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Humans and their landscape from the Alpine Last Glacial Maximum to the Middle Holocene in Trentino: geoarcheological considerations

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SUMMARY - Humans and their landscape from the Alpine Last Glacial Maximum to the Middle Holocene in Trentino: geoarcheological considerations - The aim of this paper is to present an overview of the landscape evolution of the Trentino region and its surroundings from the Alpine Last Glacial Maximum (ALGM) to the Middle Holocene, approximately between 22,000 and 4000 years cal BP. Since the 1970's, the excavation and multidisciplinary study of Late Upper Palaeolithic, Mesolithic and Neolithic sites have allowed archaeologists to gather abundant – but unevenly distributed in space and time – data on the stratigraphy, geomorphology and Quaternary geology of the region. Further data derive from the analysis of the sites archaeology, archaeobotany and archaeozoology. The available information is resumed here to outline the palaeogeography and palaeoenvironment of the southern Alpine region in the examined time span and to understand the relationships between these factors and the settlement systems of the last hunter-gatherers and first shepherds and farmers who inhabited the area. Data presentation follows a chronological approach and tries to emphasize the transitional moments, as the retreat of the Alpine Pleistocene glaciers; the contrasting environmental conditions of the Lateglacial – with the temperate scenario of the Greenland Interstadial 1 (a.k.a. Bølling and Allerød), driving the human settlement towards the Prealpine margin and plateaux, and the cold pulsation of the Greenland Stadial 1 (a.k.a. Younger Dryas); the onset of the temperate Holocene situation from Preboreal and Boreal times, when the Mesolithic groups moved as far as the main Alpine range; the biostatic phase of the Atlantic, which saw the settlement of the first Neolithic groups; and the end of Atlantic, when the first effects of human impact are observed.

RIASSUNTO - Occupazione umana e modificazioni ambientali tra Ultimo Massimo Glaciale e Olocene medio in Trentino: considerazioni geoarcheologiche - Questo contributo si propone di tracciare una panoramica dell'evoluzione ambientale del Trentino e delle aree limitrofe nell'arco di tempo compreso tra l'Ultimo Massimo Glaciale (ALGM) e l'Olocene medio, tra circa 22.000 e 4000 anni calendario BP. Gli scavi e le ricerche multidisciplinari realizzate dagli anni '70 del secolo scorso in siti del Paleolitico superiore, del Mesolitico e del Neolitico hanno permesso di raccogliere numerosi dati – anche se distribuiti irregolarmente – sulla stratigrafia, sulla geomorfologia e sulla geologia del Quaternario di questa regione. Altri dati derivano da studi archeologici, archeobotanici e archeozoologici. Queste informazioni sono qui riassunte per ricostruire l'evoluzione paleogeografica e paleoambientale delle Alpi meridionali nell'intervallo di tempo esaminato e per comprendere le relazioni tra questi fattori e i sistemi insediativi degli ultimi cacciatori-raccoglitori e dei primi pastori e agricoltori che frequentarono l'area. La presentazione dei dati segue un approccio cronologico, concentrandosi sui momenti di transizione, in particolare: il ritiro dei ghiacciai pleistocenici alpini; la situazione del Tardoglaciale, che varia dal quadro temperato del Greenland Interstadial 1 (alias Bølling e Allerød), che portò l'insediamento umano a spingersi fino al margine delle Alpi e agli altopiani prealpini, alla pulsazione fredda del Greenland Stadial 1 (alias Dryas Recent); l'instaurarsi delle condizioni temperate dell'Olocene, nel Preboreale e nel Boreale, durante i quali i gruppi mesolitici raggiunsero lo spartiacque alpino; la fase di biostasia dell'Atlantico, che vide l'insediarsi dei primi gruppi neolitici; e la fine dell'Atlantico, quando si osservano i primi effetti di impatto antropico sull'ambiente.

Key words: Late Pleistocene; Holocene; Trentino; Geoarchaeology; human-environment relationships

Parole chiave: Pleistocene superiore; Olocene; Trentino; geoarcheologia; relazioni umani-ambiente

1. INTRODUCTION

The eastern sector of the southern Alps, which corresponds to the Italian administrative regions of Trentino-Alto Adige, Veneto and Friuli, has been the scenario of extensive archaeological research on the Lateglacial and Early Holocene human occupation since the 1970's (see e.g. Broglio & Impronta 1995; Dalmeri & Lanzinger 2001;

Dalmeri *et al.* 2001 and bibliography). Surveys and excavations in this area have yielded abundant archaeological and palaeoenvironmental data. They are diverse in quantity and quality, but provide the bulk to sketch an outline of the diachronic relationships between the human occupation and the land evolution in the time interval around the Pleistocene-Holocene transition. In this paper we try to sketch such a framework, through the summary of the ge-

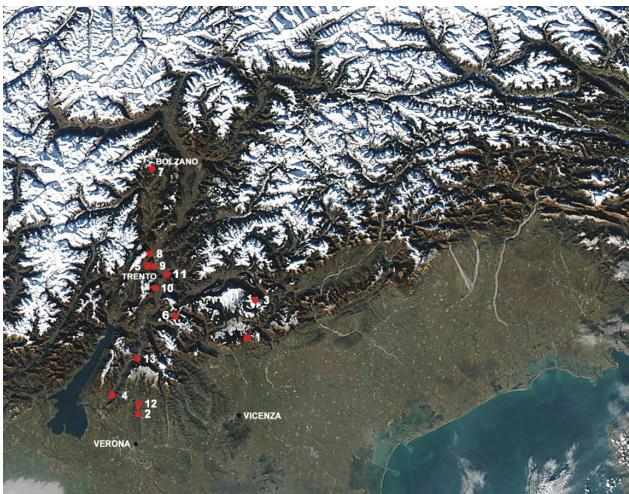


Fig. 1 - Location of the main sites mentioned in the text. 1. Vallastari, 2. Riparo Tagliente, 3. Riparo Dalmeri, 4. Riparo Soman, 5. Terlago, 6. Riparo Cogola, 7. Laghetto delle Regole di Castelfondo, 8. Vatte di Zambana, 9. Pradestel, 10. Romagnano, 11. Riparo Gaban, 12. Lugo di Grezzana, 13. Ala le Coronе.

Fig. 1 - Localizzazione dei siti citati nel testo. 1. Vallastari, 2. Riparo Tagliente, 3. Riparo Dalmeri, 4. Riparo Soman, 5. Terlago, 6. Riparo Cogola, 7. Laghetto delle Regole di Castelfondo, 8. Vatte di Zambana, 9. Pradestel, 10. Romagnano, 11. Riparo Gaban, 12. Lugo di Grezzana, 13. Ala le Corone.

archaeological data collected from a number of Epigravettian, Mesolithic and Neolithic key-sites, mainly located in the Trentino region (Fig. 1).

Data presentation follows a chronological approach and focus on the transitional moments. The chronostratigraphic units used here are those established by Ravazzi (2003). Ages are reported as 2σ calibrated years BP, unless expressly specified (radiocarbon dates were calibrated using the CALIB 5.0.1 software – Reimer *et al.* 2005). Heights are reported in meters above modern sea level.

2. THE GEOLOGY AND GEOMORPHOLOGY OF TRENTINO: BRIEF REMARKS

The Trentino region is located in the southern Alps and occupies, together with the Alto Adige/South Tyrol district, the mountain sector of the River Adige drainage basin – although some sectors of Trentino belong to the Po and Brenta drainage systems. The relief of the region is rather articulated, as a result of its geological complexity and of the polygenetic land evolution to which it was submitted during the Quaternary (Fig. 1).

The valleys of the Adige and the Sarca rivers constitute the “backbone” of this sector of the Alpine chain and grossly run N-S. The Adige Valley crosses the entire southern Alpine and Prealpine range and constitutes the primary natural connection between the Po Plain and the northern Alps. Other E-W-oriented valleys (as Valtellina, Val Pusteria and Valsugana) link the distinct segments of this part of the southern Alpine range.

The geological and structural setting of Trentino

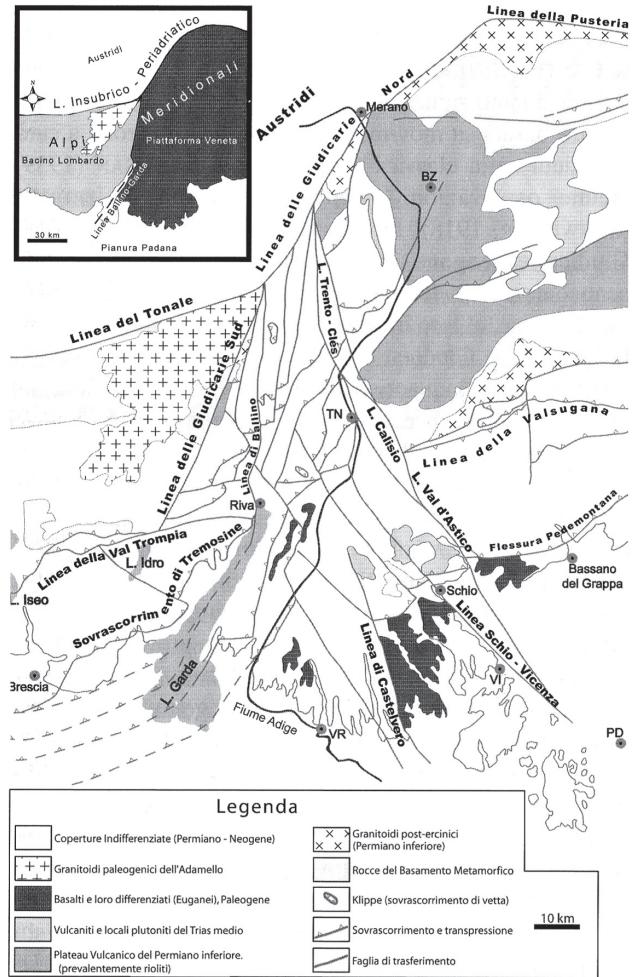


Fig. 2 - Lithological and structural sketch map of the Trentino region and surroundings (after Castellarin *et al.* 2005).

Fig. 2 - Schizzo litologico e strutturale del Trentino e aree limitrofe (da Castellarin et al. 2005).

have partly controlled its geography and geomorphology (Fig. 2). Geologically, three main domains are found in the region (Bosellini *et al.* 1999):

- southern Alpine terrains: they outcrop in the central and eastern sectors of the region and comprise pre-Permian crystalline basement materials as well as Permian to Tertiary covers, the latter including volcanic and sedimentary rocks (mainly carbonates);
 - Austroalpine terrains: they extend in the region's NW corner and are mostly composed of metamorphic lithotypes;
 - the Adamello batholith: it is found along the eastern border of Trentino and is made of granitoid lithotypes (Fig. 2).

Under a structural point of view, two main domains may be distinguished:

- to the West of the Adige Valley, structural alignments are parallel to the Giudicarie Line direction (NNE-SSW) and include overthrusts and transpressive features;
 - to the East of the Adige Valley, overthrusts are S-

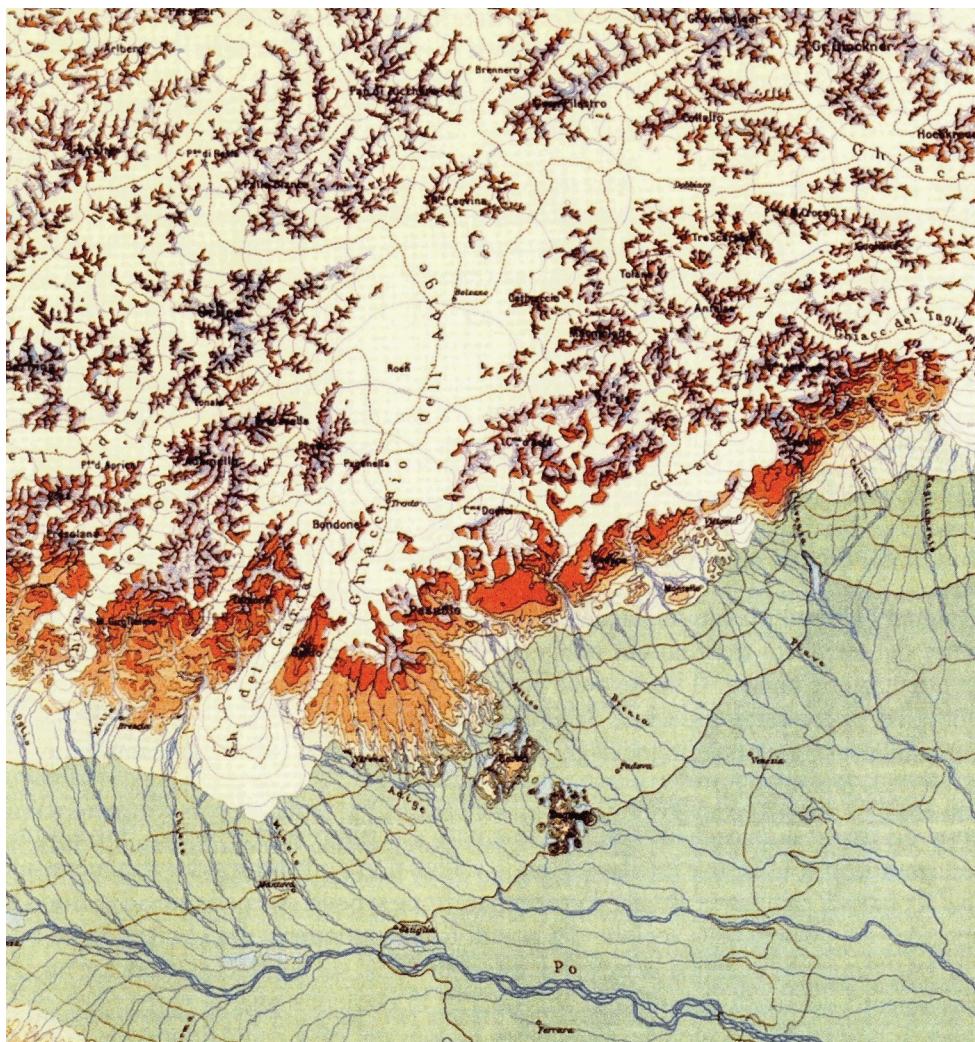


Fig. 3 - Reconstruction of the Trentino region and surroundings at the Alpine Last Glacial Maximum (after Castiglioni 1940).

Fig. 3 - Ricostruzione del Trentino e aree limitrofe durante l'Ultimo Massimo Glaciale (da Castiglioni 1940).

verging and mainly oriented WSW-ENE, while transcurrent faults are mostly directed along a NW-SE axis, i.e. parallel to the Schio-Vicenza Line set (AA. VV. 1981).

The present physiography of the region strongly depends on the dynamics related to the Last Glacial-Interglacial cycle. Structural and geological factors are responsible for the high energy of relief (heights range from 200 m to over 3000 m, often with abrupt transitions between altitudinal belts) and control the orientation of the main valleys and mountain ranges. The major drainage system (Sarca and Adige rivers) was formed during the Miocene, as a result of the intense erosion triggered by the Messinian crisis (Finckh 1978; Bini *et al.* 1978). Geophysical and mechanical prospection around the town of Trento has detected the presence of bedrock at 620 m depth, i.e. at some 435 m below the modern sea-level. Similar results were obtained near Levico, in Val Sugana, and at Riva del Garda, in the Sarca Valley, where bedrock was respectively reached at 50-100 m and 340-350 m below the present sea-level (Felber *et al.* 2000; Rosselli *et al.* 2000). It is worth noting that the principal karstic systems of the Prealpine Plateaux (Sette Comuni Plateau, Monte Baldo and Lessini Mts) had already start-

ed their development at the end of the Miocene (Bini *et al.* 1991).

Nevertheless, the most obvious features of the present landscape of Trentino are glacial and periglacial morphologies. During the coldest pulses of the Pleistocene, glaciers flew from the upland through the valleys and down to the Po Plain margin, determining an intense morphogenesis on the land system. For this reason, the ALGM, that is the moment when the Würmian glaciers reached their maximum extension during the Late Pleistocene, represents the “time-zero” for most of the archaeological record found around the region.

3. TRENTO AT THE ALPINE LAST GLACIAL MAXIMUM

The morphogenetic action of the Würmian glaciers determined a significant reshaping of Trentino’s landscape. The pre-Würmian drainage pattern was rather different from the present one: Adige River was draining through the present Sarca Valley, and most of the Adige’s East tributaries were flowing towards Brenta River. The pre-ALGM surface was reached at some 200 m depth in the Trento mechanical coring and is buried by a ca. 50

m-thick glacial till covered by fluvial and lacustrine sediments (Felber *et al.* 1998).

At the proper ALGM, at ca. 22 ka cal BP, the main valleys were filled by large glaciers reaching some 1500 km thickness around Trento, as already established by Penck & Brückner (1909), and extending to the Po Plain, which experienced steppe-like conditions (Fig. 3). At the same time, the main reliefs, including Prealpine Plateaux, were submitted to harsh periglacial conditions.

4. THE LATEGLACIAL (FROM THE DEGLACIATION TO THE YOUNGER DRYAS)

The term “Lateglacial” is used here to indicate the time span included between the retreat of the glaciers from the Alpine margin, which is dated to 21-18 ka BP (Ravazzi 2003), and the end of the Younger Dryas, i.e. the Pleistocene-Holocene limit, whose age is ca. 11,500 years BP (Frisia *et al.* 2005).

Deglaciation was a time-transgressive process and was only partly coeval to the onset of the temperate Lateglacial interstadials (see e.g. Ravazzi 2003). Unluckily, no direct data are available for maximum expansion of glaciers and the beginning of ice retreat in the Adige and Sarca valleys. Data are available at the Alpine margin for the Piave Basin, in the nearby region of Veneto. The Piave glacier reached its maximum expansion at $17,670 \pm 320$ ^{14}C BP (20,168-21,908 cal BP: Bondesan 1999) and experienced at least three deglaciation phases (Pellegrini *et al.* 2005). The oldest deglaciation phase of this glacier is dated to $16,210 \pm 50$ ^{14}C BP (19,210-19,486 cal BP), while the definitive retreat of its front from the Prealpine margin could have occurred between $14,765 \pm 135$ ^{14}C BP (17,303-18,544 cal BP) and $14,370 \pm 115$ ^{14}C BP (16,708-17,786 cal BP: Casadore *et al.* 1976).

In the mountain reach of the Adige Basin, the deglaciation probably acted relatively fast along South-exposed slopes, while the process would have been some slower in the main valley bottoms, due to the inertial effect of the ice mass (Pellegrini *et al.* 2005; Filippi *et al.* 2007). The available data on the beginning of the accumulation in lacustrine basins is an indirect evidence for that. Turf sedimentation at Palughetto (1053 m) started at $12,174 \pm 141$ ^{14}C BP (13,736-14,670 cal BP: Avigliano *et al.* 2000), while the accumulation of the succession at Lago Nero di Cornisello (2233 m a.s.l.) began at $12,320 \pm 80$ ^{14}C BP (13,990-14,740 cal BP: Filippi *et al.* 2007). The oldest dating available for the deposition of turf at Isera (219 m a.s.l.) is $12,250 \pm 110$ ^{14}C BP (13,833-14,696 cal BP: Calderoni *et al.* 1996): it shows that the Adige Valley bottom was free of ice grossly at the same time as the upland sites of Palughetto and Lago Nero di Cornisello.

From these data, it may be supposed that the Trentino region was deglaciated, up to mid altitudes, at least at ca. 14 ka cal BP. Nevertheless, during the time interval comprised between the deglaciation of the main valleys and the Bølling-Allerød interstadial, most of the Alpine land was still submitted to periglacial conditions, with the reworking of the existing glacial deposits, the subsequent reconfiguration of hillslopes and the infilling of basins and depression with sediment (Ravazzi *et al.* 2007).

Intense water discharge took place from the glacial fronts during the deglaciation process, with subsequent in-

tense sedimentary aggradation in the main valley bottoms and the formation of the wide Po Plain sandur, which is formed of a series of coalescent alluvial fans (Marchetti 1996) and is indicated in the bibliography as the “main level of the plain” (“livello fondamentale della pianura”: Petrucci & Tagliavini 1969; Cremaschi 1987). The availability of large amounts of fine material and the environmental situation in the plain enhanced aeolian activity, which led to the extensive accumulation of loess deposits during the lateglacial (Cremaschi 1990). Wind-blown dust from the Po Plain was laid down at the Alpine margin, on Prealpine plateaux and in rockshelters, in different moments of the Pleistocene. The phase of deposition dated to the Lateglacial is, at present, the more widespread and the better studied, thanks to the existence of several Epigravettian sites whose archaeological deposits are embedded in loess or loess-like sediment.

The accumulation of loess during the Lateglacial took place before the GI-1 interstadial, even if it is not clear if this phase of accumulation was synchronous all around the Prealps and coeval to the deglaciation process. Sites as Vallastari (Broglio *et al.* 1994; Angelucci & Peresani 2000) and probably Terlago (Dalmeri 1985; Cremaschi & Lanzinger 1987) also preserve the evidence of soil formation during the GI-1 interstadial (see below), which acted on post-ALGM loess sediment. The succession recorded at Vallastari (Sette Comuni Plateau, 1040 m a.s.l.) exemplifies the sequence of events that the Prealpine plateaux experienced during the Lateglacial (Tab. 1).

Several Late Upper Palaeolithic open-air sites are associated with loess deposits in the southern Prealps, beside Vallastari and Terlago: Alpe Fiorentini (Bartolomei & Broglio 1967; Angelucci 1997); Andalo (Cremaschi & Lanzinger 1984; Guerreschi 1984); Campoluzzo di Mezzo (Angelucci 2000); Viotte di Bondone (Bagolini & Guerreschi 1978). Unluckily, their deposits are often shallow, which caused the archaeological record to be submitted to near-surface conditions and to the significant impact of postdepositional processes.

A younger phase of loess deposition during the Younger Dryas (a.k.a. GS-1 stadial) was also postulated for some of these sites (Andalo, Terlago and Vallastari: Cremaschi & Lanzinger 1987; Angelucci & Peresani 2000).

The available evidence for the Lateglacial interstadial (a.k.a. GI-1 or Bølling/Allerød) is fairly abundant. The “climate amelioration” that took place during this time interval is proven by the extensive distribution of sites that bear archaeological and paleoenvironmental information throughout the southern Alps and that occupy distinct altitudinal belts, geomorphological settings and environmental situations. The general scenario indicates that the main processes triggered by the climate change at the beginning of this interstadial were: the rapid shifting of biological communities towards mid-altitude upland; the decrease of sedimentation rates and of sediment accumulation, with subsequent biostasy and soil formation; the occupation of Prealpine plateaux by Epigravettian human groups. The onset of the temperate climatic situation is indicated by the number of successions that are productive under the palaeobotanical point of view (see e.g. Bertoldi 1968; Seiwald 1980; Cattani 1994; Oeggl & Wahlmüller 1994; Kofler 1994). At Lavarone (1100 m a.s.l.), the estimated mean summer paleotemperature rose from 11 °C

Tab. 1 - Vallastari (Sette Comuni Plateau, Vicenza). Sequence of recorded events (modified after Angelucci & Peresani 2000).
 Tab. 1 - Vallastari (Altopiano dei Sette Comuni, Vicenza). Sequenza degli eventi registrati (da Angelucci & Peresani 2000, modificato).

	evidence	palaeoenvironment	chronology
1	loess-like and slope sediment	instable, cold humid	ALGM?
2	chernozem-like soil formation	biostasy	Lateglacial interstadial
3	erosion and partial soil collapse	climate "deterioration"	
4	loess-like sediment	instable, cold	Lateglacial interstadial
5	soil formation	biostasy	
	occupation surface	human occupation	
6	loess sediment	steppe-like environment	Younger Dryas
7	artefacts scattered inside the profile	human occupation	Younger Dryas?
8	soil formation (leaching)	stable, temperate	Holocene
9	coarse illuviation	soil degradation / human impact?	Late Holocene
10	intense bioturbation	stable, temperature	

Tab. 2 - Riparo Tagliente (Valpantena, Verona). Stratigraphic succession (simplified; after Castiglioni *et al.* 1990, modified).
 Tab. 2 - Riparo Tagliente (Valpantena, Verona). Successione stratigrafica semplificata (da Castiglioni *et al.* 1990, modificato).

phase	short description	chronology	dating (a cal BP)
3	Talus deposits		
2d	Alternations of occupation layers and fine breccias in silty sandy matrix (levels 14-5)	Lateglacial interstadial	13,448-14,469
2c	Medium and coarse breccias in loess matrix (levels 18-15)		
2b	Frost- and soil-creep deposits	Early Lateglacial	15,360-16,548
2a	Basal conglomerate		

to 15 °C at the end of the interstadial (Heiri 2007), that is, some 2 °C less than the modern mean summer temperature (Eccel & Saibanti 2007). Similar evidence is recorded by the study of faunal remains. For instance, temperate faunal assemblages at Riparo Tagliente appear from Unit 12, which is attributed to the Bølling, even with some uncertainty (Sala 1983; Bartolomei *et al.* 1985; Tab. 2). The Allerød stadial is clearly recognised all around the region thanks to the abundance of botanical and faunal assemblages that point to a mild climatic situations, both at low (e.g. sites as Riparo Tagliente or Riparo Soman: Sala 1983; Cattani 1994; Tagliacozzo & Cassoli 1994) and mid altitude (as at Bondone or in the Sette Comuni Plateau: Kofler 1994; Broglio *et al.* 1994).

The oldest evidence of the Lateglacial human occupation along the southern margin of the Alps is recorded in valley bottoms. One of the key-sites is Riparo Tagliente, in Valpantena (Verona, 250 m a.s.l.: Bisi *et al.* 1983; Bartolomei *et al.* 1985; Fontana *et al.* 2002; Tab. 2). This site was occupied from the Early Lateglacial, with dates ranging from $13,430 \pm 180$ ^{14}C BP (15,360-

16,548 cal BP) to $12,040 \pm 170$ ^{14}C BP (13,448-14,469 cal BP). The analysis of faunal remains have shown that humans mainly hunted ibex and, to a lesser extent, auroch, elk, bison, marmot and hare at Riparo Tagliente (Bartolomei *et al.* 1994).

Another Lateglacial site of interest is Riparo Villabruna, in Val Rosna (Belluno, 500 m a.s.l.), whose occupation is dated to the earliest phase of the Bølling-Allerød interstadial. Ibex remains prevail in the older occupation phase at Riparo Villabruna, while red deer is dominant in the youngest one (Aimar *et al.* 1994).

The earliest evidence of surface stabilization with subsequent soil formation at mid-altitude is probably documented at Vallastari, at around 12 ka ^{14}C BP, where soil formation with an isohumic-like characteristic was detected (Angelucci & Peresani 2000). Significant stabilization leading to organic matter incorporation, decarbonation and weathering is well-recorded at around 11.0-11.5 ka ^{14}C BP (former Allerød) at several sites: Terlago (Cremaschi & Lanzinger 1987), Vallastari (Angelucci & Peresani 2000), Riparo Dalmeri (Angelucci & Peresani 2001), and probably

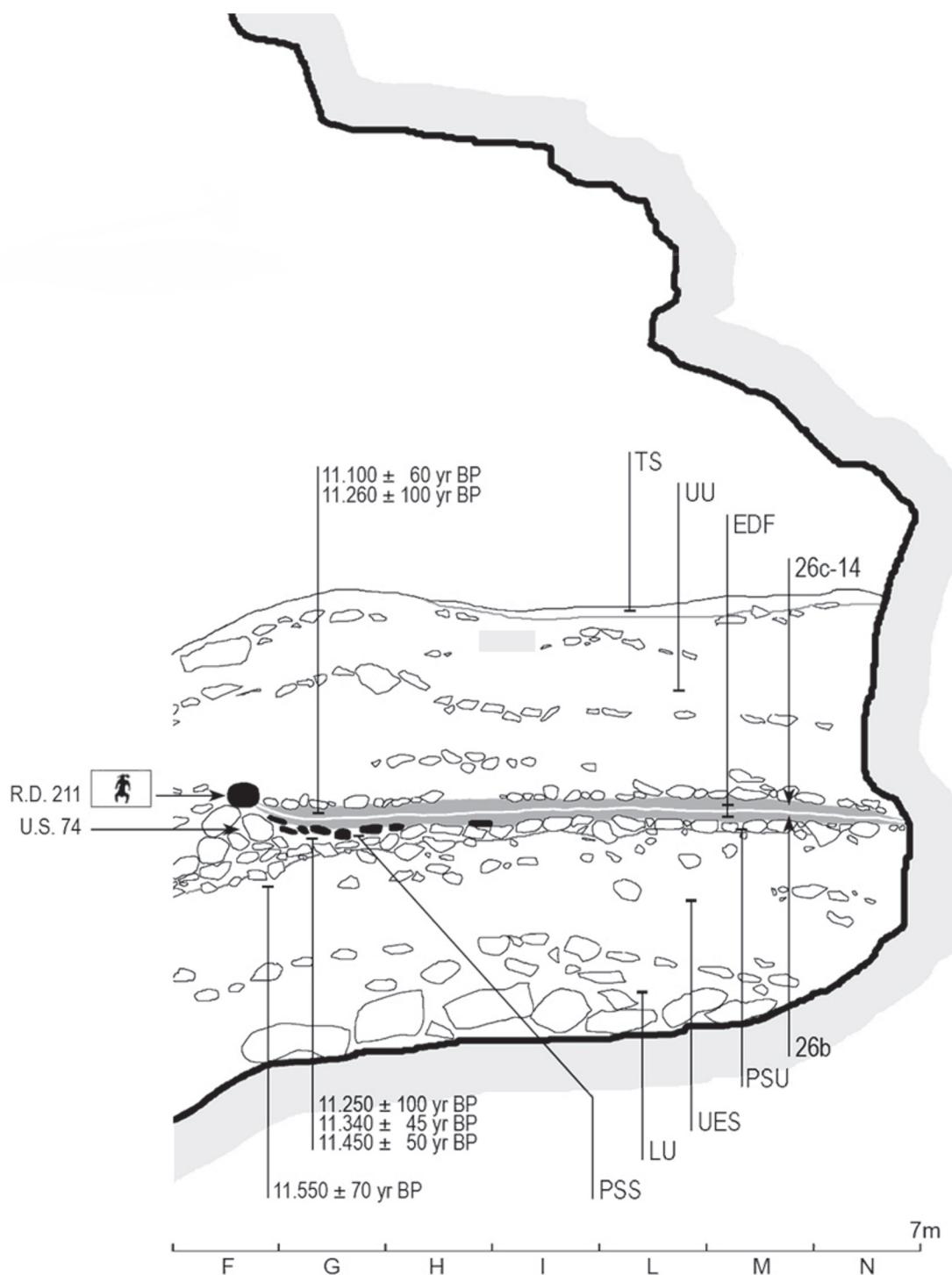


Fig. 4 - Riparo Dalmeri. Schematic N-S cross-section. LU = lower units, UES = units with aeolian inputs, PSU = pre-settlement units, PSS = painted stones structure, EDF = Epigravettian dwelling, UU = upper units, TS = top soil (after Dalmeri *et al.* 2006).
*Fig. 4 - Riparo Dalmeri. Sezione schematica N-S. LU = unità inferiori, UES = brecce con matrice eolica, PSU = brecce pre-insediamento, PSS = struttura antropica delle pietre dipinte, EDF = paleosuperficie epigravettiana, UU = brecce sommitali, TS = suolo attuale (da Dalmeri *et al.* 2006).*

Campoluzzo di Mezzo (Angelucci 2000).

The well-known site of Riparo Dalmeri (Dalmeri *et al.* 2005) shows clear evidence of the environmental situation during the Lateglacial Interstadial. The rockshelter is located along a N-oriented wall at ca. 1250 m a.s.l.

at the NE corner of the Sette Comuni Plateau, near its escarpment. Its stratification includes a rich archaeological palaeosurface dating to the Allerød, from which abundant archaeological features and objects, as well as art objects, were collected (Tab. 3; Fig. 4).

Tab. 3 - Riparo Dalmeri (Sette Comuni Plateau, Trento). Stratigraphic succession (simplified; after Dalmeri *et al.* 2005).
 Tab. 3 - Riparo Dalmeri (Altopiano dei Sette Comuni, Trento). Successione stratigrafica semplificata (da Dalmeri *et al.* 2005).

stratigraphic complex	unit(s)	short description	chronology	dating (a cal BP)
UU (Upper Units)	2-21	breccias and slope sediments	Younger Dryas - Holocene	
EDF (Epigravettian Dwelling)	26c, 26b-14	Ah horizon, <i>human occupation</i>	Lateglacial interstadial	12,900-13,303
PSS (Painted Stones Structure)	74, 15a, 65, 26d-e	various facies, <i>earliest human occupation</i>		12,943-13,405
PSU (Pre-Settlement Units)	15b, 50	open-work breccia		
UES (Units with aeolian inputs)	51, 52, 53	breccia with aeolian inputs		13,255-13,582
LU (Lower Units)	54	breccia and slope sediment with carbonate silt	Early Lateglacial	

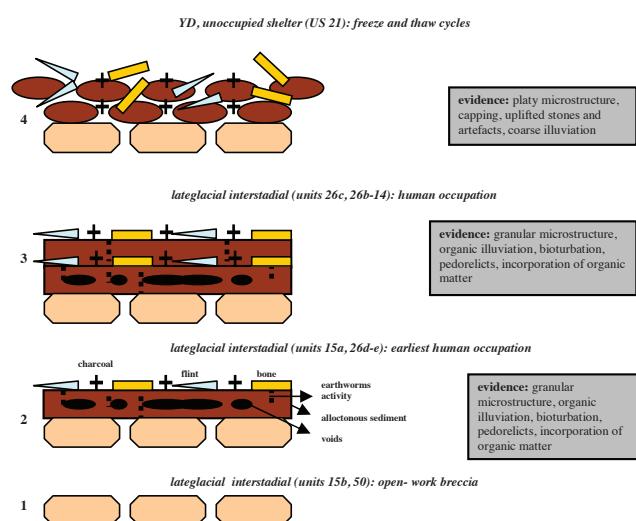


Fig. 5 - Riparo Dalmeri. Schematic representation of the main formation processes of the Epigravettian living-floor (see text for details).

Fig. 5 - Riparo Dalmeri. Rappresentazione schematica dei principali processi di formazione della paleosuperficie epigravettiana (per approfondimenti si veda il testo).

At Riparo Dalmeri, the phase of biostasy of the Allerød interstadial left several signatures that are juxtaposed to the human record of the Epigravettian occupation. The anthropogenic processes recorded in the Epigravettian palaeosurface (EDF stratigraphic complex) are related to the implementation of different activities (Fig. 5): the preparation of the occupation surfaces by means of the accumulation of silty sediment that was collected from loess deposits off the site; the accumulation of fine organic waste; tool production; trampling; and the remobilization of organic debris. The syn- and post-depositional

processes recognized are organic matter illuviation, bioturbation, clay migration and frost action. This last process was responsible for the partial destrukture of the living floor after its abandonment, especially during the Younger Dryas event. Subsequent roof-spalling driven by frost action caused the rapid burial of the archaeological surface, thus enhancing its preservation (Angelucci & Peresani 1996, 1998).

Another key-site for the study of the lateglacial in Trentino is Riparo Soman (ca. 100 m a.s.l.), which is located in Vallagarina, i.e. the lower part of the Adige Valley. This part of the valley experienced significant down-cutting during the Lateglacial, mainly due to the opening of the Chiusa dell'Adige gorge, which was formerly filled with glacial sediments. The older archaeological layers at Riparo Soman are dated to the Allerød ($11,880 \pm 170$ ^{14}C BP, $13,363-14,089$ cal BP; see Tab. 4) and contain faunal assemblages that indicate a moist and cool climatic context. The youngest phase of occupation is dated to between $10,470 \pm 150$ ^{14}C BP ($11,828-12,819$ cal BP) and $10,510 \pm 180$ ^{14}C BP ($11,824-12,850$ cal BP) and yielded faunal remains that denote cooler and moister conditions. Ibex is the main species present in this younger phase and is associated with taxa related to forest environment (red deer, roe deer, wild boar, wolf, marten and lynx – Battaglia *et al.* 1994, Broglio & Lanzinger 1985; Accorsi *et al.* 1990).

After the deglaciation, lake basins had formed in intramontane depressions, some of which remained active during the Lateglacial and part of the Holocene. One example is Terlago Lake (448 m a.s.l.), which is filled with a regressive series whose terminus ante quem dates to $11,890 \pm 90$ ^{14}C BP ($13,497-13,964$ cal BP: Baroni *et al.* 2001). An Epigravettian site is located along the northern shore of the lake (Dalmeri 1992). Its stratification has recorded the evidence of Lateglacial soil formation, which was followed by the development of a chernozem-like profile during the Younger Drays (Tab. 5). This younger profile was later affected by frost action and the polycyclic deposition of loess sediment (Cremaschi & Lanzinger 1987).

Tab. 4 - Riparo Soman (Vallagarina, Verona). Stratigraphic succession (modified after Accorsi *et al.* 1988; Broglio & Lanzinger 1995).
 Tab. 4 - Riparo Soman (Vallagarina, Verona). Successione stratigrafica (modificato da Accorsi *et al.* 1988; Broglio & Lanzinger 1995).

complex	short description	chronology	dating (cal BP)
Antropogenic sediments	human occupation, fine deposits, mainly colluvial and anthropogenic	Middle Holocene (Neolithic)	
		Early Holocene (Mesolithic)	
Sterile breccias	human occupation intercalated with breccias	Younger Dryas	11,823-12,850
Antropogenic sediments	human occupation intercalated with breccias	Lateglacial interstadial	13,363-14,089
Cemented breccias	Breccias, sometimes cemented	Early Lateglacial	
Fluviatile units	Gravel bar and overbank deposits of R. Adige		

Tab. 5 - Terlago (Trento). Stratigraphic succession (simplified; after Cremaschi & Lanzinger 1987; Baroni *et al.* 2001; Dalmeri *et al.* 1992).
 Tab. 5 - Terlago (Trento). Successione stratigrafica semplificata (da Cremaschi & Lanzinger 1987; Baroni *et al.* 2001; Dalmeri *et al.* 1992).

horizon(s)	evidence	palaeoenvironment	chronology
A1	colluvium		Late Holocene
IIB21, IIB22	decarbonatation, rubefaction, clay illuviation, soil formation (brown soil)	forest vegetation	Early Holocene
	erosion, loess deposition, frost action, soil formation (chernozem)	human occupation, steppe-like environment	Younger Dryas (Late Epigravettian)
IIIB23, IIIB3, IIICa	decarbonatation, rubefaction, clay illuviation, soil formation	forest vegetation (<i>Pinus</i> sp.)	Lateglacial interstadial
IIIC2	lacustrine sediment	regression of lake-shore lake	Lateglacial (>13,497-13,964 yrs BP)

Tab. 6 - Riparo Cogola. Simplified stratigraphic succession (modified after Bassetti *et al.* 2008).
 Tab. 6 - Riparo Cogola. Successione stratigrafica semplificata (modificato da Bassetti *et al.* 2008).

unit(s)	evidence	palaeoenvironment	chronology	dating (cal BP)
11, 12, 13, 15	soil formation, decarbonation	stable, temperate	Holocene	
16, 18, 25	frost action, soil formation, bioturbation, carbonation	human occupation (alternation of living-floors and fine breccias)	Early Holocene	10,503-11,966
19	frost action, coarse illuviation, bioturbation	human occupation (alternation of living-floors and fine breccias)	Younger Dryas	12,001-12,826
23, 24	soil formation, loess or loess-like deposition	stable	Lateglacial interstadial	

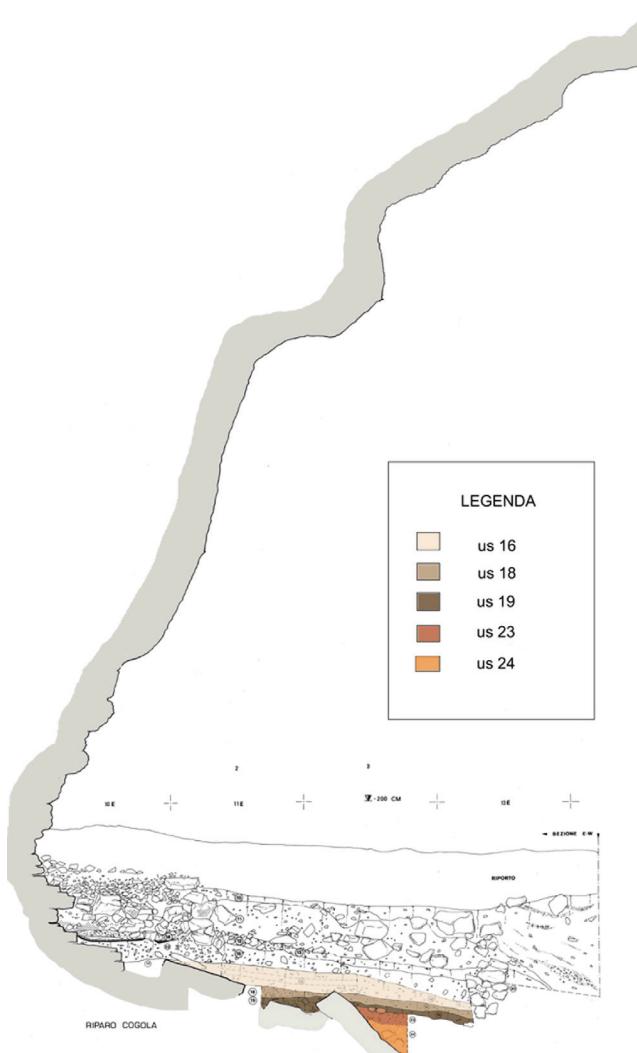


Fig. 6 - Riparo Cogola. E-W cross-section (USS 16 and 18: Preboreal; USS 19, 23 and 24: Younger Dryas - after Bassetti *et al.* 2008).

Fig. 6 - Riparo Cogola. Sezione E-W (USS 16 e 18: Preboreale; USS 19, 23 e 24: Dryas Recente - da Bassetti *et al.* 2008).

5. THE YOUNGER DRYAS

The abrupt climate change produced by GS-1 stadal (a.k.a. Younger Dryas) left contrasting evidence in the archaeological record; on the contrary, environmental data are fairly homogeneous.

During this phase, a generalised decrease of the forest cover and the lowering of the treeline are observed (Kofler 1994; Filippi *et al.* 2007). The Adige Valley bottom experienced intense alluvial accumulation processes, with an average sedimentation rate of 134 mm yr⁻¹ (Fuganti *et al.* 1996). Meanwhile, loess deposition took place at mid-altitude sites and is recorded at some Epigravettian open-air sites as Andalo, Terlago, and probably Vallastari (see above).

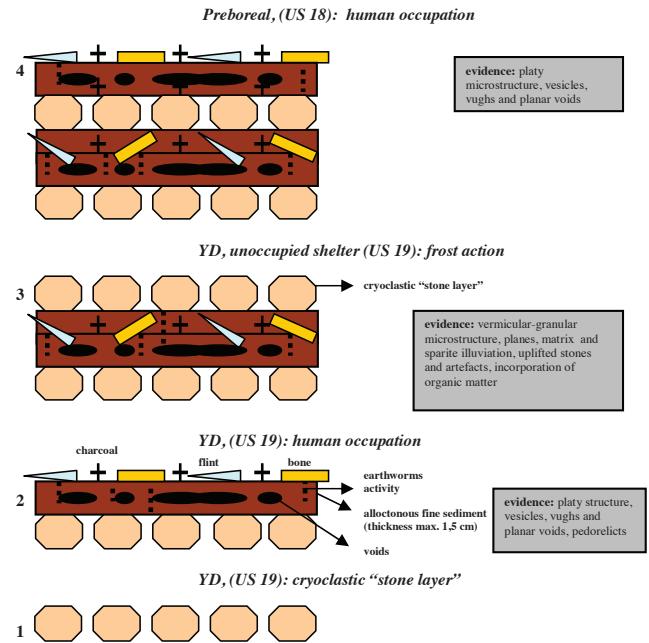


Fig. 7 - Riparo Cogola. Schematic representation of the main formation processes of the living-floor (see text for details).

Fig. 7 - Riparo Cogola. Rappresentazione schematica dei principali processi di formazione della paleosuperficie (per approfondimenti si veda il testo).

Archaeologically, the reduction of the Epigravettian “ekumene” determined the almost complete abandonment of the mid-altitude sites, even if humans continued to occupy some “refuge-areas”. The onset of the Younger Dryas at Riparo Dalmeri (see above) led to the disturbance of the Epigravettian living-floor due to discontinuous frost action and to its burial by *éboulis*. The site of Riparo Cogola provides a different scenario for the human occupation of the mid-altitude plateaux during the Younger Dryas. Riparo Cogola (ca. 1070 m a.s.l.) is a rockshelter located along a cliff oriented to the NNE near the natural Pass of Carbonare, at the W corner of the Sette Comuni Plateau. The site succession includes Late Upper Palaeolithic and Mesolithic occupations and is continuous throughout the Pleistocene-Holocene boundary (Tab. 6; Fig. 6). No evidence of frost action was detected in the samples collected from the Epigravettian and Mesolithic living floors, neither at the microscopic scale, and human signatures seem to superimpose natural ones. Together with the low-altitude rockshelter of Riparo Soman, Riparo Cogola is the only site that preserves significant evidence of the continuity of human occupation from the Lateglacial to the Early Holocene.

The processes that are involved in the formation of the archaeosurfaces of Riparo Cogola are similar to those detected at Riparo Dalmeri. At Riparo Cogola, fine sediment was collected outside of the rockshelter and brought into it, as at Riparo Dalmeri, but it is not clear whether this action was deliberate or if it was the result of other processes, such as trampling (Fig. 7). Several events concurred to the formation of the living-floors of Riparo Cogola, often

Tab. 7 - Laghetto delle Regole di Castelfondo LR1. Stratigraphic succession (modified after Dalmeri *et al.* 2002).
 Tab. 7 - Laghetto delle Regole di Castelfondo LR1. Successione stratigrafica (modificato da Dalmeri *et al.* 2002).

unit(s)	evidence	palaeoenvironment	chronology	dating (cal BP)
1	peat	lake transgression	Middle-Late Holocene	>5908
	podzol-like soil	forest vegetation, soil formation	Early-Middle Holocene	<7214-7246
2, 2A	sandy deposit	human occupation, frost action	Younger Dryas	12,077-12,623
		lake regression	lateglacial	
	diamicton	lake environment		

Tab. 8 - Vatte di Zambana. Simplified stratigraphic succession (modified after Broglio 1971; Bartolomei 1974).
 Tab. 8 - Vatte di Zambana. Successione stratigrafica semplificata (modificato da Broglio 1971; Bartolomei 1974).

unit(s)	short description	chronology	dating (cal BP)
1	breccia	Holocene	
2, 3	human occupation intercalated with breccias		7861-8328
4	breccia		
5	human occupation intercalated with breccias		8182-8543
6	breccia		
7	human occupation intercalated with breccias	Early Holocene (Sauveterrian)	8414-8985
8, 9	breccia		
10	human occupation intercalated with fine breccias in silty sandy matrix		8217-9240
11	breccia		

in rhythmically-arranged cycles:

- frost slabs production with the consequent burial of anthropic layers, during the phases of abandonment of the rockshelter;
- the progressive input of exogenous sediment due to human trampling and the development of platy microstructure with vesicular porosity, as a consequence of trampling and post-depositional freeze-thaw cycles;
- the aggradation of anthropogenic soils as a result of the accumulation of organic matter, charred wood fragments, discarded lithic artefacts and faunal remains, the last often arranged horizontally and fractured *in situ*;
- soil formation processes, as humification and the incorporation of organic matter into the groundmass (often associated with earthworm activity), carbonate dissolution and sparite precipitation;
- incipient post-depositional frost action that displaced

stones and originated the platy microstructure inherited by trampling activity, mostly when the shelter was not occupied by humans (Bassetti *et al.* 2008).

It is also worth to mention the recently excavated open-air site at Laghetto delle Regole, situated along the shore of a turf basin, at 1239 m a.s.l. The Epigravettian groups set over the sandy sediment of the lake beach (unit 2A), which belongs to the regressive sequence of a pre-existing paleolake originated during the last glacial retreat (Tab. 7). The lithic artefacts related to these occupations were post-depositionally dispersed by cryoturbation and bioturbation. This last is related to the development of a forest podzol-like soil during the Holocene, which was followed by the formation of bog deposits, from the middle Holocene. During the excavation, lithic artefacts were mainly found inside the hollows left by the stumps and the roots related to the mid-Holocene soil (Dalmeri *et al.* 2002).

Tab. 9 - Pradestel. Simplified stratigraphic succession (modified after Bartolomei 1974; Broglio 1980).
 Tab. 9 - Pradestel. Successione stratigrafica semplificata (modificata da Bartolomei 1974; Broglio 1980).

unit(s)	short description	chronology	dating (cal BP)
D1-D3	Human occupation intercalated with fine breccias in silty sandy matrix	Middle Holocene (Castelnovian)	7610-7826
E-E1			
F1			
F3			
G	minute breccia in silty sandy matrix		
H1-H2	Human occupation intercalated with fine breccias in silty sandy matrix		9014-9300
L1	fine breccia in silty sandy matrix		8608-9547
L2-L3	Human occupation intercalated with fine breccia in silty sandy matrix		
L4	fine breccia in silty sandy matrix		
L5	Human occupation intercalated with fine breccias in silty sandy matrix		
L4a-b	fine breccia in silty sandy matrix	Early Holocene (Sauveterrian)	
L7-L7c-L8	Human occupation intercalated with fine breccias in silty sandy matrix		10,300-10,681
L9	fine breccia in silty sandy matrix		
L10	Medium and coarse breccia		
L11	Human occupation intercalated with fine breccias in silty sandy matrix		
L12	fine breccia in silty sandy matrix		
L13	medium and coarse breccia		
L14	Human occupation intercalated with medium and coarse breccias		
	medium and coarse breccia		
M6	Human occupation intercalated with fine breccias in silty sandy matrix		

6. THE EARLY HOLOCENE

The onset of the Holocene meant the fast expansion of biological communities towards high altitude areas and the spreading of human groups to the upland regions. The reforestation and the appearance of faunal assemblages that can be referred to forest environments are reported all around the piedmont area and the valley bottoms during the Preboreal (e.g. Boscato & Sala 1980; Cattani 1994). At the Preboreal-Boreal transition, the timberline had reached an altitude higher than the present one in the Alpine watershed of South Tirol (Bortenschlager 1984) and the glaciers fronts were approximately located at the same position that they occupy today (Ravazzi *et al.* 1996).

Abundant bibliography is available on the Mesolithic sites scattered all around the eastern sector of the southern Alps (see e.g. Broglio & Lanzinger 1990; Dalmeri & Pedrotti 1994; Kompatscher & Hrozny Kompatscher 2007). These sites testify the intensity of the human occupation of the Alpine upland during the Early Holocene; nonetheless, they often derive from short-term human occupations. We will here shortly focus on the

few extensive stratigraphic successions available, which are located in the Adige Valley, usually in rockshelters at the top of talus screes and at the base of limestone walls, at about 200 m a.s.l. (e.g. Vatte di Zambana, Pradestel, Romagnano III, Riparo Gaban and Ala Le Corone, this last still under excavation). On average, the Mesolithic occupations recorded at these sites rest on thin organic A horizons intercalated inside limestone *éboulis*, which is often composed of frost slabs (e.g. Vatte di Zambana and Pradestel). The A horizons usually show polycyclic features, as in the case of the end-Sauveterrian to Neolithic sequence at Romagnano III (layers AC4-8 to T1). The main characteristics of the successions from Vatte di Zambana, Pradestel and Romagnano III are presented in the tables 8, 9 and 10.

7. THE ATLANTIC AND ITS END

The environmental trends established with the onset of the Holocene in the southern Alps continued during the Atlantic: glaciers reached their maximum retreat

Tab. 10 - Romagnano III. Simplified stratigraphic succession (modified after Broglio 1971; Bartolomei 1974).
Tab. 10 - Romagnano III. Successione stratigrafica semplificata (modificato da Broglio 1971; Bartolomei 1974).

unit(s)	short description	chronology	dating (cal BP)
Q	human occupation intercalated with fine breccias in silty sandy matrix	late Neolithic	5532-5645
R			
T2-1, S	human occupation, Ah horizon over fine breccia in silty sandy matrix	middle Neolithic	6183-6937
T4-3		early Neolithic	6493-7155
AA		Castelnovian	7279-7477
AB			7981-9398
AC 1-3	alluvial sediments	Sauveterrian	9015-9887
AC 4-8			9540-10,517
AC 9			
AD	human occupation, Ah horizon over fine breccia in silty sandy matrix	Sauveterrian	
AE			10,234-11,702
AF	human occupation intercalated with fine breccias in silty sandy matrix		10,874-11,616
	breccias	YD?	

(Orombelli & Porter 1982), the faunal assemblages mark the presence of forest environments all around the Pre-alpine belt (Cattani 1994; Tagliacozzo & Cassoli 1994), and the biostatic situation enhanced soil formation process (Cremaschi 1987). As a whole, faunal and floral assemblages indicate a temperate situation, which matches the Middle Holocene optimum. The overall biostatic situation is the context for the appearance of the Neolithic in the Po Valley and in its surroundings. We here present three key-sites for the Neolithization of this region and for the existence of possible feedbacks between natural and cultural factors: Riparo Gaban and Ala le Corone (Trento), and Lugo di Grezzana (Verona).

Riparo Gaban (Bagolini & Pedrotti 1996; Kozlowski & Dalmeri 2000) is a rockshelter near the town of Trento which is filled with a succession spanning the Mesolithic to the Bronze Age (Tab. 11). The site succession, particularly the stratigraphic remnant left after the excavation campaigns of the 1980s, was the object of a new geoarchaeological description and sampling, in order to understand site formation processes (Angelucci *et al.* 2009).

The preliminary results of the geoarchaeological study of Riparo Gaban give some indications on the environmental evolution during the Holocene and on the interactions between natural and cultural factors. While Early Mesolithic layers (Unit F) contain abundant anthropogenic components (wood ash, charcoal, burnt bones) and signatures, the base of the Castelnovian sequence (units E9 to E5) is formed of cryoclastic breccia embedded in fine sediment. The sediment was inwashed into the rock-

shelter from the outside and is a marker for the existence of a resistatic situation and a moist cool climatic context. As a preliminary hypothesis to be tested in the future, this evidence may represent the stratigraphic signature of the 8200 event (von Grafenstein *et al.* 1998), particularly if one takes into account that the top part of the Mesolithic sequence (units E4 to E1) contains much more anthropogenic inputs, with abundant burnt vegetal material. The Neolithic sequence is mainly formed of irregular alternations of burnt layers, often separated among them by bioturbated homogeneous sediment. Micromorphological observation shows that the burnt layers are mainly formed of burnt animal dung (spherulites are always abundant) and vegetal material (ash, charcoal, burnt bones). The common existence of reddened belts below the burnt layers denotes that most of them were burned *in situ*. The present interpretation is that the Neolithic sequence at Riparo Gaban is formed of *fumier* deposits (Angelucci *et al.* 2009) and that the rockshelter was probably used as a *grotte-bergerie* during the Neolithic. However, even if the Neolithic sequence is almost completely composed of human materials and natural inputs are scarce inside it, the evidence of climate events is still recognizable in form of the signatures related to discontinuous frost action, visible both in the Mesolithic sequence (units E1, E5, E6 and F) and in the Neolithic one (units D1 and D9).

The study of the stratification of Riparo Gaban thus suggests the progressive increase of the human signatures and inputs through the Holocene (the Bronze Age succession also contains abundant anthropogenic inputs

Tab. 11- Riparo Gaban: stratigraphy and dating (after Bagolini & Pedrotti 1996; Kozlowski & Dalmeri 2000).
Tab. 11- Riparo Gaban: stratigrafia e datazioni (da Bagolini & Pedrotti 1996; Kozlowski & Dalmeri 2000).

unit(s)	period	cultural affiliation	dating (^{14}C BP)
A1-A5	Middle Bronze age		3559-3828 (Unit A5)
A6-A10	Late ancient Bronze age	cfr. Fiavè III Culture	
B1-B6	Ancient Bronze age	Polada Culture	3992-4410 (Unit B5a2)
C1-C3	Late Copper age - beginning of Ancient Bronze age		
C4-C6	Copper age		4245-4524 (Unit C5b2)
D0	Middle Neolithic	Square Mouthed Pottery	
D1-D10	Ancient Neolithic	Gaban Group	6749-6993 (Unit D2) 6698-6948 (Unit D8-2)
E1-E6, FA	Late Mesolithic	Castelnovian	8648-8996 (Unit FA) to 7693-7926 (Unit E)
FB-FC	Ancient Mesolithic	Sauveterrian	9704-10170 (Unit FC) to 9007-9398 (Unit FB)

Tab. 12 - Ala Le Corone. Simplified stratigraphic succession (modified after Nicolis *et al.* 2007).
Tab. 12 - Ala Le Corone. Successione stratigrafica semplificata (modificato da Nicolis et al. 2007).

unit(s)	short description	chronology		dating (cal BP)	
67	human occupation	Middle Holocene	Copper Age	4420-4808	
74	fine breccia in silty sandy matrix		Middle Neolithic	6215-6601	
90, 94, 98, 99c	alternation of anthropic living floors and breccias		Ancient Neolithic	6551-6892	
96, 104, 105					
US 96	breccia	Early Holocene			
US 14	breccia		Mesolithic	7440-7573	

– D. Anesin & M. Zannini, pers. com. 2007). Similar evidence is also found at Lugo di Grezzana, a site where the micromorphological study has revealed the possibility of an early human impact on the slope system, which started since the Neolithic. Campagne di Lugo di Grezzana (Cavulli *et al.* 2002) is an open-air Neolithic settlement at the southern Alpine margin, in Valpantena (Verona), one of the valleys that cut the Lessini calcareous plateau. The excavations at Lugo di Grezzana brought to light abundant archaeological layers and features that are embedded in a several-metres deep stratification. The lower part of the site succession is composed of alluvial and slope sediments over which a thick soil had developed in pre-Atlantic times. The first Neolithic occupation layers rest on this buried soil and extend over a large area which is characterised by a variety of dwelling features, some of them truncated and buried by slope sediments, whose age range from the Neolithic to the Roman period. Stratigraphic and micromorphological data (Angelucci 2002)

led to the hypothesis of an indirect human interference in the reactivation of the slope processes that buried the site, which would indicate that human action in the Early Neolithic had modified local morphodynamics and given rise to an “anthropically-controlled” morphology, which was later retouched by Late Holocene dynamics.

The recently-discovered site at Ala Le Corone (Trento, 250 m a.s.l.) also shows similar anthropic-driven dynamics (Tab. 12). Preliminary results indicates that the sedimentary system was strongly controlled by human actions, which acted almost continuously during the early and middle Holocene (Nicolis *et al.* 2007).

8. DISCUSSION

The aim of this paper is to give an overview on the relationships between the human groups and landscape from the Alpine Last Glacial Maximum to the Middle Holocene in

the Trentino region and its surroundings. As already stated, the data on the palaeoenvironment and the human peopling are abundant, but diverse in quantity and quality; therefore the construction of a linear discourse on this subject is not easy. Nonetheless, the eastern sector of the southern Alps is one of the better studied region as far as the Pleistocene-Holocene transition is concerned (see bibliography above): the geographic and geological context is well-established; the climatic and environmental data, even if not abundant, are known; the chronostratigraphic and cultural sequence are fairly clear; the sites are abundant.

The preliminary scenario that arise from the data briefly presented here – the results of more than thirty years of fieldwork – is indicative of a high degree of complexity, in what concerns both the evolution of the environment and the human adaptations to it.

The overall scenario is as follows (see also Fig. 8):

- at the onset of the Lateglacial, the area recorded rapid deglaciation and the beginning of the shifting of the biological world (flora, fauna and humans) towards the mid-altitude upland; it is worth noting that deglaciation was far from being a straightforward process and that some upland areas were deglaciated even earlier than the valley-bottoms, due to the geographic and geomorphological control on the environmental factors;
- the scenario during the Lateglacial looks rather contrasted: on the one hand, “periglacial-like” processes (e.g. loess deposition, frost creep, erosion on slopes etc.) are active throughout this time span, on the other, the “climate amelioration” related to the Lateglacial interstadials (i.e. GI-1) is obvious, by both the paleoenvironmental data and the number of Late Upper Palaeolithic sites found all around the eastern southern Alps, particularly in the Prealpine belt. During this phase, the region was seemingly subject to biostasy, which enhanced soil formation processes;
- the Younger Dryas (*alias* GS-1) “climate degradation” determined a reduction of the human occupation of the upland, nevertheless humans still occupied refuge-sites such as Riparo Cogola and Laghetto della Regola in the upland, as well as other sites in the lowland;
- the Early Holocene warming produced the shifting of the biological communities to high-altitudes – over 2000 m height – and the widespread occupation of the valley bottoms and the upland; at the same time, well-recognizable human signatures are found at many sites, attesting to the increase of human impact on the land and the soil system. However, some natural events, as the 8200 event (von Grafenstein *et al.* 1998), are well visible in the stratigraphic record and left significant palaeoenvironmental signatures, as documented in the above-mentioned sites of Riparo Gaban and Vatte di Zambana;
- the Middle Holocene was, under the environmental point of view, a stable phase marked by soil formation processes, and, at many sites, by the predominance of human processes. Again, rapid climate shifts, as it was perhaps the abrupt climate change related to the Bond event 4, are still recognized and probably intensified by human impact.

Despite the inequality of the data, it is possible to sketch

a first synoptic model for the landscape evolution in the Trentino region, which is illustrated in figure 9. During the Early Lateglacial, the sedimentation rate is high, mainly because of the intensity of slope dynamics, which also caused the coeval loess deposits to be remobilised along hillslopes. At the same time, alluvial plains were affected by intense aggradation processes due to the increase of water discharge. The first biostatic phase is documented during the Lateglacial Intertidal, when the slope activity decreased and soil formation started – a cycle of soil formation that will continue throughout the early Holocene. Chernozem-like soils developed in the upland, while leaching and incipient “rubefaction” were the main processes in the lowland. Simultaneously, turf had begun to accumulate in the Adige Valley.

The slope dynamics started again during the Younger Dryas and led to the accumulation of slope sediment at the footslopes of the main valleys. Loss deposition also took place in this phase.

Both slope deposition and soil formation are recorded during the Early Holocene. Soil formation is documented all around the examined area during the whole Holocene, with varied processes, according to the distinct pedogenetic factors – particularly parent material and climate. Soil formation continues during the Middle Holocene, a phase when alluvial and slope deposition are also active in the main valleys.

If one takes into account the settlement pattern during this time span, the relative position of the sites –particularly their distribution inside the different sub-regions, their altitude and their location in relation to the diachronic variations of the treeline – can be considered as a good marker of the above-mentioned diachronic trends and may indicate the relationships between the natural environment and human decision-making. The graph in figure 9 reports the variation of the above-mentioned parameters between the beginning of the Lateglacial and the Middle Holocene, showing that the vast majority of the sites dated to the Late Upper Palaeolithic, the Mesolithic and the Neolithic are located below the treeline in the examined region. Only a few sites (see figure caption) are situated just above the treeline and it is not clear if this evidence depends on the actual location of these sites or to local variations of the treeline with respect to the regional curve shown here. Concerning the distribution of the sites, they are located in the valley bottoms at an altitude lower than 550 m a.s.l. and on Prealpine plateaux, between 1000 m a.s.l. and 1550 m a.s.l., during the Lateglacial. In the Early Holocene, and taking into account the available radiocarbon dates, Sauveterrian sites are set: in the valley-bottoms, below 750 m a.s.l., at the foot- or toeslope; in the upland, into two distinct altitudinal belts, that is, between 1000-1650 m a.s.l. and between 1750-2350 m a.s.l. Castelnovian sites are located: in the valley-bottoms, below 750 m a.s.l., at the foot- or toeslope; in the upland, between 1700 and 2400 m a.s.l. From the Early Neolithic onwards, archaeological sites are situated at low altitude, lower than 850-900 m a.s.l.

This diachronic model for the peopling of the eastern Alpine area during the Pleistocene-Holocene is well known and has been widely published in the scientific papers since the 1980s (see e.g. Broglio & Lanzinger 1990; Dalmeri & Pedrotti 1994; Broglio & Impronta 1995; Kompatscher & Hrozny Kompatscher 2007). However, if the general outlines of the climatic and environmental evolution and the settlement pattern are more or less known, the same is not

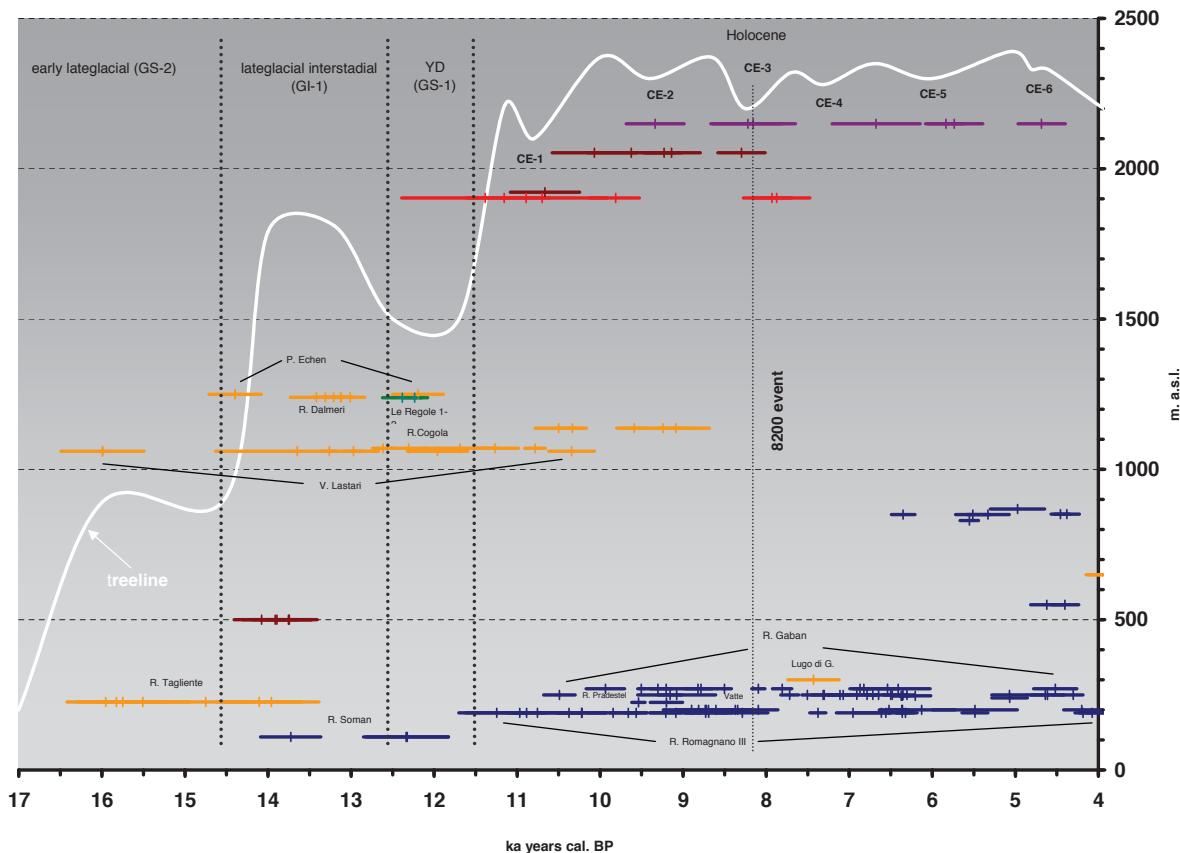


Fig. 8 - Relationships between the position of the treeline during the Lateglacial and the Holocene (after Tinner & Vescovi 2007) and the geographic and altimetric location of the archaeological sites (archaeological data from Salzani 1981; Dalmeri & Pedrotti 1994; Kompatscher & Hrozný Kompatscher 2007; chronological data from: Bagolini & Biagi 1990; Skeates 1994, 2001; Broglio & Improta 1995; Skeates & Whitehouse 1996, 1997, 1999; Dalmeri *et al.* 2002; Dalmeri *et al.* 2006; Filippi *et al.* 2006; Nicolis *et al.* 2007; Bassetti *et al.* 2008). The region is subdivided in sectors as proposed by Dalmeri & Pedrotti (1994): sector A = Adige Valley and Isarco Valley (blue segments in the figure), which includes 20 sites and 93 radiocarbon dates (Riparo Soman, Riparo Romagnano III, Riparo Pradestel, Riparo Gaban, Doss de la Forca/Galgenbuhel, Riparo Vatte di Zambana, Ala le Corone, Mezzocorona Borgonuovo, La Vela I, Isera La Torretta, Villandro Plunacker, Barbiano, Aica di Fiè/Völsraicha, Tolerait Magrè, Acquaviva di Besenello, Lasa/Laas, Pigloner Kopf, Velturino Tanzgassee, Mezzocorona Nogarole, Volano S. Rocco); sector C = Lessini Plateau and Sette Comuni Plateau (yellow), 8 sites and 23 dates (Val Lastari, Palù Echen, Riparo Tagliente, Riparo Dalmeri, Riparo Cogola, Grotta d'Ernesto, Lugo di Grezzana, Ponte di Veja); sector E= Lagorai and Passo Rolle (brown), 3 sites and 10 dates (Riparo Villabruna, Laghi del Colbricon sito 1, Lago delle Buse); sector F = Val Rendena and Val di Non (green), 2 sites and 2 dates (Laghetto delle Regole 1, Laghetto delle Regole 2); sector G = Latemar, Sella and Alpe di Siusi (red), 2 sites and 7 dates (Plan de Frea II and IV); sector H = Passo Falzarego and Passo Giac (purple), 1 site and 7 dates (Mondeval de Sora). The upper Paleolithic sites that are located above the treeline or next to it are Val Lastari, Seiser Alm/Alpe di Siusi I and Cionstoan (Kastelruth); the Mesolithic sites above the treeline or next to it are: Zufallhütte (Martell), Sasplat (Campitello di Fassa), Klamm Jochl (Sand in Taufers), Val di Dona S. Dos (Mazzin di Fassa), Fassa Joch (Kastelruth, Campitello di Fassa), Tuxer Joch (Hintertux, Austria), Grubalm Val di Fosse (Senales/Schnals) (after Dalmeri & Pedrotti 1994), and Seiser Alm/Alpe di Siusi - Fassajoch, Sellajoch/Passo Sella I-XVII, Puez, Burgum, Weissbrunalm, Ob. Marschällalm I-X, Unt. Kofelrastersee I and II, Kofelrastersee I and II, Lastfonzer Kreuz/Santa Croce (after Kompatscher & Hrozný Kompatscher 2007). CE= cold wet phases in central Europe (after Haas *et al.* 1998).

Fig. 8 - Relazioni tra il limite superiore degli alberi nel Tardoglaciale e nell'Olocene (da Tinner & Vescovi 2007) e la localizzazione geografica e altimetrica dei siti archeologici (dati archeologici da Salzani 1981; Dalmeri & Pedrotti 1994; Kompatscher & Hrozný Kompatscher 2007; dati cronologici da: Bagolini & Biagi 1990; Skeates 1994, 2001; Broglio & Improta 1995; Skeates & Whitehouse 1996, 1997, 1999; Dalmeri *et al.* 2002; Dalmeri *et al.* 2006; Filippi *et al.* 2006; Nicolis *et al.* 2007; Bassetti *et al.* 2008). La regione è suddivisa secondo i settori proposti da Dalmeri & Pedrotti (1994): settore A = valli dell'Adige e dell'Isarco Valley (segmenti in blu in figura), con 20 siti e 93 datazioni al radiocarbonio (Riparo Soman, Riparo Romagnano III, Riparo Pradestel, Riparo Gaban, Doss de la Forca/Galgenbuhel, Riparo Vatte di Zambana, Ala le Corone, Mezzocorona Borgonuovo, La Vela I, Isera La Torretta, Villandro Plunacker, Barbiano, Aica di Fiè/Völsraicha, Tolerait Magrè, Acquaviva di Besenello, Lasa/Laas, Pigloner Kopf, Velturino Tanzgassee, Mezzocorona Nogarole, Volano S. Rocco); settore C = altopiani dei Lessini e dei Sette Comuni (in giallo), 8 siti e 23 datazioni (Val Lastari, Palù Echen, Riparo Tagliente, Riparo Dalmeri, Riparo Cogola, Grotta d'Ernesto, Lugo di Grezzana, Ponte di Veja); settore E = Lagorai e Passo Rolle (in marrone), 3 siti e 10 datazioni (Riparo Villabruna, Laghi del Colbricon sito 1, Lago delle Buse); settore F = Val Rendena e Val di Non (in verde), 2 siti e 2 datazioni (Laghetto delle Regole 1, Laghetto delle Regole 2); settore G = Latemar, Sella e Alpe di Siusi (in rosso), 2 siti e 7 datazioni (Plan de Frea II and IV); settore H = Passo Falzarego e Passo Giac (in viola), 1 sito e 7 datazioni (Mondeval de Sora). I siti del Paleolitico superiore localizzati sopra o presso il limite superiore degli alberi sono: Val Lastari, Seiser Alm/Alpe di Siusi I e Cionstoan (Kastelruth); i siti mesolitici sopra o presso il limite superiore degli alberi sono: Zufallhütte (Martell), Sasplat (Campitello di Fassa), Klamm Jochl (Sand in Taufers), Val di Dona S. Dos (Mazzin di Fassa), Fassa Joch (Kastelruth, Campitello di Fassa), Tuxer Joch (Hintertux, Austria), Grubalm Val di Fosse (Senales/Schnals) (da Dalmeri & Pedrotti 1994), e Seiser Alm/Alpe di Siusi - Fassajoch, Sellajoch/Passo Sella I-XVII, Puez, Burgum, Weissbrunalm, Ob. Marschällalm I-X, Unt. Kofelrastersee I e II, Kofelrastersee I e II, Lastfonzer Kreuz/Santa Croce (da Kompatscher & Hrozný Kompatscher 2007). CE = fasi umide e fresche dell'Europa centrale (da Haas *et al.* 1998).

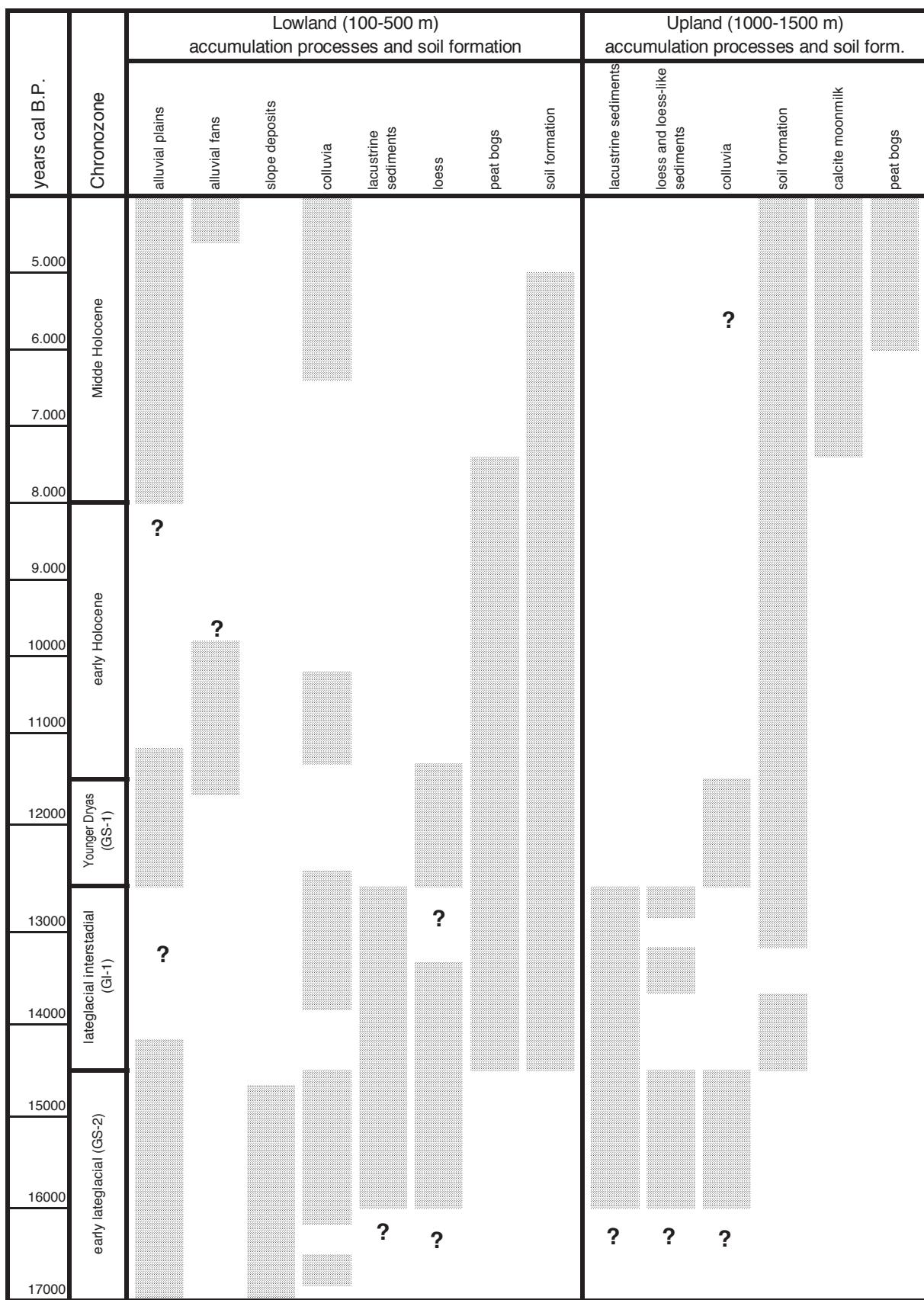


Fig. 9 - Synoptic scheme of the main sedimentary and soil formation processes recorded in the Trentino region and surroundings from the ALGM to the end of the Middle Holocene. Shaded areas represent the activity of the distinct processes (see text for details).

Fig. 9 - Schema sinottico illustrante i principali processi sedimentari e pedogenetici registrati nel Trentino e nelle aree limitrofe dall'Ultimo Massimo Glaciale alla fine dell'Olocene medio. Le aree in grigio rappresentano l'attività dei vari processi (per approfondimenti si veda il testo).

true for some geoarchaeological aspects, which are still poorly considered by the available bibliography. Our understanding of some topics such as site formation processes, the genesis of the anthropic facies documented in several sites or the organization of settlement and subsistence systems is still poor, and it is our opinion that the improvement of our knowledge on the Pleistocene-Holocene transition in this region would benefit by the enhancement of geoarchaeological and land studies, in order to comprehend the complex diachronic relationships between the natural and cultural systems in this time span.

On average, the understanding of the settlement and subsistence system of the area is constrained by the archaeological record itself, whose preservation is often restricted by the action of surface processes and postdepositional dynamics, which affect both the quality and the quantity of the information that the archaeologists analyse. These dynamics depend on the environmental context, which, as we have shown above, has changed significantly during the last 20,000 years and has consequently modified surface dynamics, whose signatures are not always well-preserved. Furthermore, as we have discussed above, the distinction between anthropic and non-anthropic processes is not always straightforward. As a middle-range conclusion, we observe a trend of human appropriation of landscape, which is recorded by the predominance of anthropic facies and signatures in the pedo-sedimentary record, and which seems to start before the Neolithic, at least with the beginning of the Holocene, even if its more severe effects are observed since the Middle Neolithic onwards. Nonetheless, there is a need for more data and, particularly, for a better-developed contextual approach.

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