

Manuscrit acceptat

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Archaeology of
Mountain Landscapes
Interdisciplinary Research Strategies of
Agro-Pastoralism in Upland Regions

Edited by
Arnau Garcia-Molsosa

Llibre

Archaeology of Mountain Landscapes. Interdisciplinary Research Strategies of Agro-Pastoralism in Upland Regions

ISBN

9781438489872

Data de publicació

Octubre 2023

Per citar aquest document:

Palet, J.M.; Orengo, H.A.; Garcia-Molsosa, A.; Polonio, T.; Ejarque, A.; Miras, Y.; Riera, S. 2023. "Landscape Archaeology in Eastern Pyrenees high mountain areas (Segre & Ter valleys, Northeast Iberian Peninsula): Human activities in the shaping of Mountain Cultural Landscapes" a Garcia-Molsosa, A. (Ed.), *Archaeology of Mountain Landscapes. Interdisciplinary Research Strategies of Agro-Pastoralism in Upland Regions*, State University of New York Press, Albany, NY, p. 179-196.

Aquest arxiu PDF conté el manuscrit amb correccions per a la seva publicació.

Postprint:

This is the accepted version of the chapter "**Landscape Archaeology in Eastern Pyrenees high mountain areas (Segre and Ter valleys, Northeast Iberian Peninsula): Human activities in the shaping of Mountain Cultural Landscapes**", included in the volume *Archaeology of Mountain Landscapes. Interdisciplinary Research Strategies of Agro-Pastoralism in Upland Regions*.

To acquire the original volume:

<https://sunypress.edu/Books/A/Archaeology-of-Mountain-Landscapes>

Citation of the original chapter:

Palet, J.M.; Orengo, H.A.; Garcia-Molsosa, A.; Polonio, T.; Ejarque, A.; Miras, Y.; Riera, S. 2023. "Landscape Archaeology in Eastern Pyrenees high mountain areas (Segre & Ter valleys, Northeast Iberian Peninsula): Human activities in the shaping of Mountain Cultural Landscapes" a Garcia-Molsosa, A. (Ed.), *Archaeology of Mountain Landscapes. Interdisciplinary Research Strategies of Agro-Pastoralism in Upland Regions*, State University of New York Press, Albany, NY, p. 179-196.

Landscape Archaeology in Eastern Pyrenees high mountain areas
(Segre & Ter valleys, Northeast Iberian Peninsula): Human
activities in the shaping of Mountain Cultural Landscapes

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Abstract Since 2004, an integrated archaeological and palaeoenvironmental research programme has been developed in the Eastern Pyrenees (Andorra and Catalonia), with the aim of studying the long-term landscape shaping of Mediterranean high-mountain

environments. This programme involved extensive surveying, GIS, excavation and radiocarbon dating of archaeological structures and the integration of multi-proxy palaeoenvironmental data. A methodological approach based on fine spatial and temporal resolution analysis has proved to be a priceless tool for assessing local human occupation and the distinctive nature of highland land-use practices on a micro-regional scale. The results underline the existence in these areas of diverse land-use and resource management strategies during the past millennia, which included fire-driven forest openings, grazing, woodland exploitation (such as resin and charcoal production), mining and melting activities. This diversity of activities has led to complex cultural landscapes in the high Pyrenean areas. During the Early and Middle Neolithic human clearances were diversified in its spatial distribution allowing the recovery of alpine forests after impacts. A major landscape change occurred in the valleys during the Late Neolithic when the alpine grassland belt expanded and human settlements have been documented at ca. 2,500 m a.s.l. Roman times report a diversification of practices including mining, metallurgy, pine resin exploitation, charcoal production, grazing activities and livestock, etc. Antiquity is configured as an important period in livestock expansion from the 2nd – 3rd centuries and during Late Antiquity. In high Medieval times (9th 10th c.), a largely grazed landscape resulted in a wide deforestation. Later on, during the modern and contemporary periods, an intensive transhumant grazing exploitation characterized these valleys land use. The history of this landscape furnishes new data for the development of management tools for the sustainability of Mediterranean highlands.

Introduction

The research into the occupation and exploitation of mountain areas has been conditioned for a long time by the marginality in which these environments were traditionally perceived by the historiography. In addition, factors such as the intensity of erosion processes, topography, the poor conservation of the archaeological record or a dense forest cover, have restricted field research. This lack, at the same time, has encouraged a marginal perception of the mountain areas. Thus, the mountain and, above all, the high mountain, had traditionally been perceived as a natural environment, characterized by the marginality of human activities.

Certainly, this situation has been changing in the last decades, thanks to a growing interest in the occupation and exploitation of European mountain spaces over time. The pioneering works developed by Ch. Rendu in the Cerdanya valley in the 1990s (Rendu 2003), by E. Gassiot in the Catalan Western Pyrenees (Gassiot, Jiménez 2006) and that coordinated by Ph. Leveau in the western Alps (Walsh, Mocci 2003; Walsh et al 2005; Palet, Ricou, Segard 2003; Walsh, Mocci, Palet 2007; Segard 2009) constitute the starting point of a research line in Europe that has developed new projects enriched with the methods and techniques of Landscape Archaeology (Orengo et al. 2014a, 2014b; Palet et al 2013, 2014; Walsh et al. 2014; Gassiot et al. 2014; Gassiot 2016). Paleoenvironmental studies have also had a growing impact with multidisciplinary and diachronic approaches (Galop 1998; Miras et al. 2007, 2010; Pèlachs et al. 2009; Ejarque et al. 2009, 2010, 2013).

The results obtained in different European mountain areas have questioned the traditional image, showing that human impact on these spaces has been intense and that these areas constitute real cultural landscapes, shaped over time.

In this context, “new archaeologies” such as "mountain archaeology" or "archaeology of pastoralism" have been defined, with approaches closely linked to Landscape Archaeology. These studies are multidisciplinary, based on the correlation of archaeological, historical, palaeoenvironmental and ethnographic data. In addition, high mountain areas are ideal environments for the analysis of socio-environmental interactions over time, that is, to study human resilience to natural variability, and landscape dynamics (Gassiot 2016; Palet et al. 2012).

Cultural landscape values are also a sustainable resource for society. In this sense, the possibilities of knowledge transfer are significant as these areas are often protected with natural and cultural heritage regulations. The results can be, for example, incorporated into social and environmental plans and contribute to the development of future management and territorial “heritagisation” policies (Criado-Boado et al. 2015).

In this framework, since 2004, the Landscape Archaeology Research Group (GIAP-ICAC) has developed a program on settlement and land-use on high mountain areas. In the Pyrenees, this research has been done in three areas located in the Andorran valleys of the Madriu, Perafita and Claror (MPCV), in La Vansa valley in the Cadí Range, and in the Ripollès, in the upper river Ter valleys (Núria, Coma de Vaca and Coma del Freser valleys) (Ejarque 2013; Ejarque et al. 2009; Ejarque et al. 2010; Euba 2009; Orengo et al. 2013, 2014a, 2014b; Palet et al. 2013, 2014, 2016) (Figure 1). The main aim of these projects is to characterize settlement dynamics, land-use and the shaping of high mountain cultural landscapes. The research is focused on an interdisciplinary perspective, based on the integration of landscape archaeology data.

In Andorra, the studied area was benefited from the inscription by the UNESCO in the list of World Heritage in the category of Cultural Landscape of MPCV. The studied sector was extended between the subalpine stadium (1,700-2,200 m), with the presence of black pine forests and firs, and the Alpine stadium (2,200-2,900 m), dominated by pastures and screes. A second area of research was placed in the western sector of the Cadí Range, between subalpine and alpine areas, from the height of 1,700 m to the main ridge line (2,400 m). This area has a special interest in mining, pastoral and forest resources. These projects ended in 2010. Finally, a third area of study, still in progress, is situated in the Eastern Pyrenees in the upper Ter valley, above the 2,000m a. s. l.

Methodology

The landscape archaeology approach included researchers from a diverse array of historical and palaeoenvironmental sciences in order to unravel the long term human-landscape relation which resulted in these cultural landscapes. These disciplines include palynology, sedimentology, geochemistry, anthracology and archaeology. The methodology was designed in order to obtain a high degree of correspondence between the archaeological and the palaeoenvironmental records based on the premise that local scale case studies are the most suitable approach to analysing human-environment interactions, particularly in upland environments (Ejarque 2013). The comparability of these will be guaranteed by the use of high-resolution temporal and spatial frameworks.

In this regard, the study cases offer a perfect setting. The presence of multiple peatbogs and lakes from which palaeoenvironmental sequences were obtained is matched by numerous closely located multi-period archaeological sites. In this sense, archaeology is approached as a complementary proxy to those offered by

palaeoenvironmental sciences. It contributes a very useful information type since it can provide data specifically related to the use humans made of the landscape. This data is chronologically and spatially referenced. The characterization of archaeological data allows the documentation of specific human activities on the landscape which can be linked to human-related disturbances in the palaeoenvironmental record by means of radiocarbon dating.

In order to retrieve a significant amount of archaeological data the studied areas were surveyed and, later, the most representative structures were subjected to test pit digging. They intended to record the structure typology but they also were designed to recover information related to landscape human use and to obtain adequate samples for radiocarbon dating. Recording methodology included, besides the standard recording of all materials, the sieving of all sediment from the occupation levels. Also, from each excavated unit a minimum of four litres of sediment was conserved for environmental sampling. Some natural soils located close to archaeological structures were also excavated in order to correlate natural sedimentation to that documented inside human occupied structures. This is especially important since stone-made habitation structures tend to present occupation levels in the inner part of the structures which has been previously removed with respect to the circulation level outside them. The excavation of test pits outside the structures can confirm that occupation levels are limited to the space covered by the habitation structure and that are related to it. In this way, it can be avoided the dating of circulation levels preserved under the structures, and previous to its construction, with no relation to human habitation (Orengo 2013).

A total number of twelve sequences from these valleys were studied: two lakes and ten peatbogs (Ejarque 2013). These sequences present a high chronologic resolution which allows comparison with archaeological data. These multi-proxy sequences

include the study of pollen, non-pollen palynomorphs (such as fungal spores, parasites or stomata) micro and macrocharcoal. The inclusion of NPP and macrocharcoal provides a local counterpart to the higher dispersion of anemophilous pollen which can be analysed in relationship with the local presence of archaeological structures. Also, the distribution of multiple sequences in different sectors offers a high spatial resolution which allows the documentation of differences in local dynamics which can be compared with the archaeological sites distribution.

Landscape and heritage in high mountain environments

A total of 430 structures were attested in Nuria and Coma de Vaca valleys (upper Ter), from which 45 were subjected to test pit digging and 38 AMS radiocarbon dates were obtained in archaeological sequences. They are associated entirely with livestock activities (huts, enclosures, milking structures) (Palet et al. 2016). In the Cadí Range, a total of 139 structures associated with livestock, farming field systems, mining, smelting kilns and charcoal mounds were documented. Archaeological excavations were carried out in 5 sites and a total of 29 AMS radiocarbon dates were available (Palet et al. 2013, 2014). In Madriu-Perafita-Claror valleys (MPCV), a total of 421 structures of different chronologies and typologies (huts, enclosures, kilns, charcoal mounds) were recorded related to livestock activities and the exploitation of forest resources. In these valleys, a total 61 radiocarbon dating were obtained from 55 structures excavated. While the structures located in the Perafita-Claror valley are related to livestock activities, in the Madriu valley, the exploitation strategies developed a wider spectrum (grazing, forest exploitation) (Palet et al. 2013, 2016, Palet, Orengo 2015) (Figure 2).

The chronological model obtained from radiocarbon dates indicates the first evidences of grazing activities from the Early Neolithic (in the Andorran valleys), and from the end of the Middle Neolithic (in the upper Ter and Cadí Range). Settlement evolution can be followed to Modern times, with the presence of a discontinuity related to a hiatus in landscape dynamics in Bronze and Iron ages. The results have allowed developing a history of human activities carried out in these valleys over time. They allow drawing a densely exploited landscape, showing the deep and ancient human occupation of these high mountain spaces.

The first evidences of grazing activities. From the Early Neolithic to the Bronze Age

GIAP's research in MPCV documented the first evidences of grazing activities in the Early Neolithic, in the mid-5th millennium BC, related to the existence of a small-scale human and cattle frequentation (Orengo et al. 2014a).

The archaeological survey attested evidences of occupation in two dry-stone huts, one situated at 2,518 m a.s.l. at Pleta de les Bacives I site, in Madriu valley; the other, roughly circular, located at Orris de la Torbera de Perafita I site, in Perafita valley. In this area, livestock activities intensify during the Middle Neolithic, as it is documented in several shepherds huts and livestock enclosures with occupation levels dated at the end of the 4th and in the 3rd millennium BC (Torbera de Perafita I, Planells de Perafita) (Orengo 2010; Orengo et al. 2014a).

It should be noted that these archaeological remains present a correlation with the palaeoenvironmental data obtained in MPCV, which show a process of deforestation, the extension of pastures, woodland clearances for grazing purposes, together with an

increase of anthropic indicators (nitrophilous-ruderal taxa and coprophilous spores) associated with local pastoral practices during the Early and Middle Neolithic. These data suggest the local nature of these deforestations and their livestock grazing function. They document a human frequentation related to itinerant pastoral practices which entail small scale forest openings for livestock grazing followed by forest recovering. This phase occurs within a warming climatic trend recorded in the central Pyrenees from ca. 5,050 to ca. 3,850 cal BC. (Miras et al. 2007, 2010; Ejarque 2013; Ejarque et al. 2009).

In Nuria and Coma de Vaca valleys, the earliest livestock activities also date from the late 4th and the 3rd millennium BC (Palet et al. 2016). It is worth mentioning a cave occupation in Coma de l'Embut site (cave 338) in the valley of Nuria, dated at the end of the 4th millennium BC. The cave is located on the edge of an itinerary that leads to Finestrelles pass and to Cerdanya plain, in a limestone substrate area. Excavations at the cave entrance provided abundant charcoals, pottery and very fragmented fauna. The anthracological analysis indicated the almost exclusive presence of *Pinus uncinata*, which suggests a nearby pine forest (Euba 2016). In this same sector, an occupation level dated at the Late Neolithic was documented (cal. 2,205 BC-2,019 BC). This level also provided abundant charcoal with the presence of *Pinus uncinata*, reinforcing the idea of a forest environment close to the site (Euba 2016).

Neolithic livestock occupation has also been attested in the nearby valleys surveyed in this sector (Coma de Vaca and Coma del Freser), where paleoenvironmental data reinforce the idea of an extension of grazing activities in this period related to local fires, inducing a lowering of the forest limit at higher altitudes.

Different livestock structures are associated to grazing activities in the upper Freser valley, an area rich in water resources and pastures, well connected through an east-west

corridor under the main ridge line (at around 2,500 m a.s.l.). Two archaeological sites have been identified in the pastures surrounding Aigols Podrits peatbog at 2,468 m a.s.l. Aigols Podrits I is characterized by a Late Neolithic livestock enclosure (cal. 2,876BC – 2,627BC) which closes an area of about 100m². Aigols Podrits II attested a cuvette hearth arranged with stone blocks, associated to an occupation level dated at the end of the Middle Neolithic (3,300-2,900 BC). The anthracological analysis of these levels also indicates the exclusive presence of *Pinus uncinata*, associated to a forested landscape in this higher part of the valley (Euba 2016) (Figure 3).

The presence of livestock activities in the Late Neolithic is also documented at Coma de Vaca I site (2,110m). Paleo-soils related to occupation remains from this period and the beginning of the Bronze Age have been attested (cal. 2,029BC-1,779BC), with abundant cooking pottery (containers, bowls and pots), related to a settlement destroyed by later constructions.

These data are coherent with the archaeological evidence documented in the MPCV, in which several sites recorded different sites related to important pastoral activities since the end of the 4th millennium BC and during the Late Neolithic (Ejarque 2013; Orengo et al. 2014a). It should be noted especially Els Estanys site in the Madriu valley. This settlement is composed by a group of four habitation structures and two enclosure areas. All elements show an integrated construction which suggests the synchrony of all structures. Radiocarbon dates obtained present a continuous occupation from 2,356 ± 113 cal. BC to 2,080 ± 114 cal. BC, corresponding to the last stages of the Late Neolithic and the beginning of the Bronze Age.

During this period anthropic action becomes, for the first time, intense enough to result in a perdurable landscape change. From this moment onwards the upper areas of the studied valleys will remain deforested until today due to continuous human pressure.

These deforestations answer the need to create grazing areas in the upper high mountain valleys. In relation to this need, fire becomes generalised as a landscape modification tool. In the upper areas, where archaeological and paleoenvironmental data provides higher resolution, this landscape modification would not be systematic or generalised, only specific areas are transformed into grasslands, notably, these around human settlements such as Els Estanys site.

Roman period and Late Antiquity

As in other areas in the Pyrenees, the period that comprises the Bronze and Iron ages is not attested in the archaeological evidence (Gassiot 2016: 125-145). Probably this hiatus does not mean the abandonment of human activities, but rather a change in settlement patterns and in the typology of domestic structures, as the paleoenvironmental records in MPCV suggest the continuity of anthropic activities.

The anthropization of Pyrenean high mountain landscapes is thus part of a long-term dynamic. In this sense, Antiquity means a new important phase in settlement intensification and land-use. In general terms, in Roman times, there is an increase in activities, with a more diversified and specialized landscape exploitation in the upper Segre (livestock, pitch and charcoal production and iron metallurgy), and a more intense livestock activity in the upper Ter (Orengo et al. 2013, Palet et al. 2014, Palet et al. 2016).

The first evidences are situated in the upper Freser at the site of Aigols Podrits II. A quadrangular shepherd hut characterized by a dry-stone basement and a posthole in the interior to support the roof has been excavated in this site. The occupation levels provided a long iron nail related to the structure, cooking ware and Iberian pottery,

consequent with their radiocarbon dating in the 2nd-1st centuries BC (Palet, García, Polonio 2017).

Coma de Vaca valley shows an intense livestock occupation from the 1st century AD to Late Roman and Visigoth times (7th cent. AD). Especially noteworthy is a dry-stone shepherd hut situated at Coma de Vaca I site, dated by Roman pottery between the end of the 1st century AD and the 2nd centuries AD (terra sigillata, African cooking ware). The structure, located in a livestock site at 2,150m a.s.l., defines a rectangular area of about 20 m² and it is slightly over-excavated (Figure 4). The hut was probably used for pastoral and forest exploitation. Its situation on the edge of a path that crosses this sector of the Pyrenees from east to west suggests that it could have also served as a stop or control point (Palet et al. 2014; Palet et al. 2016).

In the Puigmal massif, at Fontalba site (2,100 m a.s.l.), a shepherd hut and a livestock enclosure also provided abundant Roman pottery (terra sigillata, African cooking ware) which suggests a trade activity in these high mountain environments, well connected with Roman trade networks (Palet *et al* 2016).

In MPCV, the research also attested the importance and the intensity of pastoral activities reflected in the presence of several livestock structures. A group of three simultaneously small-sized oval livestock enclosures was found in the upper Madriu valley dated in the 1st century AD. It was located at 2,313 m a.s.l. in a moraine ridge overlooking an area of small ponds and peatbogs. In this same valley, a shepherd hut at Pleta de les Bacives I site was located in a glacial basin forming an enclosed area at 2,517 m a.s.l. The structure was small-sized and oblong-shaped, the occupation layer was excavated on the ground and the abandonment level was radiocarbon dated at the 5th century. In the Perafita valley, a milking corridor was dated by radiocarbon in the 4th century AD. In this valley, a shepherd hut on Planells de Perafita I site, dated in the

middle of the 3rd century AD, reinforce the presence of structures related to livestock exploitation in Roman times (Orengo 2010: 263-279, Palet et al 2013; Palet, Orengo 2015).

The paleoenvironmental data in MPCV corroborate this situation, documenting a general increase in pastoral activities between 300 cal. BC and 800 cal. AD, with a process of forest opening and the expansion of supra-forestry pastures, nitrophilous and ruderal taxa and coprophil spores (Miras et al. 2007; Ejarque et al. 2010, Ejarque 2013).

On the other hand, a total of seven pitch kilns were located in MPCV. Some pitch kilns were cut by paths and fragments of kiln wall and charcoal were scattered along it. Others were located through surface concentrations of charcoal and fragments of kiln wall. M157 (Figure 5), the only kiln fully excavated, was lying close to the surface. This structure has a circular plan of around 1.8 m in diameter, with baked clay walls of about 10 cm wide, preserved to a variable height of around 30 cm. The structure base presents a thermo-altered clay soil over which a pavement of flat stones was built. This pavement is covered with baked clay creating a smooth surface sloped towards a 20 cm orifice on the lower part of the wall. This hole would lead through a baked clay channel towards a reservoir. The finding of pine logs (*Pinus uncinata*) in the evacuation hole were in the first stages of the carbonisation process (Euba 2009). They correspond to trees main boughs of around 10 cm in diameter which carry high quantities of resin which could still be seen in their surface both macro and microscopically. In the excavation of kiln M052 it has been possible to find a group of logs piled beside the kiln related with the distillation process. Their diameters were similar to these of the branches from M157 evacuation hole and their length varied from 40 to 50 cm. Axe cut marks were still visible in their extremes (Euba 2009) (Figure 6).

Palaeoecological evidence provides further insights into this type of Roman forest exploitation. The sequences in the upper Madriu indicate the local opening of the subalpine pine forest and the extension of grassland in the area for the 2nd century AD when the earliest kilns are in use (Miras et al. 2007, Ejarque 2013). They also indicate both strong deforestation episodes linked to increase in herbaceous species in the area during this period and a low incidence of macrocharcoal. The sequences suggest therefore the deforestation process was made by tree felling and there were no human-directed fire (Ejarque et al. 2010) which is consequent with the axe marks found in the logs from M052 kiln and indicate deforestation and pitch production are related. When both initial and final dates have been obtained for the kilns, they indicate the structure to be in use during a period of slightly over 200 years. The correlation of radiocarbon dates and pollen data indicates the existence of three different pitch production episodes. In each of these episodes, at least two resin kilns were active at the same time. The activity should have started around 50 BC moment in which the pine pollen accumulation rate starts descending. Two phases of pronounced decrease and drastically increase has been attested until the 7th cent AD.

Pliny specifies that pitch is extracted from the torch-tree or *Pinus mugo* a high-altitude European pine of which the *Pinus mugo uncinata*, the one identified in the study area, is a subspecies (Nat. Hist. XVI, 52). Both archaeological and written sources agree in characterising pitch production as typical of mountain areas where resin-rich *Pinus mugo*, in the case of the Pyrenees, can be exploited. This type of high mountain intensive forest exploitation could only be economically feasible in market-oriented economies with a well-developed distribution network (Orengo 2010: 274-275; Orengo et al 2013).

The research in the Cadí Range allows documenting another activity in Roman times, typical from high mountain areas: the extraction and first treatment of iron (Palet *et al.* 2013, 2014). This activity was attested in two sites situated in the west side of the Range at around 2,030 m a.s.l.: Goleró and Pradell sites. A total of three iron reduction kilns was excavated and dated in Roman times at Goleró site (Figure 7). They served for a first treatment of iron and provided abundant archaeological material: Iberian pottery, terra sigillata, African cooking ware. This material together with the radiocarbon dates obtained suggests an occupation from the 1st century BC to the 2nd century AD (Palet *et al.* 2013, 2014). In Pradell site, several trenches for mineral extraction were also attested. Human impact could be inferred from the peatbog sequence of Pradell (1,915 m a.s.l.), where paleoenvironmental data show an increase and the extension of grazing and mining activities in Late Roman times (Ejarque *et al.* 2009).

The intensity of pastoral activities in Late Antiquity is very remarkable in the upper Ter valley. Several remains have been attested in two relevant sites from this period, Fontalba (2,100 m a.s.l.), on the south side of the Puigmal massif, and Jaça del Mig (2,080 m a.s.l.), in Coma de Vaca valley. Both sites documented a set of huts and livestock enclosures occupied in different phases from the 4th to the 7th centuries AD. There is a continuity in the occupation of both livestock areas in Early Medieval times, related to long distance transhumance (9th 11th centuries).

The abundant archaeological material recovered in these structures (cooking ware, glass, metal objects) suggests that these pastoral sites were of a certain entity in relation with the importance and the intensity of livestock activities in these valleys from Late Antiquity. Paleoenvironmental sequences in the upper Ter valley record several phases

of deforestation between the 6th and the 8th centuries, related to the exploitation of pastures and the extension of livestock activities (Palet *et al.* 2012; Palet *et al.* 2014).

The Roman period evidences, therefore, a diversification, specialization and spatialization of economic activities. Data obtained suggest a contrast between nearby study areas where human activities show a greater complementarity: the intensification of livestock activities in the upper Ter valley, a more diversified exploitation in MPCV (livestock, pitch and charcoal production) and iron metallurgy in Cadi Range (Palet *et al.* 2013, 2014).

Therefore, in Roman times, the Pyrenees in general and high mountains in particular, constituted complementary spaces that offered specific resources of great importance. The intensity of these human activities define them as an accessible, well connected areas, fully integrated into an economy and a society that, in part, depended on these resources (Leveau, Palet 2010; Orengo *et al.* 2013).

Rome and mountain territories

Landscape Archaeology results reinforce the image of Pyrenean mountain areas highly occupied in Roman times. This fact has also been attested in other Pyrenean valleys in relation with iron metallurgy (Gassiot, Jiménez 2006, Gassiot 2016). During the Roman period, the studied areas were a part of the Ceretania, which according to Strabo (Geog. III.4.11) covered the central area of the Pyrenees. Pliny the Elder (Nat. Hist. III.3.22-23) confirms this when he describes the Ceretan territory as limiting with that of the Vascons. *Iulia Libica*, modern Llívia (Girona), was the city of the Ceretans as stated by Ptolomeus (Geog. II.6.68-69) and acted as the main urban and administrative centre of the region.

The research carried out in nearby areas, in the north of the Cerdanya in the Enveig mountain, had proposed, on the contrary, a retreat during the Roman period of seasonal livestock activities, a situation that was interpreted as a reflection of a certain marginality of mountain activities in favour of farming activities in lower plains (Rendu 2003: 520). In this sense, landscape studies in Atlantic Pyrenean sectors (Ossau Valley) (Rendu et al. 2013) or in the western Alps (Walsh 2005; Segard 2009) coincided that the Roman period did not correspond to a phase of increase of the livestock activity.

This contrast is not probably related with a decline of economic activities in mountain areas, but with the specialization and diversification of human activities at regional, as well as at micro-regional level (Leveau, Palet 2010; Palet et al 2014). In fact, the studied valleys were well connected through an old Pyrenean road network linking *Gallia Narbonense* to *Hispania Tarraconense*. In the center of these valleys, the Cerdanya plain stands out, where the Roman city of *Iulia Libica* (Llívia) is located, founded in the last quarter of the 1st century BC (Olesti 2014: 357-359). This Roman town was therefore the centre of an important road network which connected with the surrounding mountains.

It is important to note that the archaeological and palaeoenvironmental data coincide in pointing out that from Late Empire and especially in Late Antiquity, the anthropization of these mountain areas is intensified due to the increase of livestock activities. In the studied areas, this is especially visible in the Cadi Range and in the upper Ter valley. Human impact in this period was important enough to create a new landscape configuration that will have continuity in Medieval and Modern times, with a greater landscape homogenization, characterized by the expansion of extensive transhumant activities.

Conclusions

European high mountain areas cannot be considered as isolated and marginal spaces as Mountain anthropogenic deforestation episodes related to the creation and maintenance of pastoral grasslands have been documented from the Early Neolithic onwards. Pastoralism has therefore played a decisive role in the human shaping of mountain Cultural Landscapes.

Methodologically, the use of high spatial and temporal resolution analysis in landscape archaeology has proved to be a priceless tool for relating historical, archaeological and palaeoenvironmental results and for assessing local human occupation and the distinctive nature of highland land-use practices on a micro-regional scale.

During the Early and Middle Neolithic human clearances were diversified in its spatial distribution allowing the recovery of alpine forests after impacts. A major landscape change occurred in the studied valleys during the Late Neolithic when the alpine grassland belt expanded. Roman times report a diversification of practices including mining, metallurgy, pine resin exploitation, charcoal production, grazing activities and livestock which are related to significant deforestation processes.

The archaeological and palaeoenvironmental studies emphasize the intense human activity in Roman times. In Antiquity, the development of micro-regional research suggests a heterogeneous landscape shaping, characterized by variability in land-use strategies. A diversification of economic activities has been documented, especially in MPCV, with forest exploitation and livestock activities. In Roman times, the exploitation of pine for pitch production and charcoal stands out. The expansion of

livestock activities is well attested from the 2nd – 3rd centuries and during Late Antiquity, especially in the upper Ter valleys and in the Cadi Range. This process could probably be in the origin of long vertical historical transhumance in NE Catalonia.

It has been suggested, in this sense, that high Pyrenean mountains in Roman times constituted an accessible and well-communicated territories, fully integrated into the Roman sociocultural complex and extra-regional trade networks. Thus, in this period, the Pyrenees and the high mountains in particular should be considered as a complementary area which offered resources of great importance (Leveau, Palet 2010; Orengo et al. 2013).

Landscape dynamics attest a clear expansion of pastoralism from Early Medieval times (9th – 10th centuries) in the studies valleys, with a re-use of Roman structures and the use of new spaces, now clearly specialized in specific livestock activities (milking structures for cheese production). In the upper Ter valleys, this expansion is well documented through the presence of enclosures and huts from the 9th and 10th centuries. In this period, a largely grazed landscape resulted in a wide deforestation.

The results show that important historical processes of social change, such as that of Romanization or the formation of feudal societies, have had a deep impact in mountain landscapes, proving that these were intimately linked to the historical processes documented at lower altitudes.

Finally, the potential of archaeological and environmental research in mountain areas has been pointed out in order to define them as Cultural Landscapes. This is important in order to underline the archaeological heritage as management tool and a cultural resource in areas protected for their landscape value. In this sense, the history of these landscapes furnishes new data for the sustainable development of Mediterranean highlands.

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Figure Captions

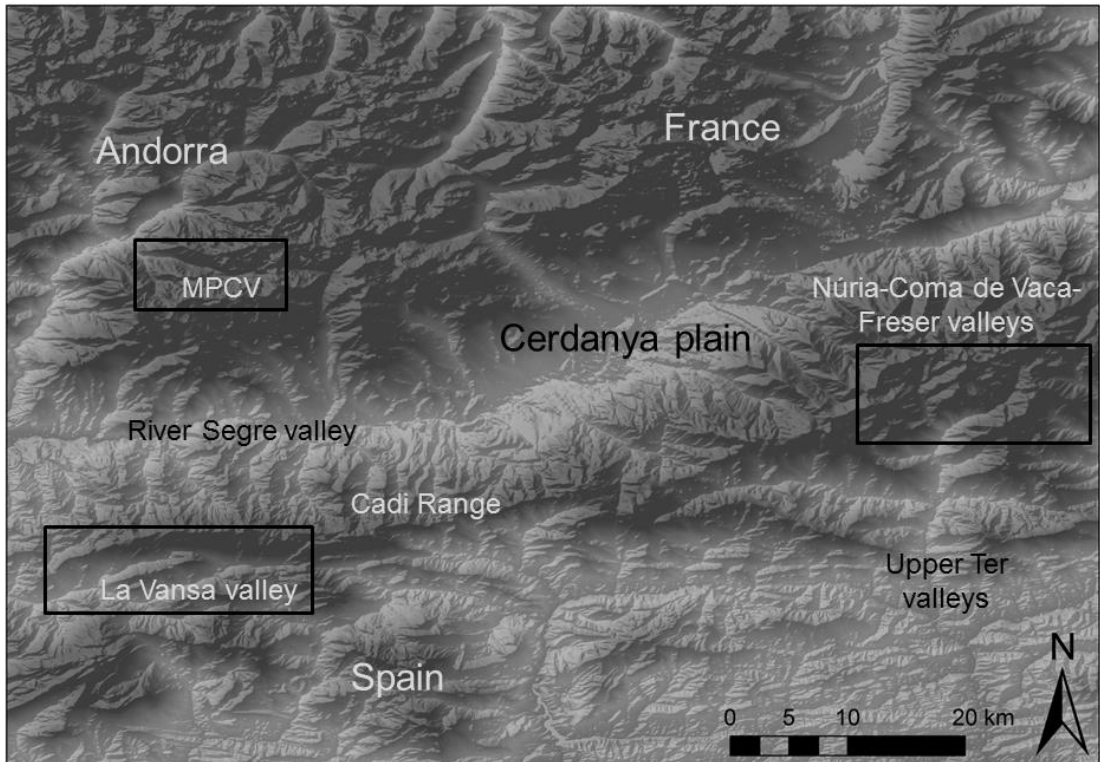


Figure 1. Map with indication of the studied areas in the Eastern Pyrenees.

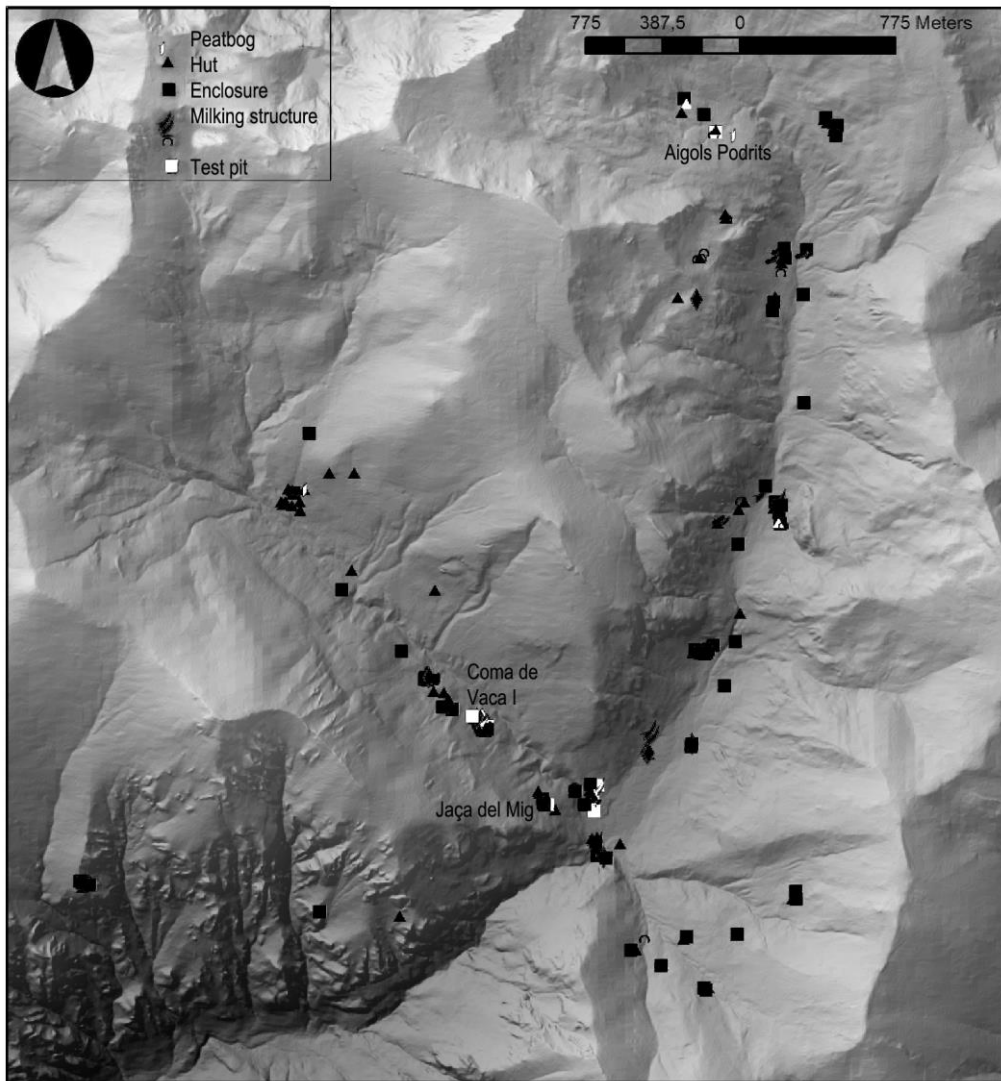


Figure 2. Archaeological map of Coma de Vaca and Coma del Freser valleys (upper Ter), with indication of the structures subjected to test pit digging.



Figure 3. General view of Aigols Podrits I and II sites in the upper Freser valley
(photo J.M. Palet).

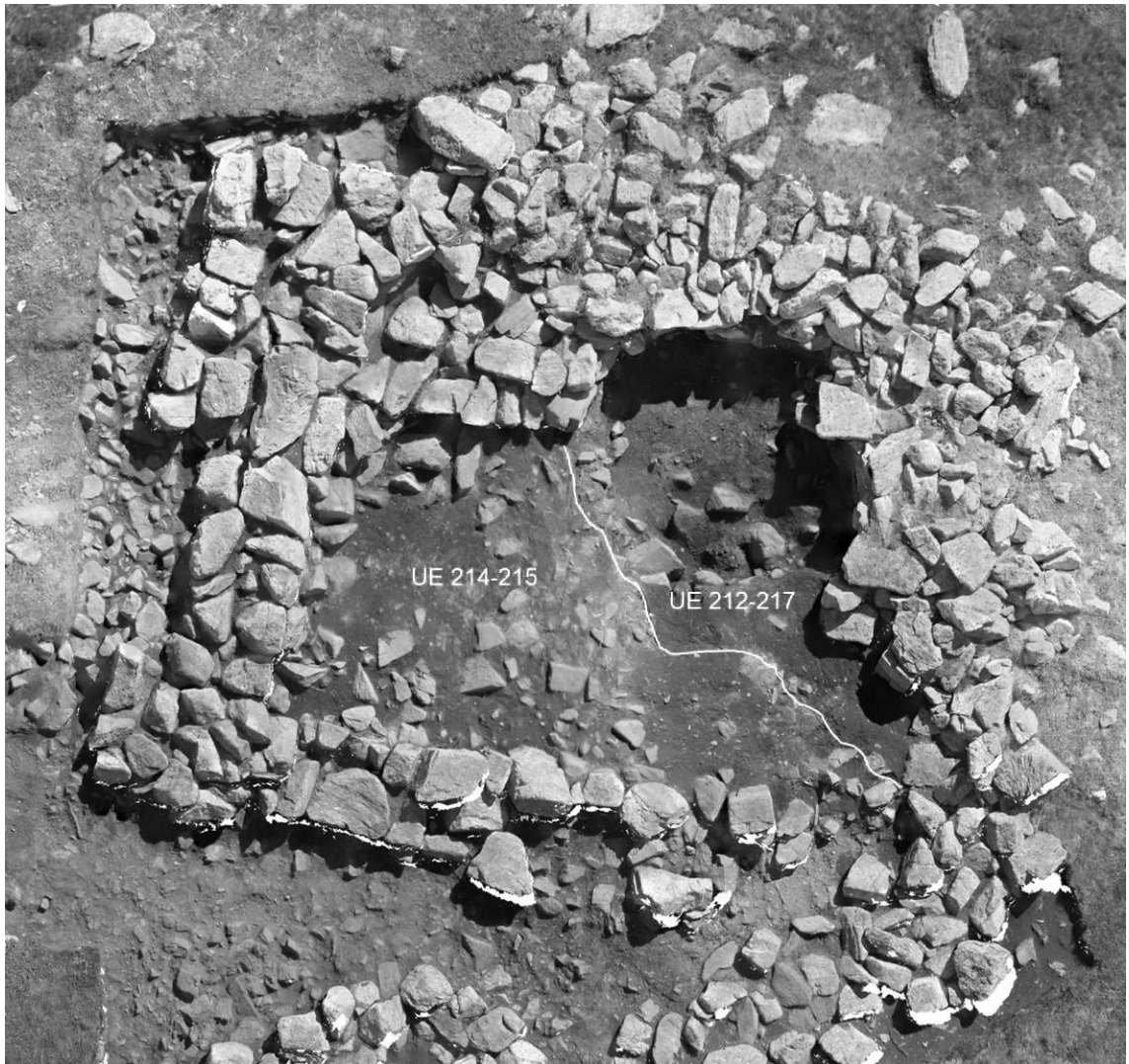


Figure 4. Ortophotography of the Roman hut 114 in Coma de Vaca I site, with the detail of the Roman occupation levels 214-215 and the Early Medieval reoccupation (photo A. García and H.A. Orengo).



Figure 5. Pitch kiln M157 at Riu dels Orris III site in the Madriu valley (Andorra)

(photo J.M. Palet).

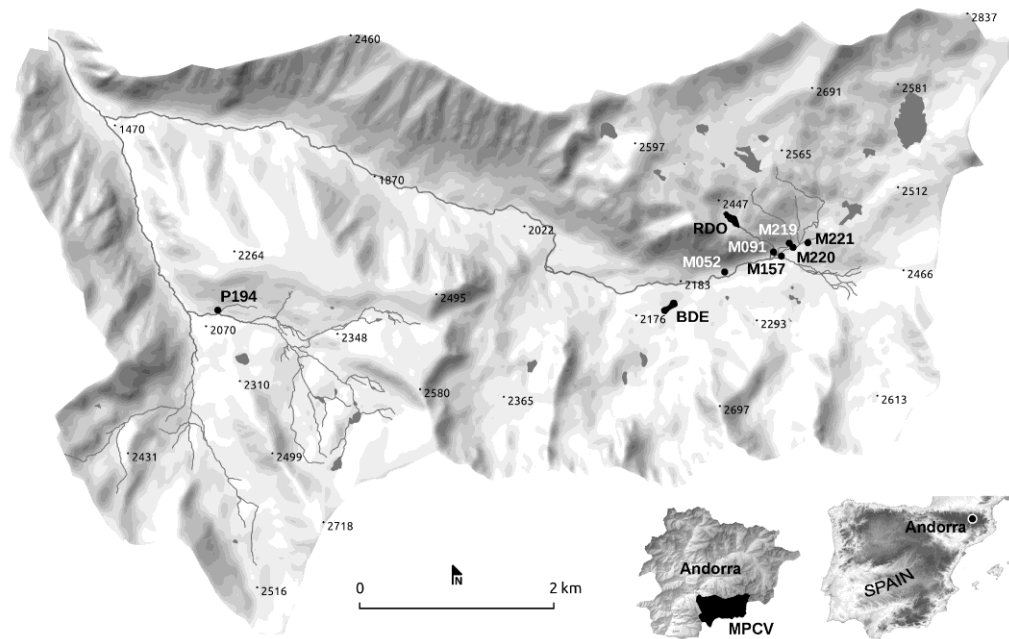


Figure 6. Archaeological map with the situation of the seven pitch kilns attested in MPCV (Andorra) (H.A Orengo).



Figure 7. Iron kilns at El Goleró site in the Cadi Range (upper Segre valley). (Photo J.M. Palet).