interpreting lithic raw material variability in Middle Palaeolithic contexts: a modeling approach with applications to the Bau de l'Aubesier (Southeastern France)

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Chapter Two

An overview of the French Middle Palaeolithic site of the Bau de l’Aubesier

1 Introduction

The Bau de l’Aubesier (hereinafter, ‘the Bau’) is a large rockshelter located at the western border of the sub-alpine chain in the department of Vaucluse, southeastern France (Figure 1). It was named by Franki Moulin at the beginning of the 20th century, ‘Bau’ being, according to Moulin, a Provençal word denoting a steep rock with a generally flat summit (Moulin 1903: 369). Indeed, the site is found today about halfway down the deep gorge of the Nesque river, in steep and challenging terrain below a large plateau (Figure 2). The gorge is carved in Lower Cretaceous (Bedoulian) limestone (see Figure 3), and although the Nesque now runs mostly dry on the surface throughout much of the year, it is the only waterway in the area (Moulin 1904: 427-48), and its surface flow is likely to have been more substantial in the past (e.g., Moulin 1903; Fernandez 2001: 11). Even today the Nesque is sometimes subject to rapid floods (e.g., Texier 2004: 83), and on occasion veritable lakes are known to have formed at the mouth of the gorge (documented, for example, in 1885 and 1900 – Moulin 1903). With easy access to water, three different types of ungulate home ranges (open flats on the plateau, wooded areas near the river, and steep escarpments), and abundant sources of high-quality flint (see Figure 3), the Bau would have thus presented a strategic location for its inhabitants in a region with many known Middle Palaeolithic sites (Figure 1).

The site’s deposits are thick (at least 12 m, but the bedrock was not reached during excavations) and extend over more than 250 m^2 (e.g., Lebel et al. 2001: 11097). They form a plateau in the rockshelter proper and appear in more or less horizontal layers down the north-facing slope at its front. They are also very rich in both faunal remains and lithic materials, deposited over a period of some 100,000 years of repeated occupation across the Middle and Upper Pleistocene. The numerous archaeological layers consist primarily of “cryoclastic breccias with variable amounts of matrix and/or cement” (Lucy Wilson, personal communication), and they comprise two main units: an upper one corresponding to the plateau, and lower one corresponding to the slope deposits. Both preserve evidence of repeated occupations. The site is remarkable in several regards, including but not limited to the richness of the horse remains it has yielded (e.g., Fernandez et al. 2006), the evidence for volumetric blade production in layers dated to MIS 7 (see Carmignani et al. 2017: 39-40), the presence hominin remains with pathologies thought to have required conspecific care (Lebel et al. 2001; Lebel and Trinkaus 2001), and the utilization of lithic raw material sources located within a relatively narrow distance interval of roughly 8-13 km from the site, despite the presence of good quality flint closer to the Bau. What follows below is a brief, synthetic overview of the history of research at the Bau and of some important finds. My goal here is not to provide a comprehensive and authoritative overview of the site – for that the reader is directed to Lucy Wilson’s upcoming book, “Shades of Laughter, Shades of Life” – but rather to provide some additional context for the analyses and results presented in Chapters 4 and 5.

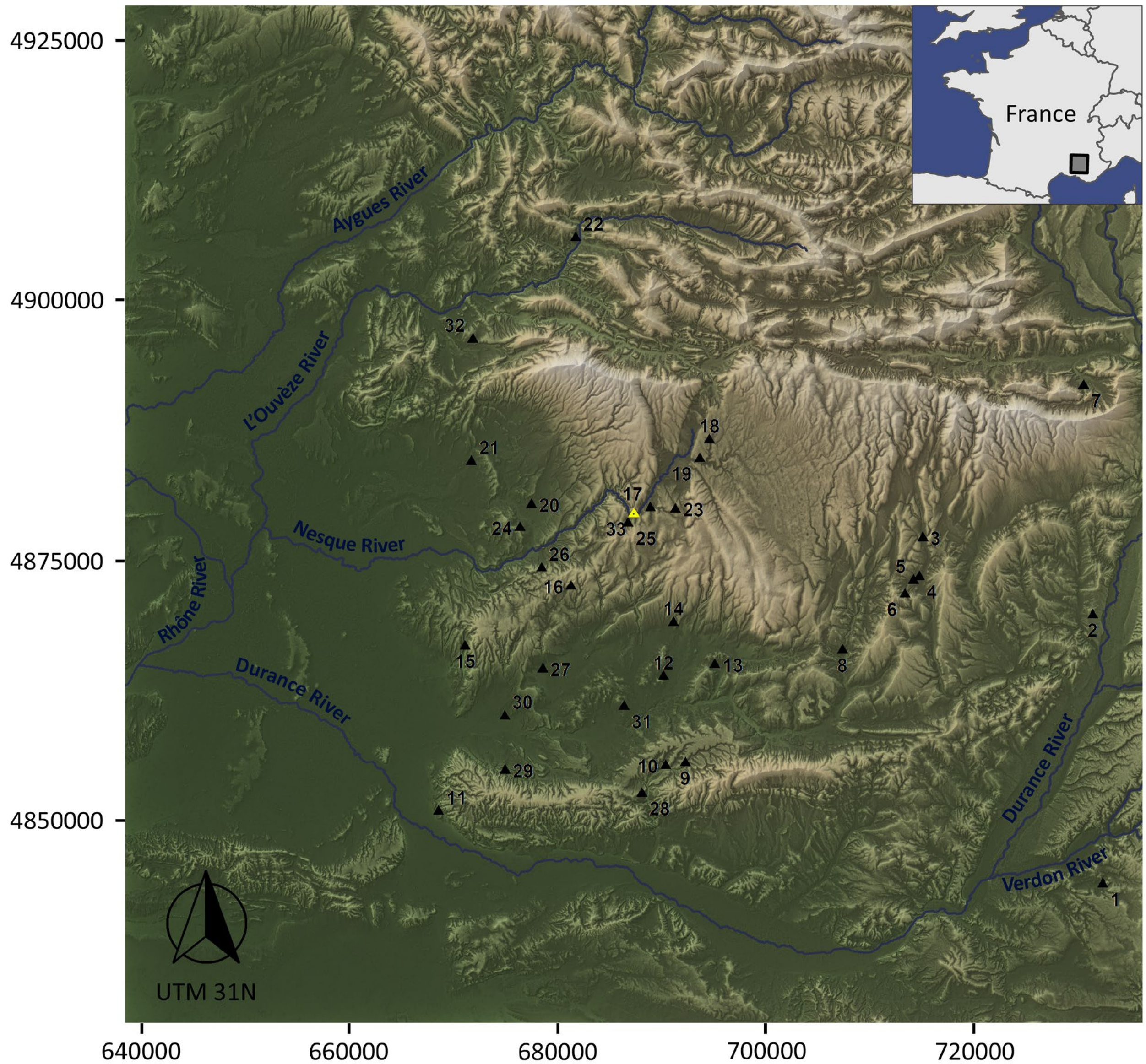

Figure 1: The Bau de l'Aubesier (17) and nearby localities with reported Middle Palaeolithic finds*.* The indicated locations are: 1. Mallavasse; 2. Pic d'Oriou; 3. Grotte du Largue; 4. Plan de Gondran; 5. Le Clos; 6. Saint-Laurent; 7. Grotte de Saint Robert; 8. Pont de la Blaque; 9. Les Peyrards; 10. Baume de Boux; 11. Grotte de la Falaise; 12. Gargas; 13. Les Trecassats; 14. Pont de Redony; 15. Vallescure; 16. Baume Troucade; 17. Bau de l'Aubesier; 18. Deffend de Sault; 19. Pied de Sault; 20. Les Sablons; 21. Coquillade; 22. Bas Guillotte; 23. La Balate; 24. Peyvoullier; 25. Combe de Saume Morte; 26. Faraud; 27. Berigoule; 28. La Combette; 29. Station d'Oppede; 30. Abri des Briquets; 31. Verrieres; 32. Les Argiliers - Malaucene; 33. Grotte de Jarle. Inset shows the location of the region within France, to scale. Location data compiled from de Lumley-Woodyear (1969) and Fernandez (2006). Coordinates are given in UTM zone 31N. Elevation data: SRTMGL1 (NASA JPL). Country border data: Natural Earth. River data: European Environmental Agency.

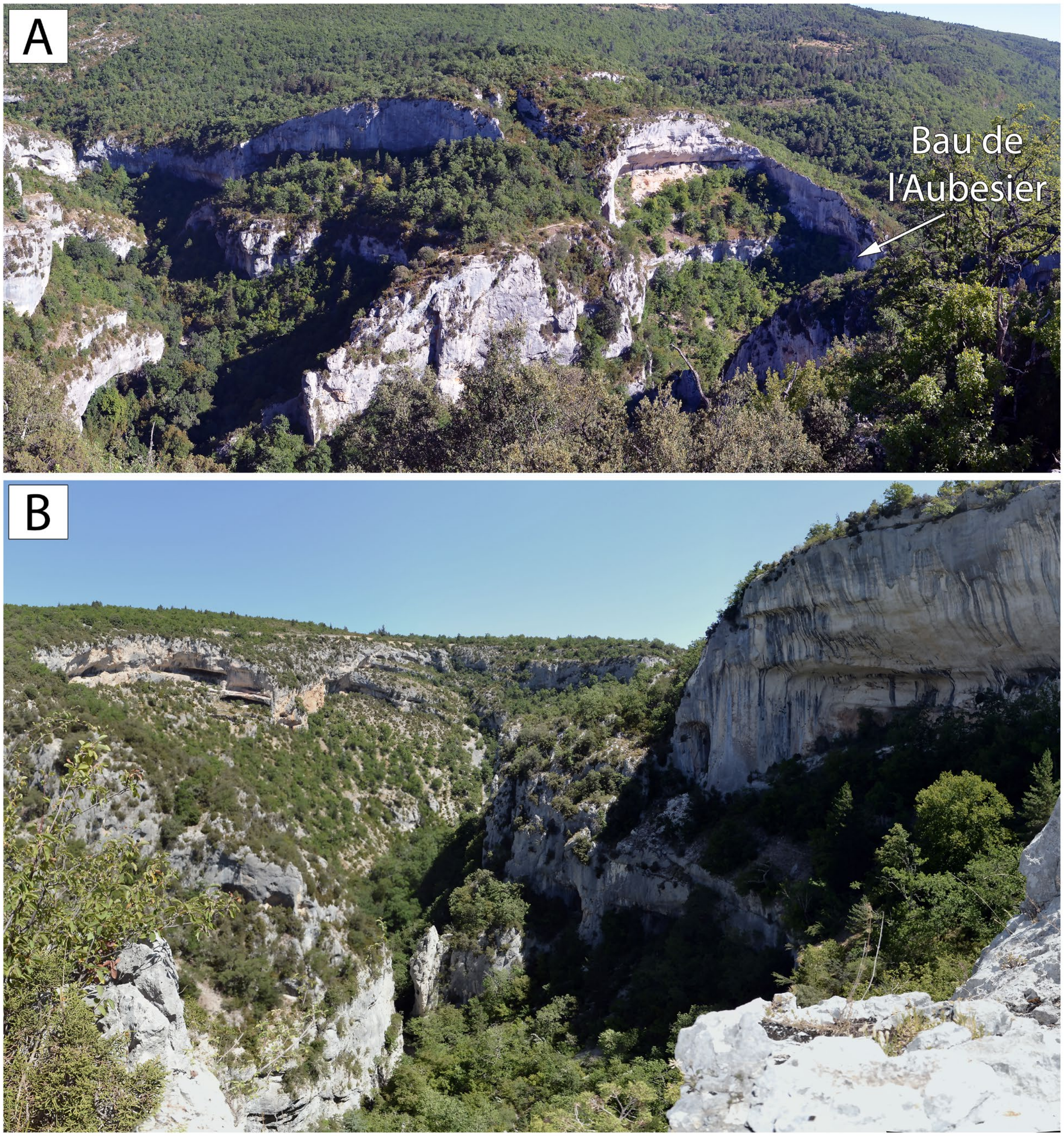

Figure 2: The gorges of the Nesque as seen from the north (A) and south (B) by the Bau. The arrow in figure A indicates the location of the Bau de l'Aubesier, and points at the lower slope excavations; the photograph in B was taken immediately above the site.

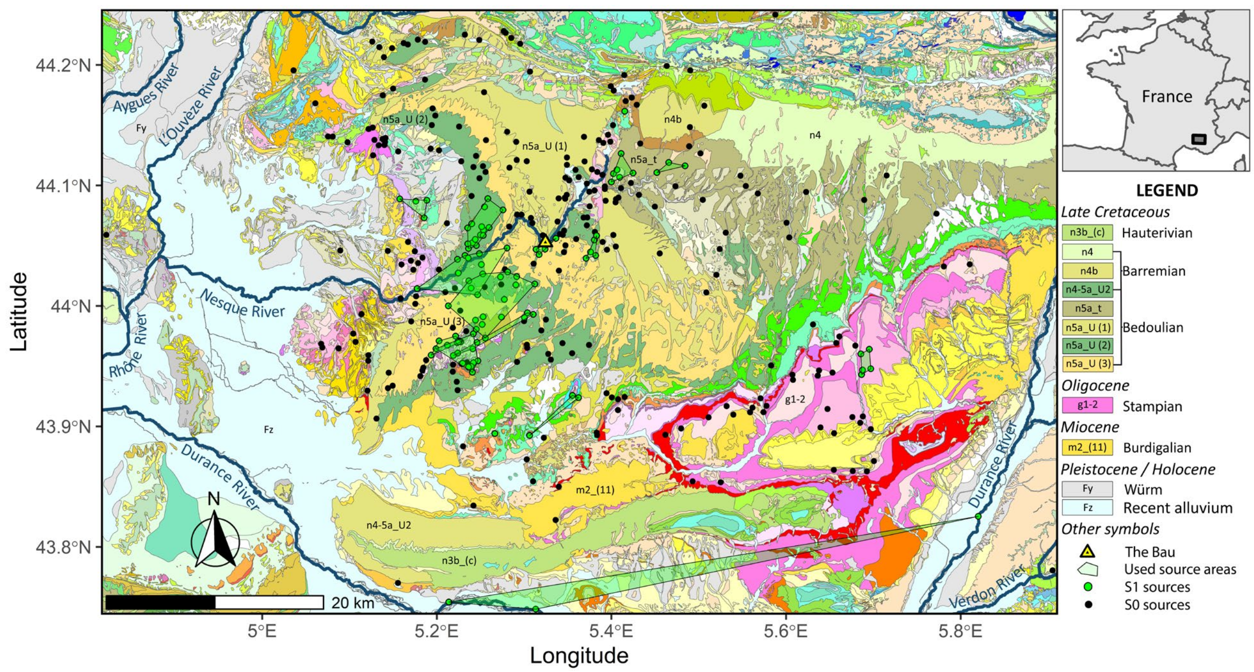

Figure 3: Geological map of the study region and sources of used and unused lithic materials. Geological data supplied by the French Geological Survey (BRGM); river data supplied by the European Environmental Agency.

2 History of research

The first excavations at the site were conducted by Franki Moulin along the western wall of the rockshelter (Figure 4), following a visit to the Bau with M. Bonnefoy in August of 1901 (de Lumley-Woodyear 1969: 384). Moulin excavated until 1903 and published an extensive 90-page report on the site in the same year (Moulin 1903) as well as a short summary in 1904. His 1904 summary included notes on stratigraphy, a one-page description on the lithic materials, which he estimated to include thousands of pieces and which he notes was dominated by points (Moulin 1904: 15), a brief discussion of faunal remains (15 species identified by Depéret), which included a *Homo* upper molar, and brief notes regarding recovered charcoal. As is made clear in the accompanying comments by Raymond and A. de Mortillet, the site was immediately seen as an important Mousterian locality (see Moulin 1904: 19).

Moulin's excavations covered an irregular area up to 16 m long and 6 m wide (see Figure 4a) within the rockshelter where, as noted above, sediments form a plateau (see Figure 7 for reference). Moulin left a section at the south-western limit as stratigraphic witness (Moulin 1903: 392) and described the sediments along two sections (lines 1 and 2 in Figure 4a), both reaching the same stratigraphic horizon consisting of sterile gravels at a depth of 185 cm in the north, closer to the talus, and 228 cm at the south (i.e., at the back of the rockshelter), where the top layers were thicker. He reported that below a thin (ca. 4 cm) earthy layer containing Neolithic pottery (Moulin 1903: 383), a mass constituted primarily of limestone elements of variable sizes contains the traces of habitation overlying the bottom gravels (Moulin 1903: 393). He considered these deposits to have accumulated over a substantial timespan during the Pleistocene (Moulin 1903: 390), and thought the habitation area was for the most part restricted to the investigated western section of the rockshelter, which may have provided, according to him, enhanced protection from winds and rain (Moulin 1903: 394).

Based on both artifact distributions and geological considerations, Moulin (1903: 396; see also Figure 5a) distinguished four distinct stratigraphic zones below a sterile layer he identified as *ab*[1] (ca. 45 cm thick in the northern profile), noting that the archaeological assemblage is perfectly homogeneous both in terms of fauna and tools (Moulin 1903: 394). At the top of the artifact-bearing deposits along the northern profile he identified a heavily agglomerated mass (labeled *ab*[2]), ca. 4 cm thick, which contained a few rare bones and flints. Below, he described a speleothem, denoted B and ca. 40 cm thick, that was rich in bone fragments intermixed with flint tools and abundant flint flakes. Moulin's layer B overlies layer C, constituted by a generally loose, black, dusty mass ca. 10-12 cm thick and very rich in organic residue of animal origin (Moulin 1903: 399) as well as abundant lithics and bone. The nature of fractures on the latter, as well as the arrangement of the former, found here, unlike in the other layers, piled on top of each other and resting on their flat surfaces and having remarkably fresh edges, suggested to Moulin that this layer represented a vast heap of refuse that was later compacted. He also thought this layer was deposited very quickly, perhaps, he speculated, in as little as 12 years (Moulin 1903: 400). Finally, at the top of the bottom gravels Moulin describes layer D, a very hard speleothem ca. 45 cm thick and constituted by a mix of limestone fragments, flint tools and small flakes, as well as faunal remains, although the bones are fewer and less heavily fragmented than in layer B. This layer is distinguished by having a blackish zone about 8-10 cm thick in the middle, denoted d^2 (see Figure 5a) which Moulin considered to reflect a momentary intensification of habitation. Charcoal in the two bottom layers C and D, belonging almost exclusively to a shrub (*Amelanchier*), suggested to Moulin that the vegetation in the immediate vicinity of the site was similar to what exists today (Moulin 1903: 431).

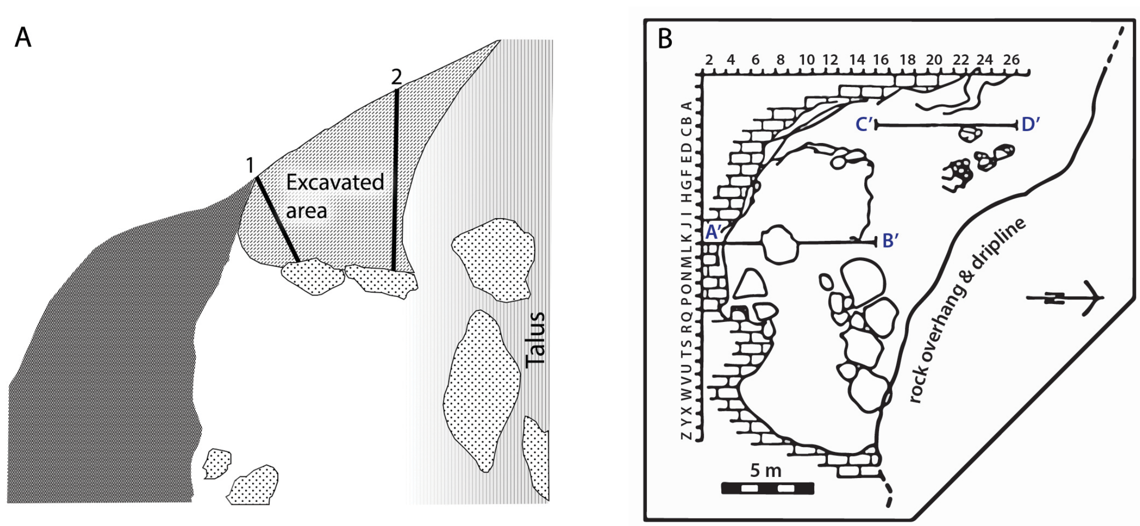

Figure 4: Partial and full plans of the rockshelter. Sub-figure A shows the area excavated by Moulin (16m long and up to 6m wide at 2 according to Moulin) and the location of the stratigraphic profiles (1 and 2) he describes; B shows the location of the stratigraphic profiles for the lower slope (C'-D') and trench L (A'-B') excavations conducted between 1987 and 2000 under the supervision of Serge Lebel. After Moulin (1903: 392) and Lebel (2000: 22; see Carmignani et al. 2017).

Subsequent investigations at the Bau were carried out after the Second World War, in the 1950s and 1960s, by Louis Gauthier, Bertrand Mary, and later de Lumley-Woodyear, who published a stratigraphic profile spanning the entire North/South extent of the site in 1969 together with a detailed description of the lithic assemblage. The stratigraphic profile published by de Lumley-Woodyear in 1969, partially reproduced in Figure 5b, retains Moulin's nomenclature for the uppermost layers but also shows the composition of the topmost sediments down the talus. It is accompanied by a short, half-page discussion. De Lumley-Woodyear considered the thick sequence to have been deposited very quickly at the end of Würm II (MIS 4-3). He thought that the alternating layers with large and smaller cryoclastic blocks reflected deposition under rigorous but variable climatic regimes, with seasonal and daily cycles of thawing and freezing respectively. These layers, he argued, subsequently underwent concretionary processes resulting in what are today very hard brecciated deposits (de Lumley-Woodyear 1969: 385).

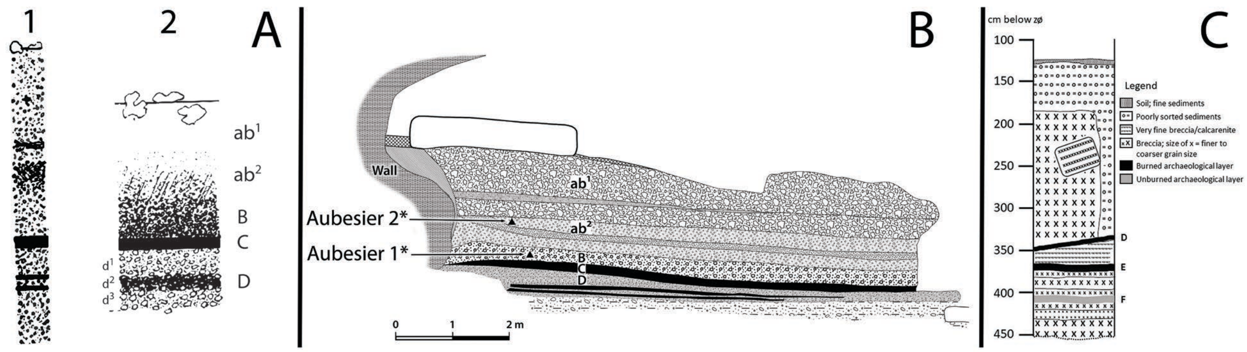

Figure 5: Stratigraphic profiles of the upper ('plateau') deposits. Subfigure A shows the profile published by Franki Moulin in 1903, edited to improve clarity (the numbers refer to the lines in Figure 4); subfigure B shows part of the profile published by de Lumley-Woodyear in 1969, redrawn and modified to correct an error in the attribution of the hominin finds (* the Aubesier 1 and Aubesier 2 labels do not appear in the original); and subfigure C shows a profile drawn in 1995 by Lucy Wilson from the Lebel excavations (personal communication, used with permission).

Most of what is known of the site today, however, comes from the extensive excavations carried out between 1987 and 2000 by a team led by Serge Lebel (two- to three-month seasons - Wilson and Browne 2014: 30). These latter excavations focused on two main zones (see Figure 4b and Figure 6): 1) trench L, in the center of the rockshelter in the upper part of the deposits, mostly excavated up to 2 m (Wilson and Browne 2014: 30); and 2) the lower slope deposits in front of the old Moulin trench, excavated inwards from the base (Wilson and Browne 2014: 30). It is these excavations that form the basis of the stratigraphic overview presented in the next section. Yet, before to discussing stratigraphic observations, it is important to first clarify some aspects of nomenclature.

The layers in the two excavated areas were defined and named according to different criteria by Lebel's team. In the western area, along the side wall, the floor of the old Moulin trench was named F, using alphabetic notation like earlier researchers. Above F, two layers (E and D) were defined early on by Lebel's team based on the archaeological concentrations observed at the bottom of the Moulin trench, and subsequently a layer C when abundant materials were encountered higher up in the deposits (Lucy Wilson, personal communication). It is important to note here that Lebel's layers C and D do not correspond to the layers C and D specified earlier by Moulin and de Lumley-Woodyear (see Figure 5); in fact, the relationship between the earliest stratigraphic descriptions and current ones remains unclear. Below layer F, and starting with the base of G, Lebel's team defined layers based on arbitrary z values, in one-meter depth intervals. When warranted, these layers were then subdivided according to sedimentological or archaeological criteria (Lucy Wilson, personal communication).

In trench L the layers were defined according to archaeological and stratigraphic criteria, as with other layers excavated on the upper plateau (i.e., by the Moulin trench). However, they were named using numerals instead of letters, because the correspondences with layers excavated by the Moulin trench were not known. Indeed, while Lebel undertook some further work at the site in 2006 to clarify how archaeological layers from the two excavated areas are connected to each other, certain aspects still remain unresolved (e.g., Wilson and Browne 2014: 30-31), and consequently different nomenclature continues to be applied to layers from trench L and the Moulin trench. It should also be noted here that Philippe Fernandes (2001: 15) defined a level 4 in his thesis, for the purposes of faunal analysis, which combines several layers from the site, including layer 4.

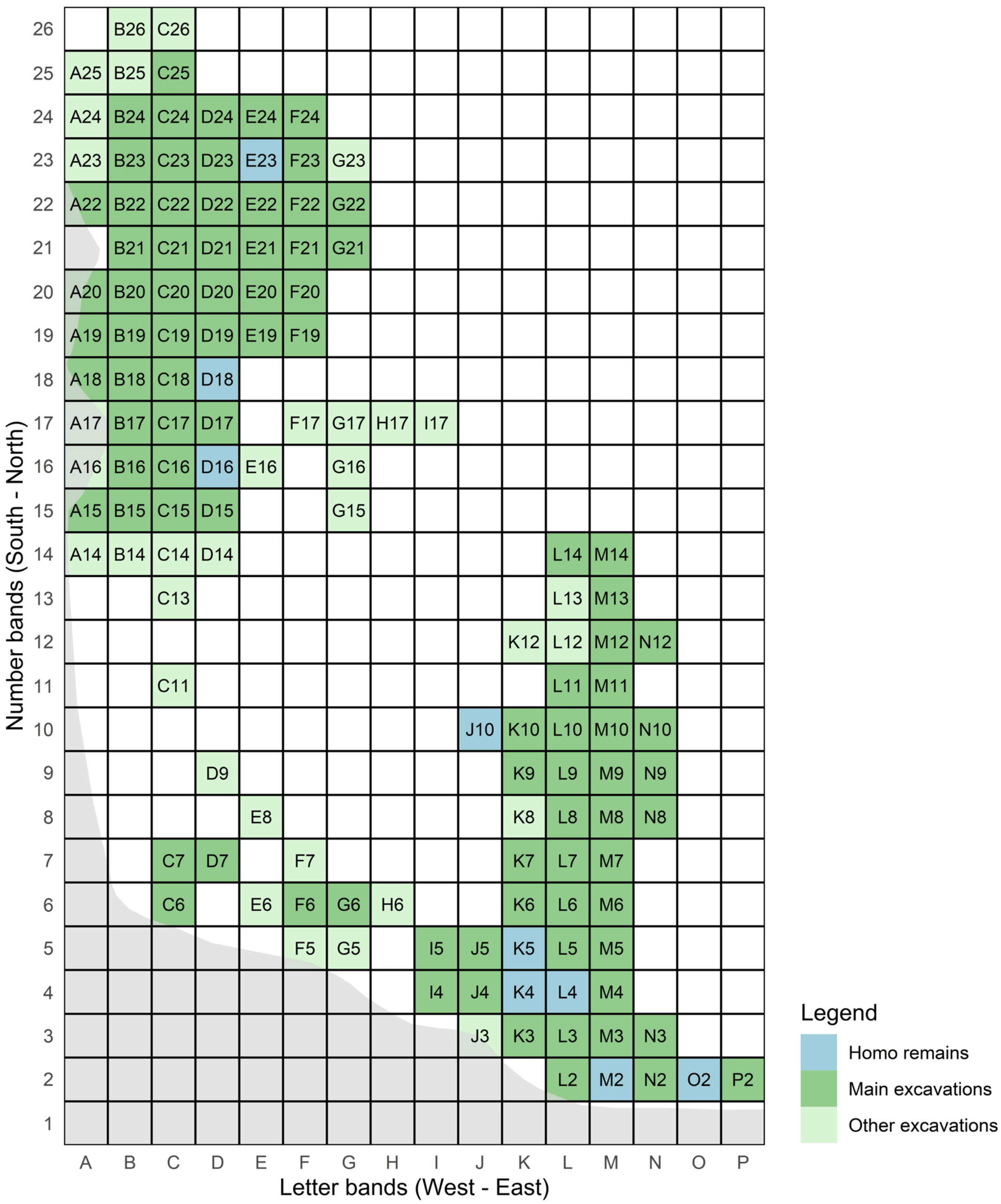

Figure 6: Partial plan of Lebel's excavations. Squares show in dark green denote the main excavated areas, while squares shown in pale green indicate other excavated areas for which I had access to some information; some areas excavated by Lebel's team are likely not included in this figure, nor are the excavations conducted by earlier researchers (e.g., Moulin). Grey denotes the rockshelter wall. Data for the figure were supplied by Lucy Wilson (personal communication).

3 STRATIGRAPHY AND THE AGE OF THE DEPOSITS

The oldest known sediments at the Bau were uncovered in a test pit excavated at the north-western margin by Lebel's team (see Figure 7). They were deposited during a cold phase (MIS 8 or earlier) and are sterile (e.g., Fernandez 2006: 14). At the time of their deposition the rockshelter would have been situated lower within the gorge of the Nesque than it is today, since rock fragments detached from the roof and walls by frost-cracking constitute the majority of the sediments at the site. Thus, both the ceiling and the floor of the rockshelter have shifted upward over time, while the rockshelter has become shallower due to a receding overhang (Lucy Wilson, personal communication). Nothing is known of the geological history of the Bau prior to the deposition of these sterile layers, since bedrock was not reached during excavations, but it likely extends back to the opening of the gorge of the Nesque, perhaps more than 5 million years ago (Lucy Wilson, personal communication).

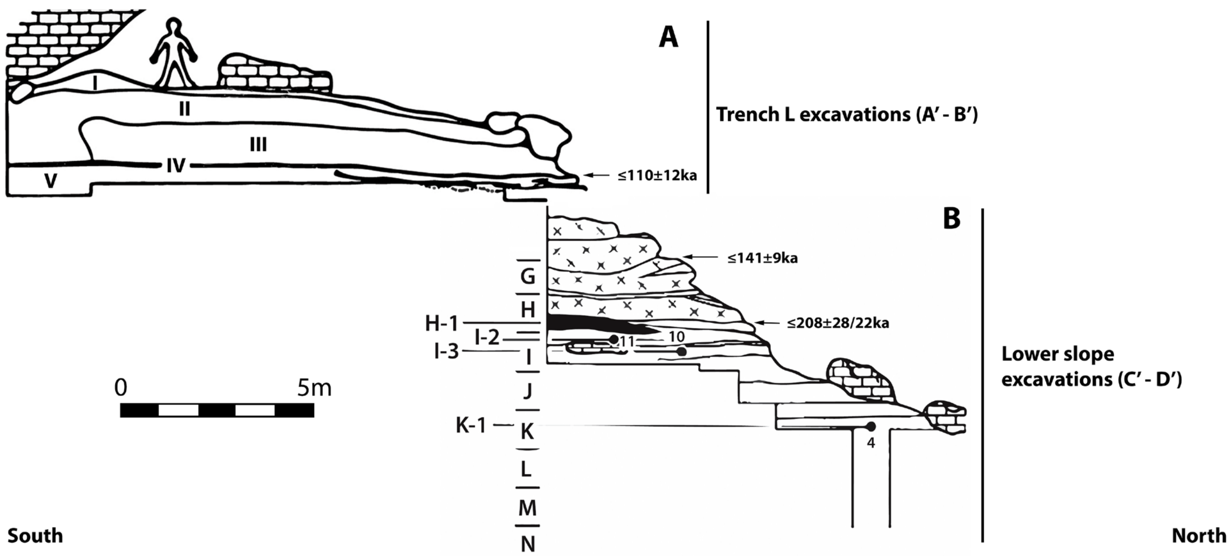

Figure 7: Stratigraphic profile of the Bau de l'Aubesier. The numbers 4, 10, and 11 indicate the locations of the respective Homo finds. Section A shows the trench L profile; section B shows the lower slope profile; refer to Figure 4 for more details. The partial set of dates corresponds to ages determined for speleothems (see main text). After Lebel et al. (2001: 11098), with modifications. Copyright (2001) National Academy of Sciences (original figure).

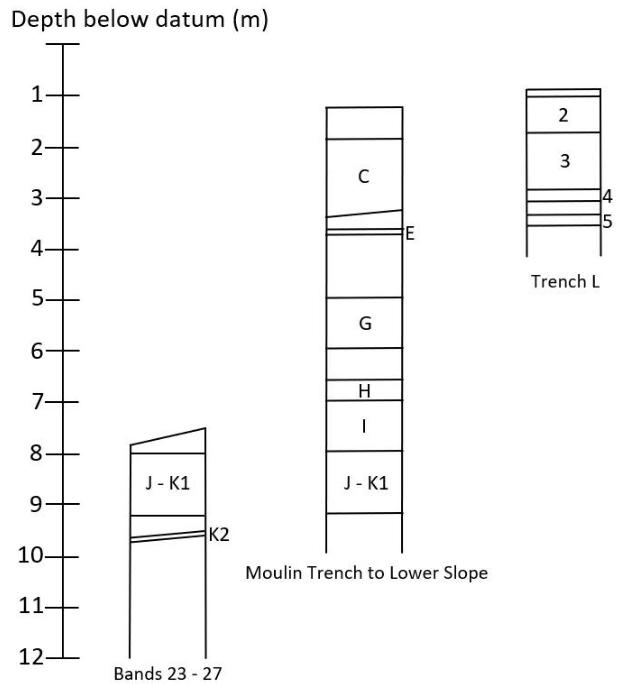

Figure 8: Simplified schematic of the stratigraphy at the Bau. Note that both roman numerals (e.g., Lebel et al. 2001) and Arabic numerals have been used to identify layers from trench L. Reproduced, with permission from Lucy Wilson, from Carmignani et al. (2017).

The earliest known archaeological layer has been named K2 (see Figure 8), and was also excavated by Lebel's team at the north-western margin of the site. It consists of fine-grained sediments that likely accumulated during a temperate phase of MIS 7 (Carmignani et al. 2017: 5) and which yielded abundant lithic and faunal remains. While some of the lithics from this layer are burnt - burned artifacts are a common feature throughout the entire sequence - no hearths were uncovered during excavations (Lucy Wilson, personal communication). Above K2, the second-oldest archaeological layer is J4-K1, a concentration of thousands of lithics and faunal remains that spans both sides of the arbitrary J/K boundary (see preceding section) in uncemented sediments at the northwest of the site. However, only limited information is available on this layer proper because publications have typically considered J and K1 together as a single unit. As a whole, J-K1 consists primarily of uncemented cryoclastic debris that likely accumulated during MIS 6 and perhaps the latter part of MIS 7 (see, e.g., Fernandez 2006: 97). These were later washed and reworked (e.g., Carmignani et al. 2017: 6), showing notable concentrations of artifacts only at the bottom (i.e., J4-K1 – Lucy Wilson, personal communication). Overall, J-K1 attests to the processing of at least 37 animals, mostly large herbivores (see Table 1).

Above layer J, more cryoclastic debris accumulated leading to the formation of the sediments of layer I. These have been divided into four sub-layers, with an indurated to cemented layer I4 at the bottom, and layers I1 and I2 at the top (Lucy Wilson, personal communication). This part of the excavated Bau sequence yielded a large number of faunal remains (MNI of 86 – see Table 1 below), particularly in the unconsolidated sediments found just below layer H (sub-layer I2). It also yielded a more modest (but still substantial) number of lithics, as well as hominin remains consisting of a tooth and a partial mandible (see next section). The faunal remains suggest an accumulation in a cold, dry, and generally open landscape, most likely during MIS 6 (e.g., Fernandez 2006).

The stratigraphy of the sediments that make up the arbitrarily defined layer H is complex, and they evidence changes in climate as well as intriguing behaviours not previously seen at the site, including the accumulation of a large number of unworked cobbles that were transported from the stream below and the intensive and very selective hunting (see Fernandez 2006: 98) of *Capreolus capreolus* (MNI = 8) and *Cervus elaphus* (MNI = 6). These behaviours are attested in the thick (30 – 45 cm), highly burned, and archaeologically very rich section that constitutes sub-layer H1, formed as a result of repeated, discontinuous occupations that were perhaps separated by centuries (Lucy Wilson, personal communication). Some sediments found at the bottom of layer H, and which resemble those found in the preceding layer I, were assigned to sub-layer H2, while above H1 the sediments of H consist of highly cemented breccia containing few artifacts (Lucy Wilson, personal communication). Overall, layer H appears to have accumulated at the end of MIS 6, as suggested by the available absolute dates (see below), and perhaps the beginning of MIS 5, as suggested by the fauna (Fernandez 2006: 97).

Layer H is covered by the thick and strongly cemented breccia of layer G, which marks the top of the slope deposits below the upper plateau. This breccia contains cryoclastic debris, like much of the rest of the sequence, and suggests deposition over a long period and under variable climatic conditions. Absolute dates (see below) obtained on two speleothems point to accumulation during MIS 6, but beyond this the information available on layer G is rather sparse; this section of the deposits received less attention both due to the difficulty of excavating it (it is very hard) and to the paucity of archaeological material it contained (Lucy Wilson, personal communication); indeed, habitation during the deposition of layer G is interpreted as sporadic and very short-term stopovers (e.g., Wilson and Browne 2014: 34) that seem to have involved *in situ* knapping and removal of processed products from the site (Lucy Wilson, personal communication).

The more recent sediments are known from excavations on the plateau. In the western section the information available from Lebel's excavations is relatively limited, since his team focused on trench L at the centre of the rockshelter. Nevertheless, it can be noted that the base of the old Moulin trench constitutes a distinct if poor archaeological layer named F by Lebel's team. The nature of the sediments, cryoclastic fragments mixed with variably indurated finer materials, indicates accumulation during a glacial period, although a more temperate phase than generally attested by layer G (Lucy Wilson, personal communication); moreover, based on the lithic assemblage hominins appear to have visited the site sporadically, if perhaps for slightly longer periods than during the deposition of G. Above F, and above a sterile section ca. 35-40 cm thick, a relatively thin and nearly horizontal layer of soft, burned sediments is found (Lucy Wilson, personal communication). This layer, rich in archaeological materials, was labeled as layer E by Lebel's team, and may correspond to parts of Moulin's layer D. Above Lebel's layer E is a strongly cemented fine-grained breccia 10 to 35 cm thick, on top of which a black layer of soft, fine-grained sediments with abundant archaeological materials accumulated (Lucy Wilson, personal communication). This corresponds to Lebel's layer D, and possibly to Moulin's layer C. Above, more cryoclastic sediments were deposited, reworked, and later cemented into breccia, making up what may be described as the hodgepodge of sub-layers (Lucy Wilson, personal communication) that corresponds to Lebel's layer C.

In the eastern excavated area, along trench L, the picture is clearer. The oldest sediments known in this section are attributed to layer V, located under the same fine-grained breccia that is found above Lebel's layer E in the western sector, although there is no clear equivalence between any of the layers excavated by the Moulin trench and layer V. The sediments are mostly loose, coarse rock fragments mixed with mainly unburned lithics and faunal remains, which overall indicate cool environmental conditions. Above layer V, and above the fine-grained breccia, lies layer IV, which may be the lateral equivalent of Lebel's layer D in the western excavated area, and possibly Moulin's layer C, but the information preserved from Lebel's layer D is insufficient to reach firm conclusions (Lucy Wilson, personal communication). In any case, this ca. 15-20 cm thick layer extends over at least 40 m^2 (Lucy Wilson, personal communication; see also Blackwell et al. 2001: 722) and is dominated by archaeological materials; it is the richest at the site, having yielded ca. half of the lithics recovered by Lebel's team, it is highly burned, and most likely represents a palimpsests of occupational episodes (Lebel, 1994 qtd. in Fernandez 2006).

After the deposition of this very rich layer IV, cold conditions caused frost-cracking of the rockshelter wall and ceiling, leading to the accumulation of cryoclastic fragments that were later cemented into breccia and/or washed during subsequent warmer phase(s) (Lucy Wilson, personal communication). This breccia, named layer III by Lebel's team, has a complex stratigraphy and has yielded relatively few archaeological materials. These have been interpreted as representing palimpsests of multiple occasional, short-term stays, as the lithics seem to mostly reflect toolkit maintenance (Lucy Wilson, personal communication). Above layer III, which may be equivalent to Lebel's layer C in the Moulin trench, the loose cryoclastic sediments of layer II contain scattered but relatively abundant archaeological materials, some of which show clear signs of movement and alteration by free-flowing water (Lucy Wilson, personal communication). Overall, the assemblage from layer II represents a palimpsest of occupations by highly mobile people who brought in materials from distant sources but also used local ones to a greater extent than seen in any other layer at the site (Lucy Wilson, personal communication). Parts of layer II may also correspond to Lebel's layer C (e.g., Wilson and Browne 2014: 30), but this layer may well simply be missing by the Moulin trench (Lucy Wilson, personal communication). Layer II, was covered by a thin deposit of recent sediment and, like in the Moulin trench (e.g., Moulin 1903, 1904) some fragments of pottery were found (Blackwell et al. 2000: 346).

From 1989 onward samples were collected for dating purposes; these included teeth for ESR, recovered from layers IV in trench L and layers D to J4 in the western excavated area (C'-D' in Figure 4b), speleothem samples for $^{230}Th/^{234}U$ dating from layers IV (trench L) to H1, and six flints for TL dating from layer H1 (e.g., Blackwell et al. 2000, 2001; Lebel et al. 2001; see also Richter 2011). Overall, the chronology is somewhat uncertain because no dates are available from the topmost or lowermost layers, multiple scenarios can account for the ESR dates, in part due to the lumpy nature of the sediments (Blackwell et al. 2000: 358), and the speleothem dates likely indicate maximum ages (Blackwell et al. 2001: 738). However, for layer IV the teeth suggest an age of 90±30 ka (assuming linear uptake of U) while $^{230}Th/^{234}U$ dates on a speleothem indicated a maximum age of 109.8 +12.5 / -11.2 ka at 2σ (Blackwell et al. 2001: 742). Moreover, a date of 141±9 ka for a speleothem recovered from the top of layer G brackets layer D, located somewhat lower than layer IV (Blackwell et al. 2001: 721), to an age between 90 and 140 ka (Blackwell et al. 2001: 742). On the other hand, three teeth from the lowermost dated layers, J2-J4, yielded ages that seem to underestimate their true age (the oldest date was 170±37 ka at 1σ), possibly due to secondary diagenesis (Blackwell et al. 2001: 752). Considering the dates obtained for overlying layers, however, Blackwell et al. (2001: 751) suggest layers J2-J4 "should exceed 160-180 ka and might be as old as, or slightly older than, 208+28/-23 ka (Blackwell et al. 2001: 742), an age that is consistent with the TL dates obtained for layer H1, and which range from an average minimum and maximum of 169±17 ka and 191±15 ka respectively (Lebel et al. 2001: 11098). Overall, then, the available dates indicate that the Middle Palaeolithic deposits at the Bau likely accumulated over a timespan of some 100,000 years or more (see also Wilson and Browne 2014: 30-31).

4 The archaeological evidence

4.1 Fauna

The first to report on the faunal material from the site was Moulin (1903; 1904), who listed a total of 13 mammalian species as well as some gastropods following determinations by Depéret. A somewhat expanded list appears in de Lumley-Woodyear (1969: 385), who also included qualitative information on their relative abundance. Further analyses of the faunal material were carried out in the late 1980s and 1990s by Faure et al. (see e.g., Fernandez 2006: 18), and subsequently by Fernandez (e.g., Fernandez 2001; Fernandez and Legendre 2003; Fernandez 2006; Fernandez et al. 2006), who assessed, for all ungulate taxa and among other aspects, the degree of preservation of the materials as well as the procurement strategies they evidence. In total, Fernandez (2006: 9) recognized 19 species in the assemblage, of which four belong to the order carnivora. These latter are represented by few remains (NISP = 49), and two (*Canis lupus* and *Lynx lynx*) are reported to occur only in what Fernandez referred to as layer II (Fernandez 2006: 18; Fernandez 2001: 22).

The overall picture that emerges is therefore of a sequence that is very rich in ungulates - over 2700 identifiable ungulate teeth and bone specimens, accounting for a minimum of 241 individuals (see Table 1), are discussed by Fernandez (2006), – and very poor in carnivores. The mortality profiles of the herbivores strongly suggest hunting rather than scavenging as the primary procurement strategy (Fernandez and Legendre 2003: 1584), and there are, generally speaking, very few traces of carnivore activity (see Fernandez 2001: 175 and 178). Conversely, numerous traces of anthropic modification are visible on the cortical surfaces of bones (e.g., Fernandez in Texier 2004: 86) which, at least in layers H1 and IV, were also used as fuel (Fernandez in Texier 2004: 86). Fernandez suggests hunting was likely collective and probably occurred on the plateau above the site or along the rugged escarpments surrounding it (Fernandez in Texier 2004: 86).

The represented ungulate species, often co-occurring in the same layers (Table 1 – see also Fernandez 2001: 262), are characterized by different predator avoidance strategies, different seasonal behaviours, and different types of home ranges, including open flats (e.g., horses, aurochs), rugged and steep terrain (e.g., tahr, ibex), and at least somewhat wooded areas (e.g., medium and small-sized cervids and wild boar). In general, animals appear to have been hunted when most abundant and most vulnerable, using hunting strategies adapted to the different taxa (Fernandez 2001). In certain layers at least, where the season of death can be established for multiple species, the Bau appears to have been inhabited at various times of the year. In layer H1, for example, chamois and tahr were likely hunted from late fall to late winter/spring (Fernandez 2001: 68, 85), horse in the summer and early fall (e.g., Fernandez 2001: 172), and roe deer between March and July (Fernandez 2001: 194); other species, such as auroch and red deer, may have been hunted throughout the year. With several taxa (e.g., horse, tahr, auroch) evidence points to systematic butchering (Fernandez 2001).

The assemblage is richest in horses and aurochs, both well-represented throughout the sequence (Table 1). Selective hunting targeting prime-age individuals characterized the procurement of these large herbivores, likely on the plateau above the shelter (Fernandez 2001). The available evidence suggests that horses were hunted seasonally (ca. July-September) throughout the sequence (based on 25 teeth, mostly from layers H and I), while the total absence of juvenile aurochs teeth indicates slaughter outside the birthing period (most frequently April-June – see Fernandez 2001: 124). Diachronic trends are also evidenced in the Bau sequence, as adult (6-15 year-old) horses attain the highest frequencies in layers H, I, and J, whereas the remains from the upper layers suggest selective hunting of younger and older animals (Fernandez and Legendre 2003: 1585).

It is important to note that the faunal remains have been subject to substantial post-depositional alteration throughout the sequence, but particularly in the basal layers. Such alteration resulted from factors such as exposure to water, episodes of freezing and thawing, intense charring in certain layers, and sediment compression (Fernandez 2001: 58). These factors complicate the identification and interpretation of anthropic alteration, which included fracturing bone (very common) for marrow extraction (e.g., with tahr – Fernandez 2001: 73 – or horse – Fernandez 2001: 178), cutmarks attesting to defleshing and probable removal of tendons (e.g., Fernandez 2001: 254), and using bone as fuel in layers H and IV (e.g., Fernandez 2001: 260). It also complicates the interpretation of carcass processing strategies, as for several taxa (e.g., horse, aurochs) the best represented anatomical parts are those with low nutritional value. Fernandez has argued that this is due to strong differential preservation rather than transport of desirable parts off-site (e.g., Fernandez 2001: 257), but in any case it is clear that the number of individuals recognizable in the assemblage, though large (Table 1), likely substantially underrepresents the true number of animals butchered at the Bau.

Table 1: Summary of faunal data for some of the represented ungulates, by layer. Data compiled from Fernandez (2006). Note: that B3[1] may represent a coding error and refer to 3B (i.e., IIIB) instead (Lucy Wilson, personal communication)**.**

Layer	M. giganteus	D. dama	C. elapus	C. capreolus	Equus	S. scrofa	B. primigenius	R. rupicapra	H. cedrensis	Total
	MNI	MNI	MNI	MNI	MNI	MNI	MNI	MNI	MNI	
I										
II			1	3	1		1	1		7
IIB								1		1
III							1			1
IIIC				1						1
IVA			1				1			2
IVM			1							1
IVP		1	2		2		1			6
IV	1	2	6	2	5	1	5	1		23
V	1	1	1		2		1			6
B3[1]							1			1
C								1		1
C1		1								1
E			1		1		1			3
F			1		1					2
G				1						1
H			1		1					2
H1	2	1	6	8	10		9	2	11	49

H2		1	1	2	3		2	1		10
I			1		2		1			4
I1	1				1	1	2		1	6
I2	2	1	3	2	11	2	8	1	4	34
I3	2	2	3		4	1	11		1	24
I4	1	1			5	1	8	1	1	18
J			1		2		1			4
J1	1				2		5			8
J2		1		1	2		6		1	11
J3					2		2			4
J4				1	3		2	1	1	8
K1					1		1			2
K2										0
Total	11	12	30	21	61	6	70	10	20	241

4.2 *Homo* remains

The human remains recovered from Bau de l'Aubesier, all considered to belong to the Neanderthal lineage with the probable exception of the Aubesier 3 incisor, consist of several isolated deciduous and permanent teeth as well as a partial mandible (e.g., Lebel et al. 2001: 11098; Lebel in Texier 2004: 87). As noted in section 2 above, the first human remains at the site were discovered early on by Moulin at the base of his layer B (Moulin 1903: 417). Unfortunately, the molar in question, a right dm^2 without pathologies and thought to have been shed naturally pre-mortem, by a 10- or 11-year-old child (Moulin 1903: 400, 417-422), is now lost (de Lumley-Woodyear 1969: 385). A second tooth, a left P_2, was found in 1964 by Bertrand Mary (de Lumley-Woodley 1969: 385) in what appears to be Moulin's layer *ab²* (see Figure 5). The rest of the human remains were discovered during the 1994 and 2000 excavation seasons (Lebel et al. 2001: 11097). The Aubesier 4 (I^2), 5 (dm^1), 10 (M^1 or M^2), 12 (M^1 or M^2) teeth, as well as the Aubesier 11 mandible were described in detail in a series of publications in the early 2000s (Trinkaus et al. 2000; Trinkaus et al. 2000a; Lebel et al. 2001; Lebel and Trinkaus 2001, 2002a). The other teeth include Aubesier 6 (dc^1, shed post-portem) and 9 (I^2, shed post-mortem), which could possibly belong to the same individual as Aubesier 12 (Lebel and Trinkaus 2002b: 556), Aubesier 7 (dm^2, shed pre-mortem), and Aubesier 8 (dm^1), all recovered from upper layer IV, towards the back of the layer (Lebel in Texier 2004: 87; Lucy Wilson, personal communication).

Lebel et al. (2001: 11098) note that Aubesier 4, 10, and 11 were found in the lower slope excavations (see Figure 7) in layers K-1, I-3, and I-2 respectively, while the rest were recovered from layer IV (Aubesier 3 was found in layer II – Lucy Wilson, personal communication). These remains belong to individuals of various ages, from immature (e.g., Aubesier 1, 5, 6, 8, 9, and perhaps 12) to prime age adults (Aubesier 4, 10), to possibly quite an old individual (Aubesier 11). They are remarkable in that two of the teeth (Aubesier 5 and 12) show evidence of caries, Aubesier 4 at least shows wear consistent with heavy non-masticatory use, and Aubesier 10 shows evidence of some dental care. The partial mandible shows extensive antemortem lesions which occurred some time before death and would have functionally compromised to the point that Lebel et al. (2001) suggested may have required care by other group members.

4.3 The lithic assemblages

Henry de Lumley-Woodyear (1969: 386) published a Bordian analysis of the sizable collection of lithics recovered by Louis Gauthier between 1950 and 1957. Those materials would have originated from the upper deposits first investigated by Moulin. Based on de Lumley-Woodyear's report, the collection included a minimum of ca. 1,340 complete or proximal flakes; however, the total number of examined pieces is unfortunately not specified. He classified the assemblage as Typical Mousterian of Levallois facies rich in scrapers (de Lumley-Woodyear 1969: 396) and suggested a late age, specifically the end of Würm II (i.e., MIS 4-3). To de Lumley-Woodyear it was evident that substantial reduction occurred outside the site and that raw materials were brought in primarily as good quality flakes. Despite this, he notes, cores are abundant, with ca. 12-13 large flakes, and ca. 4 tools per core (figures given as percentages in the original). De Lumley-Woodyear classified most of these cores as atypical (41%), with Levallois ones constituting only ca. 10% of the core total despite the very high Levallois Index (IL) of the assemblage (75.1 – de Lumley-Woodyear 1969: 386). Overall, he considered the lithic assemblage from the entire then-known sequence to be very homogeneous (de Lumley-Woodyear 1969: 386). As Texier (2004: 89) points out, however, the scientific value of de Lumley's conclusions is limited because the stratigraphic provenance of the analyzed materials is uncertain.

Further techno-typological analyses, preliminary in nature (Wilson and Browne 2014: 29), appear in a report on the 1988-2000 excavations presented by Lebel to the French Ministry of Culture and Communication in 2000. This unpublished report, briefly summarized in Wilson and Browne (2014) and also discussed by Texier (2004), included information on 4,118 technologically and typologically identifiable pieces from layers 2 to 5, C, and H to K1 (see Figure 7), including 882 cores (251 Levallois, 631 non-Levallois). Texier (2004: 89-90) notes that the material systematically recovered by Lebel's team amounted to more than 80,000 pieces of debitage, mostly (79-98% depending on the layer) small (1-3 cm), as well as 3,580 cores and shaped tools, with retouch present on 2-20% of blanks depending on the layer (Texier 2004: 91). Many of the lithics - over 44,000 pieces of debitage, mostly <2 cm (Fernandez 2006: 15), and ca. 2000 cores and retouched flakes (essentially all scrapers) - come from layer IV, a layer characterized by a high laminar index, short blades, and an important component of Upper Palaeolithic types (Texier 2004: 90). Layer H1 is also rich, having yielded almost 9,000 lithics (ca. 10% >1 cm) and more cores than layer IV (Texier 2004: 90); Texier (2004: 90) notes that a substantial portion (ca. 30%) of the cores from H1 are Levallois, and that, in general, this layer, the richest in lithics from the lower sequence (i.e., the slope deposits), is similar typologically to layer IV. Overall, the absence of cortical debitage suggests cores were partially reduced at provisioning locations, but their relatively high number in the assemblage, and the large number of small pieces present, is interpreted as indicating on-site reduction (Texier 2004: 90), echoing early observations by Moulin (1903: 408).

Subsequent techno-typological analyses of the lithic materials recovered from Lebel's excavations, as well as of some of the older collections, were conducted by Lucy Wilson and students in 2013 and 2014. These are to be published in Lucy Wilson's upcoming book. More recently, Carmignani et al. (2017) published an analysis of 3,249 lithics from the lower layers J and K. These latter analyses allow for some general observations:

1. Most of the pieces consist of debris, indicating substantial *in situ* flaking. At least for the lower layers J and K, the *in situ* flaking activity has been described as intense (Carmignani et al. 2017: 8). In these lower layers there are, on average, 11 flakes greater than 20 mm per core.

2. Retouch is rare, and at least in the lower layers J and K, it seldom modifies the shape of the blanks when present (Carmignani et al. 2017: 23). Indeed, formal tools in these layers are reported to be rare (Carmignani et al. 2017: 28).
3. Carmignani et al. (2017: 5) report that only a few pieces could be refitted, possibly indicating off-site discard.
4. The material is relatively fresh and not suggestive of displacement or strong crushing (Carmignani et al. 2017: 5).
5. A majority of the lithics were made on flint procured from relatively substantial distances from the site (>5 km) and often brought in as nodules or cores, at least in the lower layers. In these layers Carmignani et al. (2017: 37) note that raw materials from distant sources are well-represented through all stages of the *chaîne opératoire*.
6. Some diachronic changes are evidenced in technological behaviours, at least in the lower layers.

The analyses conducted by Wilson and her students in 2013 and 2014 indicate that substantial *in situ* knapping is characteristic of much of the Bau sequence, not just the lower layers, with at least some raw material types being represented at all stages of the reduction sequence (Lucy Wilson, personal communication). This is despite the fact that only in layer II does the proportion of stone procurable near the Bau exceed 7%, even then representing only 15% of the assemblage total (Lucy Wilson, personal communication). While Wilson's analyses do indicate further changes throughout the rest of the sequence, reflected for instance in the degree to which different raw material types were exploited (Wilson and Browne 2014; see also next section), they also highlight that these changes should be viewed against a background of substantial continuity. Indeed, the same major raw material types were consistently exploited, even if in different proportions and even if some layers reflect a greater diversity of raw materials than others; along the same lines, the proportion of local raw materials remains very low throughout the sequence. Blades and Levallois products continue to be present, the proportion of formal tools remains broadly similar, and burned lithics and bones are a consistent feature of the assemblages despite the lack of other evidence for fire use in some of the layers. In brief, some of the general observations noted above for the lower layers are broadly applicable to the entire sequence. With others (e.g., refitting), the information to which I have access is not detailed enough to allow for further comments. It is important to note, however, that occasional examples of double patina, or partially patinated artifacts, point to at least some degree of recycling (Lucy Wilson, personal communication), and that some aspects of the assemblages indicate tool maintenance and repurposing (Lucy Wilson, personal communication).

5 LITHIC RAW MATERIAL PROCUREMENT AT THE BAU

The lithic materials used at the Bau are virtually all flint (e.g., Wilson and Browne 2014: 33). Concerns regarding the source of the raw materials used at the site extend back to the very first investigations conducted by Moulin. Indeed, in his 1903 publication he devoted six pages (403-409) to a discussion of flint-bearing formations in the region and the incidence and utilization of sources. Through his investigation of the area surrounding the Bau he identified a potential source for two cores from layer D (1903: 397, 408); these, he suggested, were roughly worked at the source and then reduced at the Bau, as indicated by the abundance of small flakes (408). Such early efforts notwithstanding, it was only with Lucy Wilson's work at end of the 20th century that lithic raw material use at the site became well-known.

In 1987 Lucy Wilson began a survey project aimed at identifying and characterizing potential raw material sources in the region surrounding the Bau (e.g., Wilson 2007a: 389). Over the course of more than two decades Wilson sampled and systematically described 350 primary and secondary raw material deposits, containing mostly Cretaceous and Oligocene flints (see Figure 1). She has also analyzed over 40,000 archaeological pieces of types all sizes from throughout the sequence, including over 23,000 lithics recovered from the upper layers II-V in the trench L excavation, the majority (> 20,000) from layer IV, and ca. 16,000 from layers C to K2 along the western wall (see Figure 7; see also SOM 2 in Wilson and Browne 2014).

Wilson (2007b: 318) reports that geological samples collected at each potential source were characterized primarily by means of macroscopically visible features and through petrographic analyses of thin sections, supplemented by limited geochemical data and focusing on properties such as microfossils that can be used to distinguish materials by age and depositional environments. Archaeological artifacts on the other hand, were classified by Wilson into distinct types based primarily on characteristics "visible to the naked eye or under a hand lens" (Wilson and Browne 2014: 33) and under field conditions (Wilson and Browne 2014: 31). Petrographic analyses of thin sections from the identified types complemented these characterizations (e.g., Wilson and Browne 2014: 33; Browne and Wilson 2011: 599). The artifacts were initially classified into 32 distinct variants with known sources in the region, as well as 7 types whose provenance is undeterminable due to weathering or burning, and 7 types from unknown sources (see Browne and Wilson 2011: 599).

The 32 variants known to occur throughout the region could ultimately be traced to some 101 locations within 17 "source areas" (see Browne and Wilson 2011), with more than one location often containing indistinguishable raw materials and with more than one variant possibly occurring at a given location. In total these variants accounted for only 15,674 artifacts, most lithics being impossible to source due to various types of alteration (see also Texier 2004: 90). The percentage of undeterminable lithics varied by layer, from between ca. 89% in layer E to ca. 31% in layer G with a mean of ca. 60% (see SOM 2 in Wilson and Browne 2014), but there is no evidence of differential alteration across flint types, so the sample of sourced artefacts is considered to be representative (Wilson and Browne 2014: 33). The number of artifacts which were procured from unknown sources, on the other hand, is very small, amounting to only 171 artifacts (Lucy Wilson, personal communication). Overall, the Bau appears to be quite centrally located within its raw material supply zone (see Figure 1), with most artifacts made from raw materials found within 13 km of the site, but seldom closer than 10 km (e.g., Wilson et al. 2018: 96).

The resulting database, which is very large and comprehensive compared to that available for most other Middle Palaeolithic sites, enabled a series of publications that not only elucidated raw material procurement at the Bau, but also made important theoretical and methodological contributions. Thus, in 2007, Wilson examined terrain difficulty (kcal/km) as an explanatory variable for source utilization (Wilson 2007b; see also Wilson 2003) and demonstrated that, at least at the Bau, it affected procurement choices. In the same year she introduced an equation aimed at quantifying the attractiveness of potential raw material sources when considering intrinsic properties (i.e., geological, geographic) alone, and proposed using the resulting values in a gravity model that accounted for distances as well (e.g., between potential sources and sites - see Wilson 2007a: 402). The two-fold goal of this latter publication was to assess the degree of fit between the actual use of sources at the Bau and their calculated attraction values, in order to better understand the human factors (as opposed to physical factors) that shaped procurement, and to present a method of determining areas where specific sources should have been used given the presence of competing neighbours. Wilson demonstrated the utility of the approach considering 11 sources represented in layer IV at the Bau (Wilson 2007a: 400-401).

A subsequent publication with Constance Browne in 2011 aimed to overcome some limitations of the developing approach by considering optimal weighing of the variables included in Wilson's 2007 equation, adding new predictors, assessing different ways of evaluating access costs, expanding the number of considered sources to all for which data was available, and including combined provenance data from multiple layers. This work was based on the formulation and evaluation of generalized linear models that simultaneously considered the influence of the different variables, and treated sources of indistinguishable raw materials together as 'source areas' (110 in total - a number eventually increased to 122 - 17 of which are represented at the Bau; see above, and Browne and Wilson 2011: 600). This latter feature constituted an important deviation from the earlier work, since a representative source, ultimately the one with the highest quality raw materials (Browne and Wilson 2011: 605), had to be selected to describe each source area. Overall, this work indicated that hominins at the Bau were selectively procuring raw materials from sources that were easy to access and contained abundant and easy to find larger (>16 cm), high-quality rocks (see Browne and Wilson 2011: 601, 605), evidencing an optimizing behaviour in line with expectations from optimal foraging theory.

The aforementioned publication also set out plans to apply the model to individual layers within the site, and to other sites in the region (Browne and Wilson 2011: 606). These goals would be addressed a few years later (Wilson and Browne 2014; Wilson et al. 2018), with an intervening publication by Browne and Wilson in 2013 aimed at clarifying the observation that calculating travel costs from sources to the Bau along straight-line routes resulted in better models of source attractiveness, or resource selection, than using least-cost routes computed in ArcGIS (Browne and Wilson 2011: 605). The authors therefore assessed the effects of using different map resolutions and different ways of computing travel paths, and found that, at least at the Bau, models using Shuttle Radar Topography Mission (SRTM) data and straight-line routes indeed provided better results than using higher resolution digital data (provided by SPOT) and/or least-cost paths.

The application to multiple archaeological layers from the upper and lower sequences was reported by Wilson and Browne in 2014. That publication examined diachronic changes in the contribution of included predictors and in the choices of source areas, finding no striking differences in the latter, but identifying an abrupt change in the former: the characteristics of the raw materials themselves (quality, size) appear to have become suddenly more important in the upper layers (II, III, IV, V, and C), deposited after ca. 141 ka ago (see also section 3 above), than in the older, lower layers where terrain variables contributed most to resource selection (Wilson and Browne 2014: 35). Similar albeit more gradual changes were also noted in the faunal and techno-typological lithic data, with the younger deposits evidencing an increasing emphasis on smaller prey and a more intense utilization of the raw materials echoed in lower proportions of cores, tools, and Levallois products (see Wilson and Browne 2014: 36).

Wilson and Browne interpreted the findings in terms of Kuhn's (1995) schema of contrasting provisioning strategies (i.e., of places and individuals). They suggested that the lower layers at the Bau represent longer-term occupations, when the site itself tended to be provisioned with raw materials that were somewhat easier to procure, whereas the upper layers may represent shorter-term occupations by hominins more concerned with the quality of their mobile toolkits. The change, reflecting perhaps a re-organization of the economy, may have been triggered by the harsh climate of late MIS 6, evidenced first in changes to aspects of hominin adaptation that shaped raw material procurement, and then more gradually in prey choice and technological behaviours. An alternative briefly considered by the authors is that the differences reflect two hominin populations, or even species (Wilson and Browne 2014: 36), but as they note there is no need to invoke such explanation. Indeed, it is important to consider the observed trends against a background of substantial continuity throughout the sequence (see section 4.3). It is also important to keep in mind that the abrupt change from the lower to the upper deposits is evidenced in the quantity of pieces ultimately derived from specific source areas rather than their weight, and the number of by-products (e.g., debris) generated with increasing reduction is not proportional to their mass, which complicates interpretation.

More insight into raw material procurement at the Bau came from the comparison ensuing from the first application of the approach to another site, namely La Combette (Wilson et al. 2018). This smaller rockshelter, containing younger (ca. 60-78 ka) and rapidly accumulated deposits (see Wilson et al. 2018: 90), is located in the same region as the Bau but in easier terrain and at the southern fringes of its raw material provisioning zone (Wilson et al. 2018: 88; see also Figure 1). The comparison revealed that while site catchments (*sensu* Higgs, see Bailey and Davidson 1983) were of roughly similar size (ca. 1600-1700 km^2) and display substantial overlap (Wilson et al. 2018: 97), the most intensely exploited sources (>10 artifacts, corresponding perhaps to the site exploitation territories *sensu* Bailey and Davidson 1983: 88) at the Bau occur within a territory that is considerably smaller than at La Combette (223 km^2 at Bau, versus 790 km^2 for La Combette), reflecting perhaps its greater resource richness and/or longer occupations. It also revealed that that most provisioning occurred within a much narrower distance interval, between ca. 8 and 13 km from the site (Wilson et al. 2018: 96). On the other hand, differences in the importance of resource selection predictors at the two sites serve to contextualize some previous interpretations. For instance, the importance of raw material quality in the upper layers at the Bau (see above) contrasts with the relatively lower importance of this variable at La Combette, even though both cases are associated with more mobile groups whose provisioning strategies align more with Kuhn's provisioning of individuals than of places (see Wilson et al. 2018: 88, 96, and Wilson and Browne 2014). Finally, the comparison of La Combette to the Bau also served to highlight the overall theoretical and methodological contributions of the approach developed over the years by Wilson and Browne, by signaling its wider applicability.

6 Summary

The Bau de l'Aubesier contains a rich and complex Middle Palaeolithic sequence that records some 100,000 years of relatively continuous Neanderthal presence in the Vaucluse department of southeastern France. Found in an area of variable topography that has not experienced major geomorphological changes since the deposition of the first known traces of habitation, the site provides one of the most comprehensive and consistent lithic provenance datasets available for a Middle Palaeolithic site. As discussed in section 5 above, this dataset is well-studied, albeit not from a simulation perspective, and documents the extensive use of relatively distant sources despite the availability of suitable raw materials nearby. While questions remain regarding the stratigraphy and dating of the site's deposits, and about the nature and drivers of the typological and technological variability evidenced in the lithic assemblages, the site is, overall, understood quite well.

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