

Human palaeontology and prehistory

Occupation and land-use history of a medium mountain from the Mid-Holocene: A multidisciplinary study performed in the South Cantal (French Massif Central)

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Abstract

A multidisciplinary investigation combining archaeological and palaeoecological approaches (pollen, micro-charcoal, major elements geochemistry, and radiocarbon data) has been carried out since 2000 in the southern Cantal (French Massif Central) in order to achieve a better understanding of the environmental/anthropogenic interactions in a mountain ecosystem ranging from 1000 to 1600 m a.s.l. from the Mid-Holocene to the end of Modern Times. This medium mountain area must be considered as a complex landscape shaped during a long-term land-use history. Pollen and archaeological evidences suggest a human frequentation as early as the beginning of the 6th millennium BC. For the following periods, different stages related to the human settlement and anthropogenic activities of land clearance and agro-pastoralism have been documented: the final Neolithic/Early Bronze Age and the Roman period (mainly the 3rd and 4th centuries AD). Middle Ages (between the 10th and the 12th centuries AD) and Modern Times (since the 14th–16th centuries AD) appear to be two key phases revealing complex spatial patterns of land-use. **To cite this article:** F. Surmely et al., *C. R. Palevol* 8 (2009).

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Résumé

Peuplement et stratégies d'exploitation d'une moyenne montagne depuis la mi-Holocène : une recherche pluridisciplinaire menée dans le Sud Cantal (Massif central, France). Une recherche pluridisciplinaire associant une approche archéologique et paléoécologique (pollen, micro-charbon, géochimie et datations radiocarbone) a été engagée depuis l'an 2000. Menée à

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haute résolution spatiale et temporelle dans le Sud Cantal (Massif central), elle a pour objectif d'étudier les interactions Homme/Environnements dans des écosystèmes montagnards situés entre 1000 et 1600 m d'altitude depuis la mi-Holocène jusqu'à aujourd'hui. Différentes étapes ont pu être mises en évidence dans le peuplement de la zone, ainsi que sur les stratégies d'exploitation des espaces (déforestations, activités agro-pastorales) depuis la transition Mésolithique/Néolithique jusqu'à la fin de l'époque moderne. *Pour citer cet article : F. Surmely et al., C. R. Palevol 8 (2009).*

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1. Introduction

Medium mountains have always been considered as marginal and risky areas, occupied comparatively late in Prehistory, and then only intermittently by humans, largely because of the harsh climate. Recent archaeological work carried out in the French Massif Central [24,25], concerning the early prehistoric period, indicates an important and early human presence in the uplands. It also demonstrates the significance of taphonomic factors (poor site preservation).

Since 2000, a multidisciplinary investigation combining archaeological, historical and palaeoecological approaches has been carried out in the southern Cantal

(French Massif Central) [11,19] in order to reconstruct the land-use history from the mid-Holocene to the present day. This integrated research has been performed in order to achieve a better understanding of environmental and anthropogenic interactions throughout the Holocene in these mountain ecosystems ranging from 1000 to 1600 m a.s.l.

2. Study area

The study area corresponds to the southern “planèze” of the Plomb du Cantal, a wide triangular plateau originating from the volcanic flow emitted during the last phases of the Cantal strato-volcano activity [13] (Fig. 1).



Fig. 1. Study sites and archaeological context. ★ Prehistoric sites, ●: “Mounds”; ▲: Bronze Age sites; ▼: Iron Age sites; ■: Gallo-Roman sites, ◆: Medieval and Modern sites; 1: Peyre peat bog; 2: Vèze peat bog.

Fig. 1. Localisation des sites et cadre archéologique. ★ Sites préhistoriques, ●: « Tertres »; ▲: sites de l'Âge du Bronze; ▼: sites de l'Âge du Fer; ■: sites de l'époque gallo-romaine; ◆: sites médiévaux et modernes; 1: tourbière de Peyre; 2: tourbière de Vèze.

The tabular surface offers a quite regular slope from north (1600 m a.s.l.) to south (1000 m a.s.l.). The relief has mainly been shaped by the fluvial and glacial erosion. This is the result of deep incisions by many river valleys causing the plateau surface to be irregular. The study area is located in five rural districts: Pailherols, St-Clément, Lacapelle-Barrès, Malbo and Brezons. The continental climate is particularly harsh, with very low temperatures, and heavy snow and rainfall (over 2 m per year) which underlines its oceanic tendency. The study zone is finally characterized by rich and fertile volcanic soils, though no mineral resources (flint, ore) are available.

3. Methodology

Archaeological fieldwork was carried out in an area of 35 km² where no previous studies had been undertaken. The methodology developed is based on foot and aerial prospections, test excavations, diggings and archival studies. All the sites and evidences of sites were accurately located with GPS and cross-checked with ancient and recent cartographic documents in an attempt to get a spatial analysis of the archaeological data.

Three peat profiles were recovered from Peyre (two parallel cores 1 and 2, 44° 57' 37" N, 2° 43' 08" E, 1100 m a.s.l., both 800 cm long) and Vèze (44° 58' 07" N, 2° 43' 15" E, 1147 m a.s.l., 325 cm long) peat bogs using a Russian corer. Pollen sampling was performed every 5 cm. Pollen preparation followed standard methods using treatment with 10% HCL, 10% KOH, HF acetolysis and final mounting in glycerine [4]. Minimum pollen counts of 500 dry land pollen grains per sample were made. Pollen values were calculated as a percentage of total land pollen excluding Cyperaceae, fern spores and aquatic plants. The Peyre sequence was also sampled each 20 cm for geochemical analyses: drying at 106 °C during 24 h and combustion at 550 °C for 5 h to respectively obtain the water content and the Loss On Ignition (both expressed in weight %) and drying associated with an ultra-pure H₂O₂ action until the complete dissolution of the organic fraction of peat for analysing the chemical content (anions and cations).

Magnetic susceptibility and charcoal analyses were undertaken on a twin core from Peyre peat-bog. Volume Magnetic Susceptibility (κ) was measured with a MS2E1 surface-scanning sensor from Bartington Instruments. This sensor is well adapted to measure κ of split cores with fine resolution [27]. Measurements were made at 5 mm intervals. Macroscopic charcoal sedimentary concentrations were estimated from 465 samples between 0 and 465 cm depth. Data are based on the tallying of particles at 40× from contiguous 1-cm sediment sam-

ples of 2 cm³ washed on a 160 μm mesh sieve after acid and peroxide treatments [28]. Macroscopic charcoal particles (>160 μm) reflect local fire history although micro-regional fire episodes mainly depend on fire size and intensity [16].

A total of 24 AMS radiocarbon dating measurements were performed and calibrated using the CALIB 5.0.1 program [23]. Sixteen radiocarbon dates were obtained on peat sediment for the palaeoecological research. Some of these dates must be rejected because they are incoherent with radiometric data obtained for similar botanical event in previous research (Table 1). Interpolated dates for undated event were obtained by linear regression between accepted calibrated ages. The time period covered starts at the beginning of the Late Glacial (Peyre-coring 1) and the Late Glacial/Early Holocene boundary (Peyre coring 2 and Vèze). As the overall objective of this paper is the reconstruction of land-use history, the palaeoecological results presented concern only the Mid and Late Holocene. A total of eight archaeological sites or stratigraphic units were radiocarbon dated. The dates were obtained on charcoal extracted from clearly defined stratigraphic layers (Table 2).

4. Results and discussion

Six hundred and eight sites and evidences of sites were recorded from the end of the Mesolithic to the Modern period (Fig. 1). This represents only a part of the archaeological heritage of the area because of permanent vegetation cover (meadows) which makes it difficult to find new sites. Known archaeological site locations, mainly the ancient ones without stone structures, mostly coincide with erosion (fluvial and recent human management) which is particularly severe in these upland areas implying also the destruction of a great number of sites. Nevertheless, there is no uniform distribution of the archaeological data which might have implied their general reworking.

4.1. Prehistory and Early Protohistory (Chalcolithic and Bronze Age)

The prehistoric period is particularly well represented (163 sites or evidence of sites) at every altitude. Nevertheless, only one or two lithic finds were often discovered, which is not sufficient enough to give any precise chronological characterization. The different types of archaeological data prevent a precise characterisation of the settlement patterns. Nevertheless, since these evidences correspond to the entire *chaîne opératoire*, some knapping activities might have taken place

Table 1
Calibrated radiocarbon dates obtained from Peyre (coring 1 and 2) and Vèze peat bogs.
Tableau 1

Datations radiocarbones calibrées, obtenues pour les tourbières de Peyre (séquences 1 et 2) et de Vèze.

Core	Depth (in cm)	Laboratory reference	Conventional age (^{14}C yr BP)	Calibrated age (2 σ) (cal. yr BP)	Calibrated age (2 σ) (cal. yr BC/AD)	Comments
Peyre core 1	29–36	Ly-2606	1715 \pm 50	1739–1520	AD 237–422	Accepted radiocarbon date because coherent with the regional vegetation history [18]
Peyre core 1	255–260	Ly-12607	3795 \pm 65	4409–4066	BC 2461–1985	
Peyre core 1	430–436	Wk-14803	6914 \pm 49	7854–7660	BC 5900–5710	Accepted radiocarbon date although a bit old. Similar botanical event (optimum of <i>Fraxinus</i>) dated in the Cantal to 6270 \pm 75 BP [10] which is coherent with the regional vegetation history [18]
Peyre core 1	459–465	Ly-12608	2450 \pm 65	2714–2354	BC 792–397	Rejected radiocarbon date because uncoherent
Peyre core 1	510–516	Wk-14804	8257 \pm 69	9428–9072	BC 7480–7080	Rejected radiocarbon date because too old. Similar botanical event (start of the expansion of <i>Tilia</i>) are dated to 7520 \pm 130 BP [1] and ca 7000 BP [9]
Peyre core 1	584–590	Ly-12082	9060 \pm 120	10522–9885	BC 8550–7923	Accepted radiocarbon date. Similar botanical event are dated to 9530 \pm 200 BP [1] and 9250 \pm 380 BP [17]
Peyre core 1	625–630	Ly-2458	10396 \pm 50	12592–12462	BC 10381–1003	Accepted radiocarbon date. Similar botanical event are dated to 10270 \pm 530 BP and 10450 \pm 250 BP [1]
Peyre core 2	40–41	Poz-19270	2480 \pm 30	2718–2452	BC 769–503	Accepted radiocarbon date because coherent with the regional vegetation history [1,17,18,10]
Peyre core 2	98–99	Poz-13563	2635 \pm 35	2796–2719	BC 847–770	
Peyre core 2	188–189	Poz-12059	4105 \pm 35	4815–4713	BC 2866–2571	
Peyre core 2	243–244	Poz-19271	4485 \pm 35	5295–5037	BC 3346–3088	
Peyre core 2	296–297	Poz-12061	4775 \pm 35	5592–5464	BC 3643–3515	
Peyre core 2	422–423	Poz-13507	6730 \pm 40	7667–7560	BC 5718–5611	
Vèze	36	Poz-24509	335 \pm 30	477–309	AD 1473–1641	
Vèze	148	Poz-24510	5440 \pm 40	6306–6182	BC 4357–4233	
Vèze	219	Poz-24511	8190 \pm 40	9269–9024	BC 7320–7075	

Table 2
Calibrated radiocarbon dates obtained from archaeological structures.
Tableau 2

Datations radiocarbones calibrées, obtenues dans les structures archéologiques.

Structures	Dated material	Laboratory reference	Conventional age (^{14}C yr BP)	Calibrated age (2 σ) (cal. yr AD)
97 (mound) – Peyre	Charcoal	POZ-16366	1506 \pm 33	435–637
53 – Bouyssou	Charcoal	VERA-3750	885 \pm 30	1040–1220
1277 – Vixouze	Charcoal	POZ-26646	935 \pm 30	1020–1210
95 – Peyre	Charcoal	VERA-3749	370 \pm 30	1440–1640
54S2-US31 – Bouyssou	Charcoal	POZ-26644	355 \pm 30	1450–1650
54S2-US40 – Bouyssou	Charcoal	POZ-26645	565 \pm 30	1300–1440
54S3-US25 – Bouyssou	Charcoal	POZ-26643	570 \pm 30	1300–1440
13-2 – Montagne de Vèze	Charcoal	POZ-22125	370 \pm 30	1440–1550

in the area. Moreover, procurement of raw lithic material supply is not a reasonable explanation as there are no local siliceous resources. Thus, prehistoric peoples did not simply visit the area during short expeditions but

probably established real camps. Lithic assemblages are composed of Tertiary flint available a few kilometres farther down in elevation [21]. No imported flint has been found which is quite characteristic of prehistoric sites

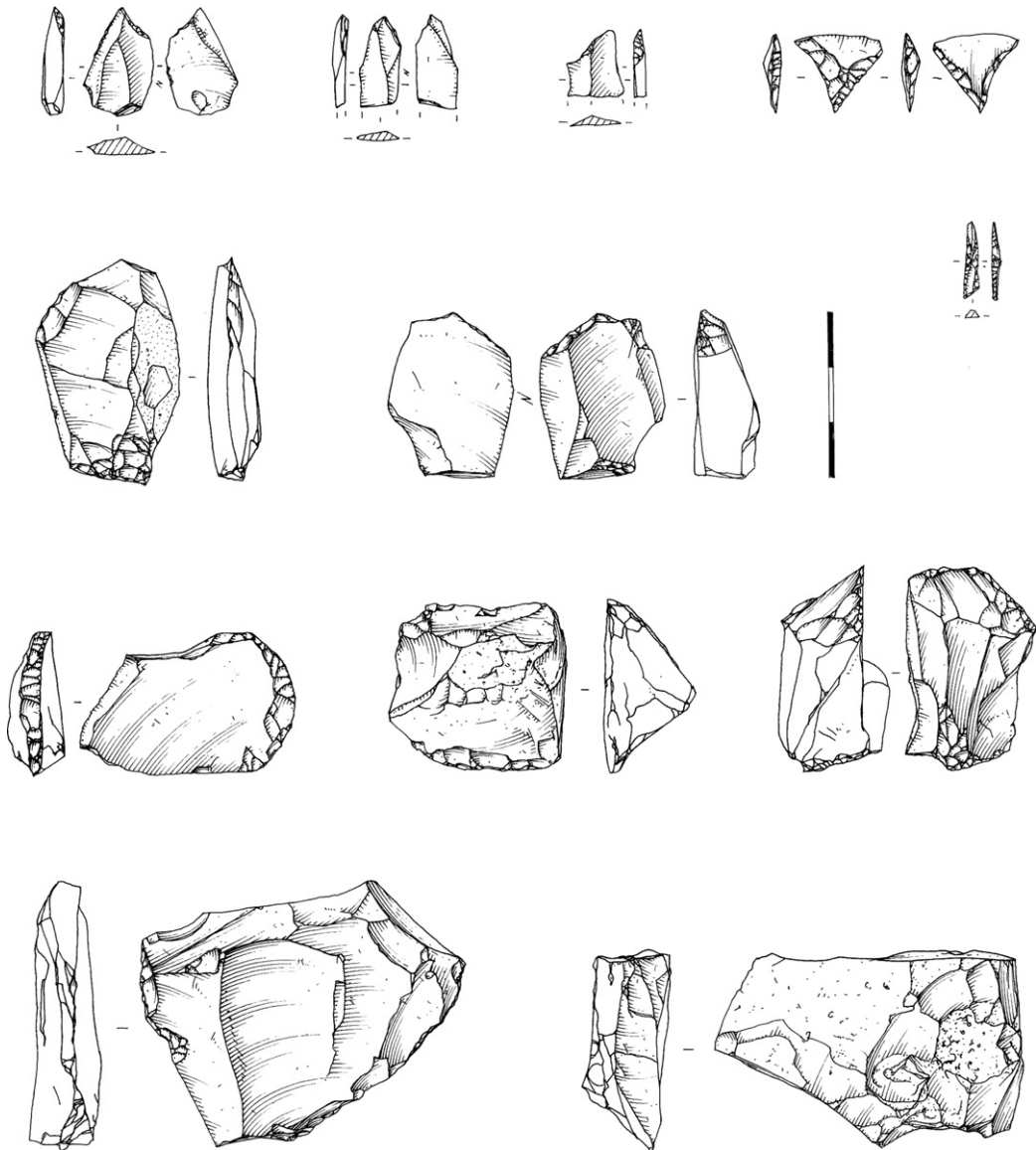


Fig. 2. Early Neolithic lithic assemblage. Site 582 (La Montagne du Clos, Saint-Clément). Drawing, P. Alix.
 Fig. 2. Pièces lithiques du Néolithique ancien. Site 582 (La Montagne du Clos, Saint-Clément). Dessins P. Alix.

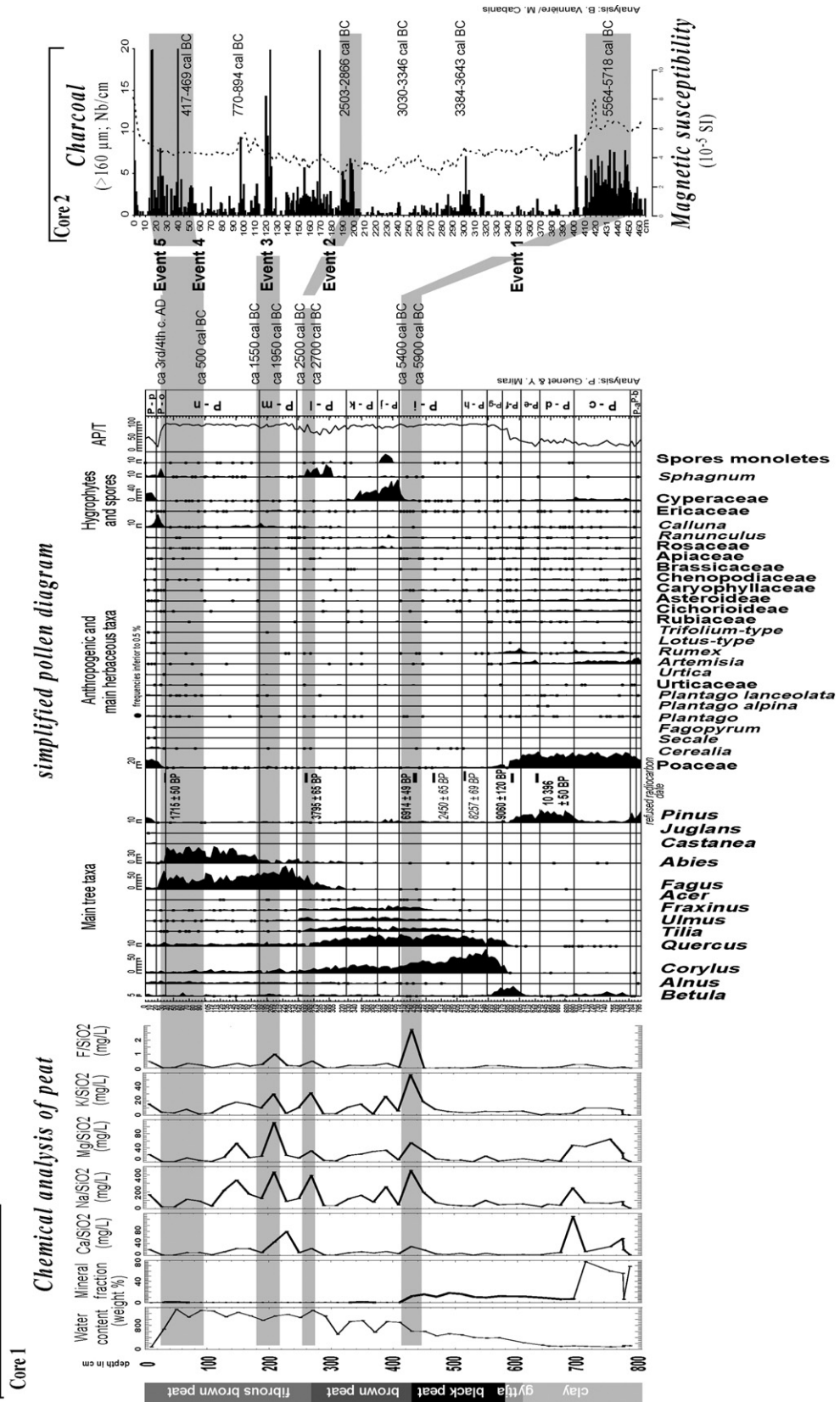
(all periods) located on the western side of the Cantal massif [24].

4.2. First Mesolithic and Early Neolithic occupations

A fragment of an elongated scalene triangle with three retouched edges was discovered at 1493 m a.s.l. which suggests a Middle Mesolithic occupation (Fig. 1). Moreover, abundant lithic assemblages (n° 61, 64, 426, 578, 582) could be dated to the Final Mesolithic/Early Neolithic boundary and Early Neolithic (Fig. 2). Unfor-

tunately, these sites have been ruined by natural erosion or by posterior human activities. As a result, no precise link can be established between the sites and natural geographical characteristics (such as springs, mountain passes etc.). Concerning the palaeoecological data, the first regular occurrences of *Cerealia* pollen-type observed since 7100 cal BC (beginning of biozone [P-i], Fig. 3) must not be taken into account as no other contemporaneous anthropogenic pollen indicators are evidenced. Moreover, O'Connell et al. [14] showed the important role played by wild grasses with high pollen grain-size in the vegetation since the Lateglacial. Despite

Peyre peat-bog (1100 m a.s.l., Cantal, France)



this, palaeoecological data (pollen, charcoal, major and trace elements) converge between ca 5900 and 5400 cal BC indicating an Early Neolithic human occupation (Event 1: biozone [P-i], Fig. 3). Pastoral pollen indicators (*Plantago sp*, *Rumex*, *Artemisia*, Urticaceae etc.) associated with a more reliable *Cerealia* pollen-type observation at ca 5800 cal BC, a slight rise in Poaceae frequencies and evidences of clearances mainly of the oak woodlands (decrease of *Quercus* values at 20%) are contemporaneous with chemical variations of the peat and a phase of charcoal inputs. Fire-induced deforestation may have caused the abrupt physical and chemical erosion of soils and superficial formations confirmed by a rise of the magnetic susceptibility. From these studies, the anthropogenic origin of fire is thus discussed, even if a climate-driven fire regime is also supposed because similar fire frequency increases have been recorded during this period in different European contexts [28].

4.3. Late Neolithic and Early Protohistory

Several pollen indicators of pastoral activities reflect a Final Neolithic human occupation in the area (Event 2: end of biozone [P-l], Fig. 3). Direct evidence for cultivation can be correlated with the pollen record of slight beech-fir forest clearances between ca 2700 and 2500 cal BC, inducing soil erosion and peat chemistry variation. A new increase in charcoal sedimentary concentration indicates fire occurrences that could be associated with forest clearances. The use of fire by Neolithic peoples during this period is widely documented in France [26]. Soils made from decayed volcanic rock must have been particularly fertile and easy to till. A more palpable episode of local human activity is also recorded around 1950–1550 cal BC as shown by pollen (noticeable occurrences of *Plantago lanceolata*, Urticaceae and rise in *Calluna*, decline of *Fagus* rates at a mean of 50%) and new chemical variations of the peat (Event 3: biozone [P-m], Fig. 3). Charcoal concentration from Core 2 remains high during these periods, but the absence of radiocarbon dates prevents direct correlations and identification of this event in Core 2. Archaeological data also confirm Late Neolithic and Early Protohistoric human occupation, even if the evidence of sites is few in number. A problem of differential conservation could be avoided for these periods

as pottery assemblages have been discovered at high altitudes.

Seventy-six small circular mounds corresponding to 166 structures have been recorded (Fig. 4). They were traditionally considered as Protohistoric funeral mounds [17]. However, test excavations performed on 12 structures demonstrate that they correspond to heaps of rocks removed from fields, from Gallo-Roman period to Modern times (Table 2). Furthermore, these “mounds” are located below 1200 m of altitude, which represents the maximal elevation for cultivation. Future research will aim to determine if other bigger mounds (which are less-represented) are truly Protohistoric funeral mounds.

4.4. Iron Age and Gallo-Roman period

Between ca 600/500 cal BC, pastoral and secondarily arable pollen indicators show an overall tendency to rise reflecting an increased in land-use in the immediate surroundings of the Peyre site (regular occurrences of *Plantago lanceolata*, *Plantago sp*; Event 4: second half of biozone [P-n], Fig. 3). A charcoal phase is observed ca 400–500 cal BC while contemporaneous clearances of the beech-fir forests are recorded (new decline in *Fagus* values and *Abies* ones at ca 30%, Fig. 3). Contrary to the previous events described, no significant chemical variations of the peat are noticed. This can be explained by the decrease of the peat sedimentation rate which may restrict the precision of the chemical indicators for the bottom of the sequence. These clearances culminate around the 3rd–4th centuries AD when large-scale systematic deforestations with agro-pastoral purposes start to yield a poorly forested landscape (Event 5: drastic decline in the AP/T ratio from 85 to 60%, end of the biozone [P-n] in Fig. 3 and start of biozone [V-a] in Fig. 5). According to the pollen data, the Gallo-Roman period represents an important threshold in the landscape history of this mountain while archaeological evidences are scarce (6 sites or evidences of sites [Fig. 1] with a probable enclosure dated by ceramic finds to the 3rd–4th centuries AD, Table 2). As cereal pollen-types (including *Secale*, biozone [V-a] in Fig. 5) do not increase more intensively and rapidly than pastoral indicators, a possible explanation is a pastoral exploitation of the upper zone (above 1100 m a.s.l.) with population concentrations in the lower valleys.

Fig. 3. Simplified pollen diagram in relative frequencies (%) and geochemical results of Peyre coring 1. Sedimentological results and fire signal of Peyre coring 2.

Fig. 3. Diagramme pollinique simplifié en fréquences relatives et résultats géochimiques obtenus sur la séquence Peyre-1. Résultats sédimentologiques et signal feu, obtenus dans la séquence Peyre-2.



Fig. 4. Small circular mound (site 35-1, la Montagne de Vixouze, Pailherols).
 Fig. 4. Petit tertre circulaire (site 35-1, La Montagne de Vixouze, Pailherols).

4.5. Medieval and Modern period

In addition to several remains of agricultural terraces and signs of parcel limits, numerous half-buried structures called huts found in the whole study area must be assigned to Medieval and Modern periods. Two hundred and eighty-seven assemblages were identified that correspond to 565 structures ranging from isolated structures to clusters composed of 15 structures (Fig. 1).

Three main types of structures can be distinguished. First are groups of rectangular structures with stone wall foundations, sometimes partitioned and surrounded by various expansions: paths, gullies supplying water, enclosures etc (Fig. 6). The six sites observed are situ-

ated below 1250 m a.s.l. One (site 53) had been excavated and radiocarbon dated to around the 11th–12th centuries (Table 2). These groups may correspond to medieval deserted hamlets, similar to those described in the north of the Massif Central [3,5], and probably linked to permanent settlement based on an agro-pastoral economy as the pollen evidences of grazing and arable farming suggest (continuous curves of *Cerealia* pollen-type and maximum of pastoral indicators, biozone [P-o] in Fig. 3 and end of [V-a] in Fig. 5).

A second type of structures consists of isolated ones or by pairs (213 sites). Most of them have stone wall foundations. Their dimensions (inside) vary with lengths ranging from 6 or 8 to 21 m and widths rang-

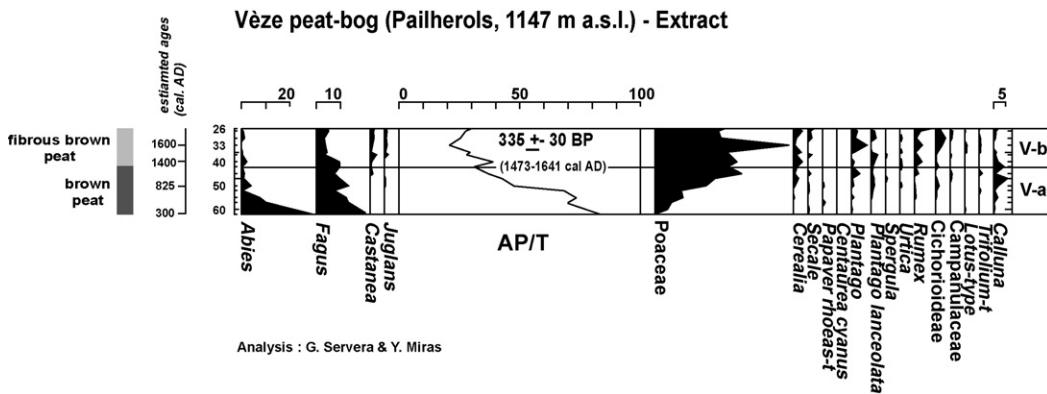


Fig. 5. Extract of a simplified pollen diagram in relative frequencies of Vèze peat bog.
 Fig. 5. Extrait du diagramme pollinique simplifié (fréquences relatives) de la tourbière de Vèze.



Fig. 6. Medieval deserted village (site 39, La Montagne de Caillac, Pailherols).
 Fig. 6. Village médiéval déserté (site 39, La Montagne de Caillac, Pailherols).

ing from 2.8 to 5.7 m. They are often divided in two unequal rooms. Their geographic distribution is wider but strictly limited below 1400 m a.s.l. These structures are located most of the time near the pastoral modern “burons” or mountain dairies. Their great diversity suggests different functions (barns, cowshed etc.) and different chronologies: ca 11th–12th centuries (site n° 1277) or between ca 1440 and 1550 cal AD (structures n° 13-2) (Table 2). These structures could be

linked to a seasonal pastoral economy, at least for the highest ones above 1200 m a.s.l. Thus pollen data express the existence of a fully agro-pastoral open landscape (the average AP/T ratio is inferior to 30%, biozone [V-b] Fig. 5). Even if grazing remained the primary activity at a local scale in accordance with historical data indicating the start of intensive pastoral farming around the 15th century [2], diversified agriculture activities progressed including cereal farm-



Fig. 7. Square huts: a: “Bunch” pattern (site 54, La Montagne du Bouyssou, Pailherols); b: aligned pattern (sites 58 and 676, La Montagne de Caillac, Pailherols).
 Fig. 7. Structures quadrangulaires : a : modèle « en grappe » (site 54, La Montagne du Bouyssou, Pailherols) ; b : modèle « aligné » (sites 58 and 676, La Montagne de Caillac, Pailherols).

ing (Rye/*Secale*), buckwheat (*Fagopyrum*) culture at the altitudinal range of the study peat sites (until 1150 m a.s.l.), and also regional arboriculture (Chestnut/*Castanea*, Walnut/*Juglans*) (biozone [P-p] in Fig. 3 and biozone [V-b] in Fig. 5).

Third structures are many isolated square huts located in the whole study area from 1120 to 1450 m a.s.l. (283 sites). Their dimensions are constant between 4 and 5 m a side without stone wall foundations. Similar square huts are nucleated with five to 11 structures in clusters (31 listed sites, Fig. 1, Fig. 7). Some of these structures are aligned which is similar to those described in the Cézaillier and Monts Dore [6]. However, in the predominant “bunch” pattern, structures are gathered at a minimal distance of 12 m. Mixed patterns have also been observed. Four of these nucleated square huts were excavated and radiocarbon dated. Two were dated to the end of the late Middle Ages (ca 1300–1430 cal AD, Table 2) with a phase of reoccupation at the beginning of Modern Times. The last two date to the end of Modern times (ca 1440–1640 AD, Table 2).

All of these huts are situated along the eastern slope of a small hillock, affording both a distant view over the surrounding area and protection against prevailing winds. The entrance is to the east or the south. Investigations carried out on two small structures suggest they were constructed with perishable materials. These structures could be compared to the huts referred to “foguals” or “mazucs” in historical sources of the 16th–18th centuries [2,6]. The high-frequency of this nucleated pattern might be explained by the collective character of land ownership, which was important according to the historical archives [2]. At the transition of the 16th–17th centuries, the palaeoecological data evidence a rise of grasses suggesting an expansion of probably better managed pastures because characteristic pastoral indicators for the French Massif Central [10] such as *Lotus*-type, *Trifolium*-type are present as well as optimum representation of the more classical ones (*Plantago lanceolata*, *Plantago sp.*, *Rumex*, *Artemisia* etc.). At the same time, a slight agricultural contraction or removal is recorded since the 17th century approximately for an altitudinal range around 1000–1150 m a.s.l. (end of biozone [V-b], Fig. 5). Archaeological and palaeoecological data thus converge to indicate a lowering in altitude (below 1150–1200 m a.s.l.) for summer grazing activity since the 16th–18th centuries. The quite entire mountain of the South Cantal started thus to be specialised in a seasonal pastoral economy until the middle of the 20th century when the “buron” (pastoral structures of the modern and recent period) were abandoned.

5. Conclusion

Both archaeological and palaeoecological studies document at a local scale the first human occupations as far back as the Mesolithic/Neolithic transition and Early Neolithic, even at ca 1150 m a.s.l. Repeated local forest fires are concomitant at the beginning of the 6th millennium BC with relevant grazing pollen indicators, and first cereal pollen-types are recorded as early as ca 5800 cal BC. Even if the nature of the archaeological evidence prevents us from characterising precisely prehistorical settlement patterns, these artefacts represent the entire *chaîne opératoire*. Some knapping activities took place in the study area, which reveals that Neolithic peoples established real camps. Multidisciplinary research carried out in West European mountainous areas reflects similar early occupation of high altitude spaces, most of them since the end of the Mesolithic (Alps: [29]; Pyrenees: [7,15,20] etc.). Far from being marginal or isolated areas, medium and high mountains must be considered as complex landscapes shaped during a long-term land-use history marked by important thresholds. For instance, palaeoecological records provide two key phases in the history of this mountain occupation. More significant impacts between ca 2700–2500 cal BC and 1950–1550 cal BC indicate a Final Neolithic/Early Bronze Age agro-pastoral management which remembers similar data obtained in other areas of the French Massif Central [10,12]. Nevertheless, protohistorical sites are few in number. The recorded mounds correspond to heaps of rocks removed for agricultural purposes. The Roman Period (mainly the 3rd and 4th centuries AD) appears to be a complex threshold in the shaping of this medium mountain landscape suggesting important variabilities in mountain area settlements. Large beech-fir forest clearances are related to an important agro-pastoral extension which had considerable impact on the rapid change from a relatively undisturbed landscape on a regional scale towards a human dominated cultural landscape and induced modification of the rates of physical and chemical erosion of soils [22]. Conversely, the archaeological evidences are rare. Further research will focus on the Gallo-Roman occupation model: exploitation of the natural resources in the upper part of the mountain (above 1100 m a.s.l.) and settlements in the lower valleys?

Between the 10th and the 12th centuries approximately, an important and probable permanent human settlement in this mountain region might have been organised in hamlets ranging to an elevation of 1250 m a.s.l. The agro-system developed may have included grazing and cereal cultivation. The upper part of the mountain (above 1250/1300 m a.s.l.) might have

remained devoted to pastoral activity. Towards the 14th though the 16th centuries, a new spatial pattern of land-use is suggested by a new altitudinal gradient of human practices. A significant cultural shift in the exploitation system reveals a change in landscape organisation and functionality, especially for the zone ranging from 1100 to 1250 m a.s.l. Archaeological data (multiplication of the pastoral square huts called “proto-burons”), but also historical and palynological data, indicate that during the transition of the 16th–17th centuries permanent mixed arable-pastoral farming was progressively substituted by a strict pastoral one based on summer grazing. If the Little Ice Age could have sustained and accelerated these changes, this climatic deterioration alone provides an incomplete explanation for this land-use evolution. Like other French Massif Central areas (e.g. Limousin, [8]), the role of socio-economic transformations must be considered. To conclude, the results presented here provide the basis for assessing how interactions between environmental (particularly climatic), agricultural, social, demographic and economic factors affected land-use dynamics. Further research – mainly historical archival studies cross-checked with high resolution palaeoenvironmental analyses – will have to examine environmental and anthropogenic triggers upon land-use dynamics.

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