] An about 1.5 m deep trench dug in the debris underneath SU 400 did not evidence any anthropogenic layers.

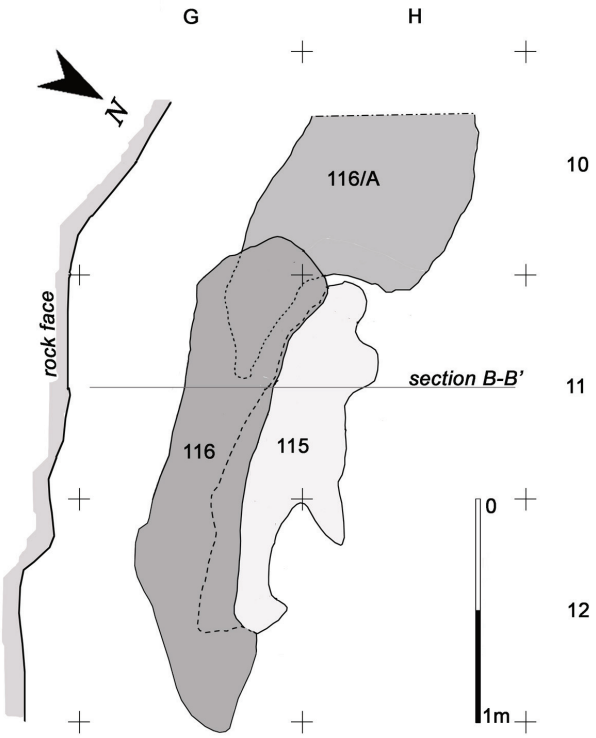

Fig. 7 - Hearth feature SU 116 which cuts SU 115. SU 116/A, strongly anthropogenic, is related to the hearth (drawings by M. Battisti, M. Bazzanella, M. Lomonaco and U. Wierer; digital elaboration by U. Wierer).
Fig. 7 - Struttura del focolare, US 116 che taglia la US 115. US 116/A, fortemente antropizzata, è in relazione con la struttura (disegno di M. Battisti, M. Bazzanella, M. Lomonaco e U. Wierer; elaborazione digitale U. Wierer).

the mid 9th to the mid 8th millennium BC cal., corresponding to a duration of about 1000 calendar years. The results are in accordance with the attribution of the lithic assemblages to the Middle Sauveterrian. The dates are comparable to those obtained for the Middle Sauveterrian of the reference series Romagnano III, Pradestel and Riparo Gaban located further south near Trento (Broglio 1992; Kozlowski & Dalmeri 2002).

6. MICROMORPHOLOGY

Soil micromorphology allows a qualitative or semi-quantitative observation of the changes through time of soil-forming environments in terms of past climatic and environmental dynamics (Kemp 1985; Courty *et al*. 1989; Catt 1990; Kemp 1998). However, where pedogenic features are missing, micromorphological observations are useful to describe the internal fabric and sedimentological characters of anthropic or debris-rich layers and to understand the relative influence of "natural" and anthropically induced (or influenced) geomorphological processes. Micromorphological analyses allow a more detailed physical and chemical characterisation of the stratigraphic subdivisions. The investigated samples of Galgenbühel were collected from the anthropogenic layers (Fig. 3) revealing the presence of 4 main microfacies with different vertical and lateral relationships. Their characters differ mainly according to the composition (relative amount of mineral and organic fraction and wood ash), the evidence of surface disturbance (mainly compaction) and the presence of burning features. Their characters can be summarized as follows:

- microfacies a: containing up to 90% of ash mixed with rare burnt bones, shell and charcoal fragments;
- microfacies b: made of burnt coarse rock fragments and reddish-brownish thin ash *laminae*. Vesicular voids, due to air bubbles formed during burning, are typically associated to both microfacies (Fig. 5). These microfacies, directly related to fire, show also evidence of compaction of the surface such as piano-parallel laminations, suggesting that the fireplaces were re-utilised. Furthermore, the main micritic and subordinate opaline composition of the ash suggests the main use of wood as fuel for the fire (Canti 2003);
- microfacies c: made mostly of bone, charcoal and shell fragments with a subordinate coarse fraction and ash (Fig. 6). Bones and shells are burnt at different degrees, assuming colours ranging from whitish to reddish-black and are typically thinly laminated parallel to the surface, suggesting a disturbance due to compaction. Their concentration may indicate levels of food waste or cooking. This facies is also associated to the presence of rounded exotic sandy granules of fluvial origin carried up from the valley bottom, maybe associated to fish or molluscs. They are scarce and usually concentrated in thin *laminae* or dispersed in the groundmass;
- microfacies d: is typically chaotically arranged and made of a mineral fraction (coarse to very coarse rock fragments), an organic fraction (small bones, shell and charcoal fragments) and ash. It is often characterized by erosive surfaces associated to rough cross-laminations. It may represent the result of reworking of the fireplaces and also contain very rare calcitic pedofeatures associated to root voids that imply at least short periods of surface stability.

7. PRELIMINARY REMARKS ABOUT THE HEARTHS

At Galgenbühel several kinds of anthropogenic features have been recognized, most of them related to burning activities (Fig. 3). Rarely hearths are lined with stones. One is located at the base of SU 312, level I: flat stones, aligned for about 3 m, bound the southern border of an area rich in charcoal fragments and fish bones. Also SU 301 is associated with stones: the fire pit, measuring about 1 x 0.8 m, was deepened among emerging boulders.

Other features are simple pits dug in the underlying sediment. Sometimes they are superimposed on top of one another (SSUU 116, 113, 111, 38). These features, containing high concentrations of charcoal, could be related to food processing (cooking or smoking, Bazzanella *et al*. 2006). SU 116 (2.0x0.5x0.15 m) has a longish shape and runs parallel to the rear rock face (Fig. 7). It was dug in the underlying debris (SU 120, reddened by the fire) and cuts part of an ash heap (SU 115). The filling

Tab. 1 - Radiocarbon dates with dendrochronological calibration.
Tab. 1 - Datazioni al radiocarbonio con relativa calibrazione dendrocronologica.

Lab. nr.	SU	AMS - ^{14}C age	$\delta^{13}C$ [o/oo]	cal. age - 2 σ
ETH-22091	13	8560±65 yrs BP	-24.9±1.1	BC 7705-7478 (95.1%)
ETH-22089	47	8190±65 yrs BP	-22.6±1.1	BC 7326-7032 (91.3%)
ETH-27176	47	8580±65 yrs BP	-23.4±1.2	BC 7876-7813 (6.7%) BC 7712-7483 (92.8%)
ETH-27177	301	8760±70 yrws BP	-25.8±1.2	BC 7952-7583 (100.0%)
ETH-27175	30	8760±70 yrs BP	-25.0±1.2	BC 7952-7583 (100.0%)
ETH-27174	116	8825±70 yrs BP	-26.7±1.2	BC 8024-7690 (96.6%)
ETH-27173	312 / I	9265±70 yrs BP	-26.0±1.2	BC 8425-8089 (100.0%)

contains numerous faunal remains – mainly fish bones – and lithic artefacts.

8. DISCUSSION AND CONCLUSIONS

The Early Mesolithic human occupation of the Adige Valley across the provinces of Bozen and Trento is documented by several sites located on the slopes along the valley bottom (Dalmeri & Pedrotti 1992). At that time, the alluvial plain was probably occupied by swamps and small lakes related to the meandering pattern of the river. The plain underwent flooding events and occasional shifting of the riverbed leading to a general instability of the river banks, as documented up to historical times (Werth 2003). The slopes were characterized by a series of coalescent *talus* and alluvial fans that provided a higher topographic level where the ancient tracks had to be located. This topographic setting, together with the presence of overhanging rocks usable as shelters, favoured the establishment of campsites. For the Galgenbühel/Dos de la Forca site, the altitude and distance from the valley bottom during Mesolithic times is not known in detail, but it had to be not so different from the present-day. This topographic setting had to be particularly suitable for the intense exploitation of aquatic resources, among which fish remains are overrepresented. Subsistence was based also on hunting beavers (as well as forest ungulates) and collecting freshwater molluscs and turtles. The occupation lasted for a relatively short time of about 1000 years. During this time span the stratigraphy is characterized by the progressive growth and progradation of the talus fed by the degradation of the steep slope. The interbedding of debris layers and anthropogenic layers suggests an intermittent occupation by the human groups. The fact that debris layers are quite thin reveals that debris accumulation was rather slow. Only at ca. 8.7 ka BP a single, almost continuous debris layer including boulders seems deposited almost instantaneously. Stratigraphic and micromorphological evidence revealed the occurrence of *in situ* burning and waste related layers. Various anthropogenic features, mainly related to combustion, were dug in the underlying sediments and the excavated deposits accumulated nearby, as shown by the concave-convex geometry of the layering. These superimposed burning structures together with the abundance of fish and mammal remains, suggest cooking or even food-conservation purposes, maybe by means of smoking. The hearths are usually located in proximity to the rock wall and the overhang. Fireplaces shift progressively inwards, possibly in order to prevent the risk of occasional debris fall. The definitive abandonment of the site by the Mesolithic groups could be linked to the growth of the *talus* and the associated anthropogenic layers that sealed the shelter preventing its use.

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