

The sedimentary sequence of Riparo Dalmeri (Grigno Valsugana, TN): pedostratigraphic and micromorphological features

DIEGO E. ANGELUCCI & MARCO PERESANI

ABSTRACT - The geoarchaeological setting of Riparo Dalmeri is examined to reconstruct pedo-sedimentary formation processes, the inference between cultural and natural processes, the paleoenvironmental context and its modifications in time. The geoarchaeological study has included the field description of sediments and soils, their sampling, the performance of routine analyses and micromorphological observations. The data are briefly illustrated and explained, and some considerations on the sedimentology, pedology and palaeoenvironmental context of the site are made.

Key words: Riparo Dalmeri, Veneto Prealps, Epigravettian, Geoarchaeology, Micromorphology

Parole chiave: Riparo Dalmeri, Prealpi Venete, Epigravettiano, Geoarcheologia, Micromorfologia

Diego Angelucci – Centro de Investigação em Paleoecologia Humana e Arqueociências, Av. da Índia, 136 P-1300-300 Lisboa (Portugal). E-mail: diego@ipa.min-cultura.pt

Marco Peresani – Dipartimento di Scienze della Terra, Corso Ercole I D'Este 32, I-44100 Ferrara (Italia). E-mail: psm@unife.it

1. INTRODUCTION

The present text gathers data referring to the geoarchaeology of Riparo Dalmeri and confronts the problems concerning the paleoenvironmental reconstruction and the pedo-sedimentary formation processes of the filling deposits¹.

The geoarchaeological study has been articulated in various phases:

- a - field description carried out in different ways depending on the characteristics of the archaeological sediments and soils (ADIWIGANDA & LANGOHR, 1989; FAO, 1990; SANESI, 1977) in order to supply mixed pedo-sedimentological descriptions²;
- b - sample collecting for routine analysis and for micromorphological investigations;
- c - grain size analysis and the determining of pH values, as the content of carbonates, organic matter, total nitrogen, absorbable phosphorous and potassium (analysis carried out by the Istituto Agrario di S. Michele all'Adige, Trento);
- d - micromorphological observation (on thin sections prepared by the laboratories of the I.T.C. for Post Graduate Soil Scientists of Ghent, Belgium, and Servizi per la Geologia of Piombino, Italy), carried out with petrographic microscope with 10x to 500x

magnifications. The existing bibliography was referred to for the descriptions (BULLOCK *et al.*, 1985; COURTNEY *et al.*, 1989). Changes were made to some of the terms and to the descriptive sequence.

2. GENERAL INFORMATION ON THE SITE

Riparo Dalmeri is located on the NE part of the Sette Comuni Plateau (Veneto Prealps), a limestone massif which is geographically, fisiographically and anthropically well identified. The plateau confines with Valle dell'Astico towards West and with Valsugana towards North and East (Fig. 1). It features an upper area where gentle morphologies and hillslopes prevail, surrounded by high escarpments. The area in question confines with the right slope of Valsugana, with a difference in altitude of almost a thousand metres.

Modelled into the thick Meso-cenozoic Veneto Series (BARBIERI, 1995), the Plateau presents mainly structural and karst morphologies which are one of the typical features of the area (CASTIGLIONI *et al.*, 1989). It is thought that glacial phenomena in the past were both of local origin, as in the Marcesina area even in the Würm (PELLEGRINI & SAURO, 1994), and due to the

Adige glacier, flowing along the Brenta valley (TREVISAN, 1939).

Due to its position overlooking the Po Plain, rainfalls are abundant on the Plateau and the present climate is very wet. On the whole the mesoclimate may be defined as subcontinental and typically Prealpine, with cold winters and cool summers. In comparison to similar areas at the same altitude but situated further within the Alpine range, the temperatures and the precipitation here are higher, with maximums in spring and autumn (FRIGO, 1982/83). Two observations must be made: it is evident, at least from a qualitative point of view, from the comparison of the average monthly minimum and maximum temperatures, that the Plateau is potentially subject to cycles of freezing/thawing from November to April. Then, the data regarding rainfalls attest that the climatic regime does not comprise any seasonal hydric deficit, especially in the vegetative period, enhancing leaching.

Dalmeri rockshelter is situated at the top of the right slope of the Brenta valley, just off the northern border of the Marcesina basin, at an altitude of 1 240 m. It is opened at the foot of a rock wall of the Jurassic stratified limestone of Calcari grigi di Noriglio Formation, which forms a morphological relief along the bottom of the Ombra valley, the small water stream that drains the hillslope. Even though the valley is usually dry due to karstic phenomena, it can also become rather humid and during its activity phases transport material into the rockshelter.

Some locational characteristics are important for the sedimentology and pedology of the succession of the shelter, because they supply a distinctive microenvironmental characterisation. Apart from what has already been said about the general meteorological conditions of the Plateau, the following aspects must be stressed: the steepness of the slope; the presence of the small valley which drains into the rockshelter; its orientation facing North; its setting in a low-altitude mountain context. As a result of these factors, the rockshelter presents a microclimate with relatively low temperatures and a high degree of humidity, which affect the rock of the vault and roof. Even though the bedrock is not highly frost-labile there are evident traces of its degradation as a result of the freezing/thawing cycles.

3. THE SEDIMENTARY SEQUENCE

3.1. General features

The stratigraphic layout of the succession shows an evident spatial and temporal variability resulting from the processes that have affected and still affect

the shelter. Various longitudinally arranged depositional microenvironments are recognizable in the site depositional system in relation to the morphology of the cavity. The rockshelter is opened towards East to the left side of a little valley and its present topographical surface coincides with a small depositional cone coming from the slope, a situation which was observed also for the Epigravettian units. Its central part features mainly horizontal stratification, while its eastern part is affected by water percolation, due to the cracks and holes in the shelter roof in correspondance to the Ombra valley *talweg*. Consequently, the stratification in sq. 48, 49 and 50 is more complex than towards West because of erosional morphologies that have been cut and refilled in different phases. Transversally the typical depositional entrance effect can be seen, with the formation of microrelief along the dripline. The rockshelter is still subject to dripping with varied intensity, while the roof degradation is very limited.

3.2. Field description

Three groups of units can be distinguished in the sedimentary succession, depending on their position with regard to the anthropic deposits of the Epigravettian occupation surface. These are the pre- and post-settlement units and the complex regarding the settlement phase dated to the Allerød chronozone. By dividing them, a reference sequence can be obtained and even though this is debatable it can be justified by the presence of only one investigated test trench that has been dug into the lower stratification units (along the line of sq. 47) and by the fact that the post-settlement succession seems fairly homogeneous (Fig. 2).

The post-settlement succession covers the lapse of time between the Allerød and present day. Starting from the top and considering the inner part of the shelter, the Ah horizon related to the present day soil surface (US 1) can be distinguished: it is highly organic, with only a few stones. A 2Ab horizon (US 2) emerges beneath: it is silty loam, very dark grey, granular, with abundant calcareous stones, as a result of the degradation of the vault. This feature is common in all the units except for US 1. This is followed by the 2Bw horizon (US 3 p.p.), partially open-work breccia with slightly bleached silty loam matrix, and 2C horizon (US 3 p.p., 5 and 7), mainly composed of clastic elements, with scarce clayey colourless matrix and irregular areas cemented by carbonates. This *sequum* lays on US 8, a unit which is richer in clayey matrix and subangular fine gravel, passing through to the breccia of US 8a (horizon 3C) enriched with carbonate silt. These units erode the anthropic complex both above and laterally.

The complex of units related to the Epigravetti-

an occupation surface is very variable. Using US 26 as a reference, the units are normally made of clast-supported breccia with a silty loam, micaceous, very dark grey, moderately aggregated soil material, with subhorizontal ice lenses. The matrix fills all the pores, the organic matter is abundant and there are no roots; there are carbonatic coatings on the stones, covered by fine grey clay coating, and on some ped surfaces. The lower boundary is clear, being defined by the disappearance of the fine material.

US 26 has been divided in different sublayers (from 26a to 26d) and extends over the whole area of the excavation, except for the NE area where it is missing because of erosion. It is sub-horizontal with a vague rise towards north, and has a maximum thickness of 20 cm. In the middle part (sq. 46I-L-M, 45L-M) there are subcentimetrical light brown silt lenses, often curled up, usually discontinuous but sometimes continuous and forming a single level (e.g. in sq.45L).

In sq. 47I the stratigraphy is more articulated because at the bottom of US 14/26 there are archaeological deposits that are not present elsewhere. Here, unit 26 lays on US 15, open-work breccia, with fine coatings and organic capping on the stones, together with clay coatings. The lower US 50 is formed of grey clayey matrix and lays upon an anthropic Ah horizon (US 51), breccia-like, with clayey loam, dark grey, micaceous, moderately aggregate fine material.

The pre-settlement sequence was surveyed in sq. 47, where the anthropic units of US 14/26 lay on a thick sequence of breccia articulated in various units. US 52 (horizon 6AC) is a breccia with platy fragments which are often upright, with silty loam, brown, micaceous, granular matrix, passing through to US 53 (horizon 7C), breccia with brownish yellow loamy fine material, which almost completely fills the voids. Fine clayey coatings cover the stones and are sometimes present in the matrix along the discontinuous surfaces. The lowest observed stratigraphic unit is US 54, clast-supported breccia with clayey, light brownish yellow, massive, non-porous fine material.

3.3. Routine analyses

The results are summarised in Fig. 3. The grain size distributions show a prevailing silt fraction in the two upper successions, except for US 51, where there is equilibrium between silt and sand. There are no significant variations in the clay and sand fractions and, except for US 14, they are characterised by a substantial equilibrium of the frequency values. An important variation of sand contents, with consequently less silt fraction, can be observed in the pre-settlement succession (UUS 52-54). The samples present subalkaline to alkaline reactions; the pH value drops

as the organic matter increases in the samples of the anthropic units and in the present Ah horizon. The comparison between the variation of the carbonate and organic matter contents shows an antithetic behaviour, above all in the two upper sequences. The lowest value in the carbonate curve is particularly evident in the present Ah horizon and in US 26c, where there is a correspondent higher value in the content of organic matter.

3.4. *An outline of micromorphology, with particular reference to anthropic sediments*

The specific objectives of the micromorphological study are: analysing the organic and non-organic soil components on a microscopic scale in order to distinguish autochthonous and external inputs; recognizing the depositional processes before the ancient Epigravettian occupation; recognizing particular features resulting from anthropic activities; tracing back to the processes of modification of the anthropic sediments. For the micromorphological features which are not described hereby please, see ANGELUCCI & PERESANI, 1996; ANGELUCCI, 1997 (the authors are preparing a more detailed study).

The distinctive character of the shelter microenvironment determines the presence of a series of reoccurring features in almost all the samples that have been observed, which consist of fragments of heterometricoolitic or micritic limestone, always exceeding 50%. The fragments range from angular to subangular shape and show rims with evidence of selective corrosion, which are sometimes marked with films of oxide and a progressive sparitisation from the centre to the borders. The sand and the silt fractions are made up of limestone fragments and ooides released by the solubilisation of the calcite cement.

Along with these there are: chert fragments, some of which are partly weathered, generally of small dimensions (max 1-2 cm); quartz grains, with a clear sorting in the fine sand and medium-coarse silt sizes; silt-sized mica grains; light grey (c/f 3 μ m limit), micritic groundmass, with black particles undefinable through the microscope, in the samples which are poorer in organic matter; small quantities of light brownish yellow clay.

The units of the anthropic complex contain other recurrent elements: abundant organic fraction, responsible for the dark tones of colour; abundant charcoal fragments of different size; very dark reddish brown, moderately decomposed organic fragments (sometimes undefinable through the microscope), that form the groundmass of most of the samples; heterometric fragments of bone, with traces of phosphatisation (Fig. 4:1). These components arrange according to different distribution pattern and may form centimetre levels, some of which were already

recognized in the field. The microstructure is generally granular and poorly developed, sometimes intergrade to platy. There are different generations of coatings such as: calcitic silty laminated cappings and links, with punctuations and charcoal microfragments; layered silt and sand cappings; dusty clay coatings (Fig. 4:2-3).

The possible presence of occupation surfaces structured in the samples gathered from US 25a and US 29 should be noted. A compact level of 4-5 mm, mainly composed of grains of quartz, feldspar and mica of the fine sand and coarse silt fraction, frequent flints, few charcoal fragments and scattered bone fragments (Fig. 4: 4), can be seen in these thin sections. The following features are also visible: a blocky angular microstructure, absent at the top and gradually better developed towards the bottom; a platy microstructure, which is poorly developed in the upper part and contains pores parallel to the upper boundary of the unit, correlated with a superficial compaction and with the subhorizontal orientation pattern of the mica crystals which are randomly arranged elsewhere. In thin section 25a, the structure is not so clear, rounded aggregates are present as well as fragments of the silt level mentioned above.

4. INTERPRETATION OF THE ANALYTICAL DATA AND CONSIDERATIONS

The overall sedimentological and pedological features of the stratification reflects the microenvironment of the rockshelter. With regard to the sedimentary deposits, natural and cultural materials, coming from both inside and outside the rockshelter, can be distinguished.

Among the natural components, the "infrabasin" ones are represented by limestone frost-slabs from the vault, which can be found in all the units, and carbonate silt. The "extrabasin" constituents are more varied and include fine alluvial material from the small valley (sand and fine gravel), colluvial inputs from the slopes (silt and angular gravel) and possibly direct aeolian inputs of silt.

The anthropic inputs are very diversified and are obviously correlated to the activities carried out on the site: an abundant quantity of organic material, artefacts (mainly lithics), ecofacts (charcoal and bones), manuports and possibly fine sediments from outside.

The anthropic complex persists on an already stabilised surface, affected by incipient soil formation with an accumulation of organic matter and decarbonation. The formation processes are connected with various types of human actions, coming along with a series of post-depositional modifications,

mainly due to biological factors and frost action.

The most interesting human features are the microfacies observed in the thin sections from US 25a to 29. The composition and the grain size distribution of the fine inorganic fraction, the evident compaction and the scarcity of organic matter, charcoal and bone in the matrix suggest that the intentional deposition of material from outside the rockshelter, probably from pre-existing aeolian sediments. The presence of structured occupation surfaces limited to certain areas of the shelter, can be presumed from the distribution pattern of these prevalently inorganic facies (cfr. G   *et al.*, 1993). Other aspects such as the compaction and the scarcity of organic matter lead to the view that the surfaces had been intensively occupied and that the organic refuses were cleared out and not accumulated here. In the other samples, the micromorphological features suggest incorporation mechanisms such as trampling, the discarding and clearing away of waste materials, and artefact manufacturing, resulting in the formation of organic units. The analysis also helped recognize non-cultural processes contemporary to occupation, such as illuviation of organic matter down to the complex underlying the anthropic units, bioturbation, the degradation of the structured occupation surfaces in US 25a, which caused its breaking and the formation of aggregates.

The geoarchaeological investigation has also brought to light a series of post-depositional processes responsible for the pedoturbation of the sediments and particularly of the anthropic ones. The most common of these are the action of discontinuous frost (cryoturbation), responsible for the convolution of the interfaces, the iso-orientation of the stones, the origin of platy pedality and ice lensing, and bioturbation, which can be recognized by the presence of voids of biological origin, of excrements and of microgranular structures. Other pedogenic factors that are associated with pedoturbation are the migration of clay and other materials, the accumulation of organic matter, decarbonation and carbonation. The intensity of these processes, which can only be detected on meso- and microscopic scale, was undoubtedly limited whereas the erosion of the anthropic units on the external part of the shelter is much more important. It must be underlined however, that the sequence and its anthropic features were well preserved due to the relatively rapid aggradation of the surface through the accumulation of the breccia of the post-settlement complex.

On the whole, the sequence registers the local changes in the period of time from Pleniglacial II to modern day. Because of the peculiar characteristics of the locality, the climate fluctuations do not bring about great changes of the sedimentary inputs and of the soil formation processes. It is more a matter of particulars, such as the quantity of external inputs or the generations of pedofeatures (as coatings).

The lower units which were surveyed are the consequence of the deposition of materials that come from inside, in a rather cold and humid context (US54 and 53), followed by a gradual increase of external inputs (US52 and 51) and the surface stabilisation, on which the anthropic occupation sets. After their deposition, the archaeological units probably register a "climatic deterioration" with cryoturbation and erosion, further sedimentation of external materials (US8a) and a long, probably discontinuous period, of frost-shattered stones accumulation (US3 and 5). The stabilisation, still lasting today, closes the sequence.

NOTES

1 - Research financed by C.N.R. (Progetto Finalizzato "Beni Culturali", CT N° 96.01083.PF 36) and the Museo Tridentino di Scienze Naturali.

2 - The units described in paragraph 3.2 are to be considered as pedostratigraphic entities, or otherwise excavation units; in fact their definition is based on integrated criteria related to stratigraphic standards such as pedological, archaeological or other types.

SUMMARY - The routine analyses and micromorphological investigations of the sedimentary sequence of Riparo Dalmeri has given useful data for understanding the environmental context during the occupation of the site; special attention has been paid for reconstructing the formation processes of the occupation surface of the units 26 and related. The sequence attests different climatic phases, i.e. from a relatively cold and humid situation, towards a temperate one during the LUP occupation, and, later, to another cold context, probably during the Younger Dryas. The upper part of the sequence records the present day stable situation. The results of the geoarcheological investigation indicate that humans occupied a soil surface which was already stable and affected by soil formation, in particular by the accumulation of organic matter and by the leaching of carbonates. The formation processes of the unit 26 are related to various activities, as the preparation of structured occupation surfaces through the deposition of aeolian silt sediment which was collected outside the shelter; the strong compaction and the scarcity of organic components in the matrix suggest the existence of surfaces which were intensively occupied, with the predominant tossing of the organic refuse, more than its accumulation in situ. Furthermore, the formation of organic refuse layers through its accumulation and incorporation in the soil matrix, which is related to trampling, refuse mobilisation and manufacturing, is recorded. Sin- and post-depositional modification processes have been observed in the unit 26. The former are represented by organic illuviation in the underlying soil, the bioturbation of the organic soil with the formation of microgranular structure, the degradation of the structured occupation surface, which is particularly well recognizable in some of the samples. The latter include the cryoturbation, which re-sets the former granular structure, bioturbation and clay illuviation in depth.

RIASSUNTO - Le analisi sedimentologiche e micromorfologiche della serie di riempimento di Riparo Dalmeri consentono di ricostruire l'evoluzione del contesto ambientale nel quale si inserisce la frequentazione antropica rivolgendosi, nel contempo, una particolare attenzione ai processi di formazione del suolo d'abitato dell'unità 26 e correlate. La serie documenta una successione di fasi climatiche che, da tendenzialmente fredde ed umide, diventano più temperate in corrispondenza dell'occupazione epigravettiana, per ritornare a nuovamente fredde, verosimilmente nel Dryas Recente. La serie si chiude con un suolo che documenta la sostanziale stabilità del microambiente atriale. Nel complesso i risultati mostrano come la frequentazione antropica insista su una superficie già stabilizzata, interessata da una incipiente pedogenesi con accumulo di sostanza organica e lisciviazione dei carbonati. Più specificatamente i processi antropici di formazione dell'unità 26 sono pertinenti ad attività di vario tipo: strutturazione di superfici di occupazione mediante deposizione di limi prelevati in depositi eolici esterni al sito; esistenza di superfici di occupazione intensa con un'attività prevalente di evacuazione dei rifiuti organici piuttosto che di accumulo, come indicato dalla forte compattazione e dalla scarsità di elementi organici incorporati nella matrice; calpestio, mobilitazione di rifiuti, lavorazione di materiali, responsabili della formazione di unità di detrito organico per accumulo ed incorporazione nella matrice. Sono stati inoltre individuati processi sin e post-deposizionali all'unità 26. Tra i primi, l'illuviazione di sostanza organica anche nel profilo pedologico sottostante, la bioturbazione del suolo organico, responsabile della formazione di aggregazione granulare, la degradazione della superficie di occupazione strutturata, particolarmente evidente in alcuni campioni. Tra i secondi, la crioturbazione che riorganizza precedenti strutture granulari, la bioturbazione e l'illuviazione di argilla negli orizzonti del suolo sottostante l'antropico.

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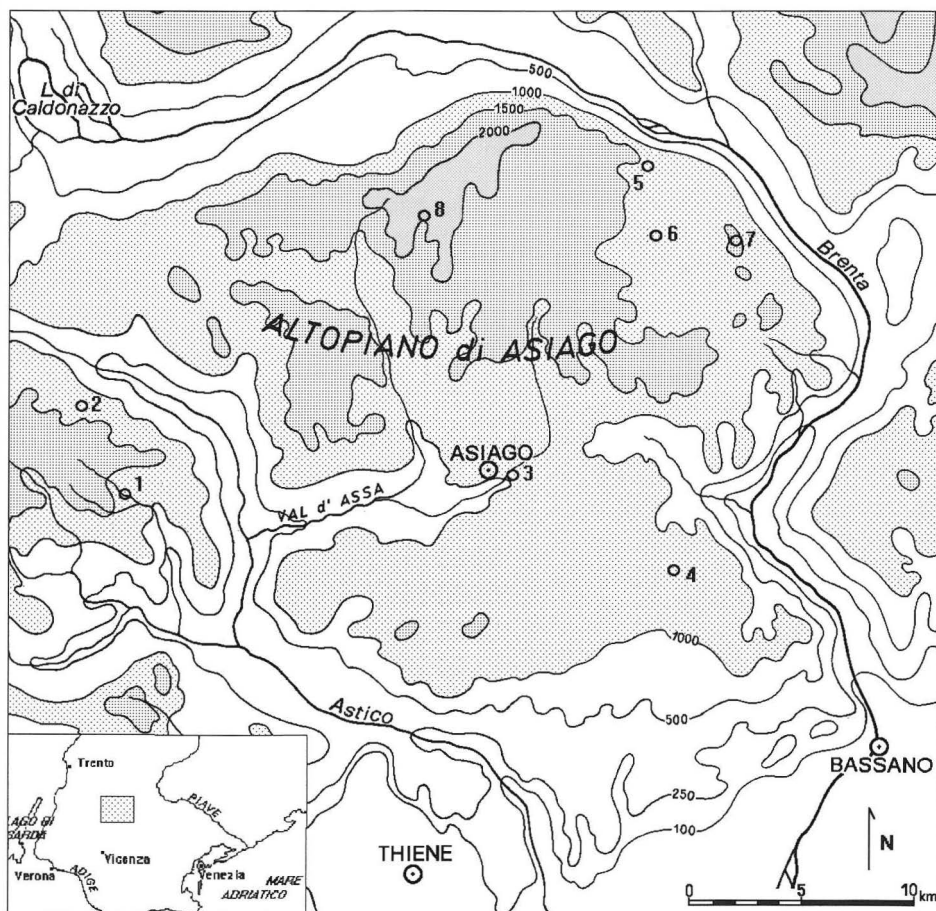


Fig.1 - Geographical sketch of the Asiago Plateau and of the surrounding areas, with the main localities of the Upper Paleolithic and of the Mesolithic period: 1) Malga Campoluzzo di Mezzo; 2) Alpe Fiorentini; 3) Battaglia rockshelter; 4) Val Lastari; 5) Dalmeri rockshelter; 6) Marcesina sites; 7) Ernesto Cave; 8) S di Cima Dodici sites

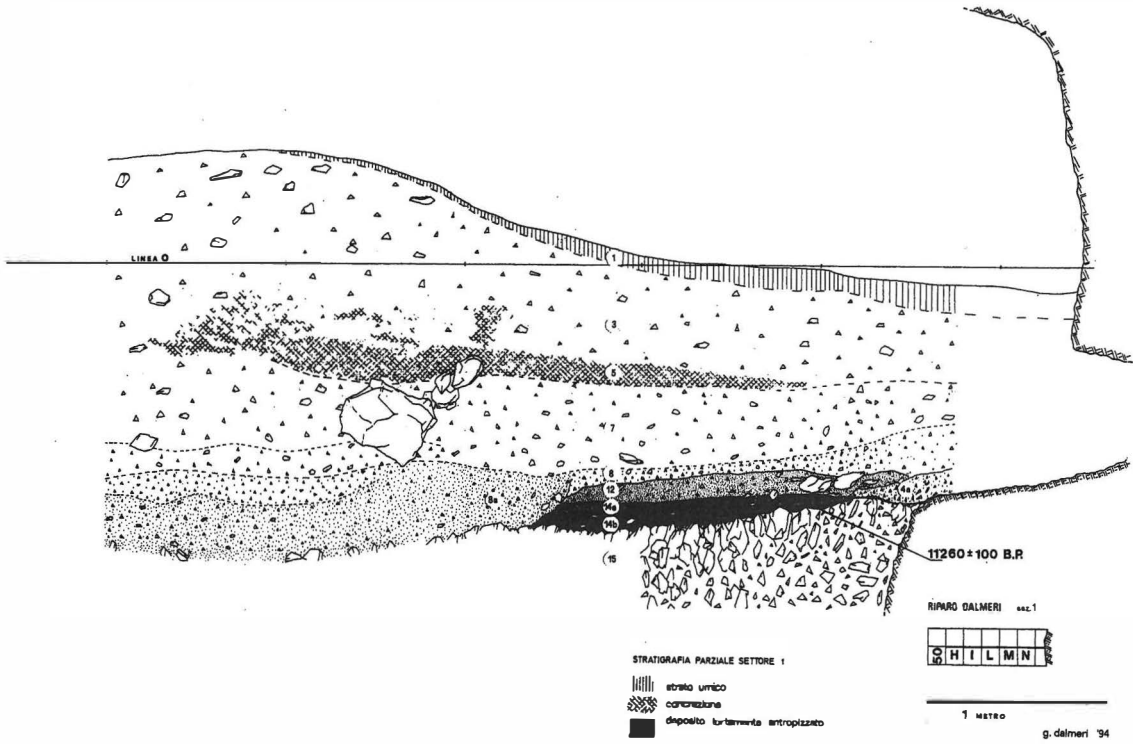
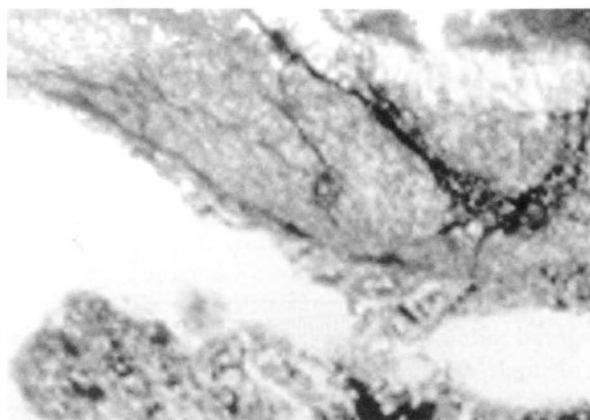


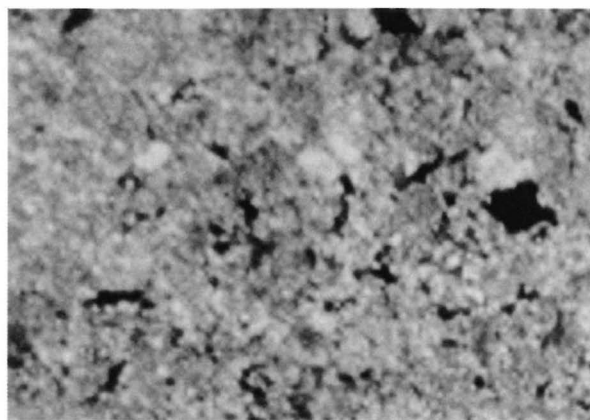
Fig.2 - Section of the upper part of the sedimentary sequence of Dalmeri rockshelter (by DALMERI & BASSETTI, 1993)

US	q.	S	L	A	pH	carb.	s.o.	N	P	K
		%	%	%		%	%	%		
1	47	-	-	-	7,6	10,76	38,71	2,30	417	103
3	47	24	59	17	8,2	83,54	2,64	0,16	260	113
8a	47	20	61	19	8,1	77,97	3,90	0,27	169	53
21	47	16	65	19	8,4	87,30	3,05	0,17	439	60
14	51	36	51	13	8,2	60,27	7,04	0,36	168	106
26b	41li	-	-	-	8,2	53,17	13,08	0,71	161	63
26c	41Lg	-	-	-	8,2	33,81	19,82	1,04	161	36
50	47	22	56	22	8,3	79,36	2,79	0,14	188	34
51	47	42	43	15	8,2	58,44	4,68	0,22	153	56
52	47	52	35	13	8,6	51,34	< 0,5	0,02	40	60
53	47	56	33	11	8,6	50,55	< 0,5	0,02	34	58
54	47	48	39	13	8,8	73,48	< 0,5	0,01	34	36

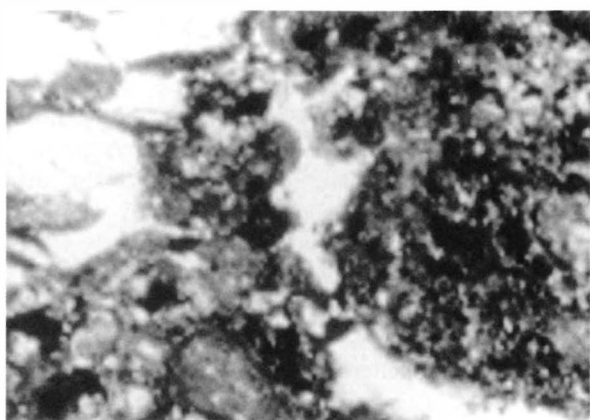
Fig. 3 - Results of the pedosedimentological routine analyses. Legend: US) sq - unit and square of origin of the specimen; S, L, A) percentage values of sand, silt and clay; pH) pH value (determined by electrometric method, in water, 1:5 ratio); carb) total carbonates (determined by calcimetric De Astis); s.o.) organic matter (determined by bicromate oxidation, carbon organic conversion factors-organic matter equal to 1.724); N) total nitrogen (determined by Kjeldahl method); P) phosphorus absorbability (determined by Olsen method); K) potassium absorbability (extracted with ammonium acetate)



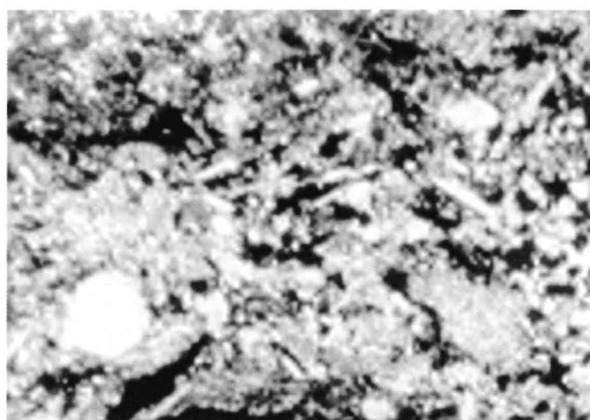
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2



2



4

Fig. 4 - Micrographies of Dalmeri rockshelter.

- 1) RD24A: PPL view of the anthropic sediment; note the abundance of biogenic elements (fragments of bone and carbons) and at the top part of the picture, the mixing of a material of the soil with different features, as a result of cryoturbation.
- 2) RD24A: organic capping covering a fragment of limestone already subjected to calcium carbonate precipitation.
- 3) RD24B: the microstructure of the sediment, rich of components of anthropic origin, clearly derives from the combined action of biological and cryogenic processes (PPL).
- 4) RD29/3: the upper part of unit 29, characterised, in its upper part, by a strong compaction that completely lacks porosity and in its lower part, by an subhorizontal isorientation of the tubular components and of the gaps (XPL). The length of the long side of all the pictures is 9mm