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SPY CAVE

125 years of multidisciplinary research
at the Betche aux Rotches
(Jemeppe-sur-Sambre, Province of Namur, Belgium)

Edited by Hélène ROUGIER & Patrick SEMAL

Volume 1

2013

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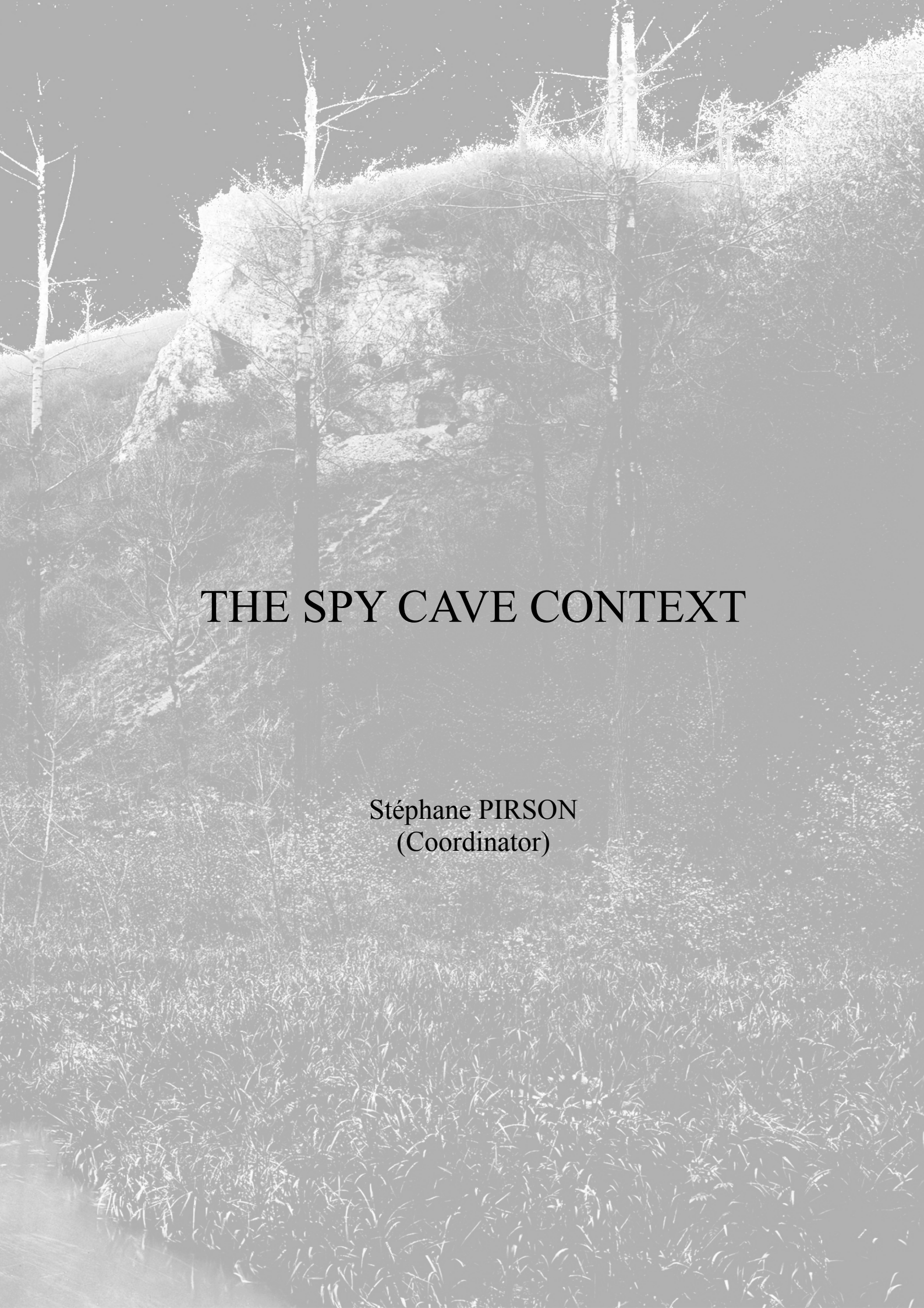

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Stéphane PIRSON
(Coordinator)

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CHAPTER VI

THE STRATIGRAPHY OF SPY CAVE A REVIEW OF THE AVAILABLE LITHOSTRATIGRAPHIC AND ARCHAEOSTRATIGRAPHIC INFORMATION

Stéphane PIRSON, Kévin DI MODICA, Cécile JUNGELS, Damien FLAS, Anne HAUZEUR, Michel TOUSSAINT & Patrick SEMAL

Abstract

This chapter presents a general review of the lithostratigraphy associated with the various excavations carried out at Spy cave since the end of the 19th century, incorporating what little information is available concerning sedimentogenesis. In addition to reviewing the types and possible causes underlying the mixed nature of the Spy archaeological material, the history of the published archaeostratigraphic interpretations of the site is presented alongside the different techno-complexes identified amongst the Spy material. Finally, the stratigraphic position of the Neandertal remains is considered and an overall stratigraphy is proposed that takes into consideration the available chronostratigraphic data.

INTRODUCTION

Spy cave was excavated several times over a period of more than a century (see Semal *et al.*, this volume: chapter II). Both excavation techniques and the quality of the recorded information naturally varied between the different excavations, as do the stratigraphic descriptions. Such changes in the stratigraphic descriptions are not at all surprising given the complexity of deposits at cave entrances, which can include significant lateral variations (Pirson, 2007; Pirson & Draily, 2011). Moreover, depending on the publication, these descriptions can themselves vary even for the same excavation. This is notably the case with the work of M. De Puydt and M. Lohest, during which most of the *in situ* Neandertal remains found were recovered.

This chapter presents an overview of the different lithostratigraphic and archaeostratigraphic interpretations of the site, and addresses several key issues related to the early date of the site's original exploration and the number of subsequent excavations of its rich archaeological deposits. This includes the reliability of the available data, the relevance of the stratigraphic correlations between the different excavations, and difficulties connecting the sedimentary deposits with the archaeological material. This synthesis of the lithostratigraphic and archaeostratigraphic framework employed by the different studies contained in this monograph also includes some considerations concerning site formation processes and the stratigraphic position of the Neandertal remains.

LITHOSTRATIGRAPHY

The history of the different excavations at Spy is summarised elsewhere (Semal *et al.*, this volume: chapter II), therefore we will focus particular attention on information related to the site's lithostratigraphy, distinguishing the cave's interior, the terrace, and the slope leading from the terrace to the Orneau River.

The 1879 excavations of A. Rucquoy

A. Rucquoy exclusively explored the interior of the cave in 1879, focusing on the right gallery (Figure 1), and presented his results seven years later on the 25th of October 1886 at a meeting of the *Société d'Anthropologie de Bruxelles* (Rucquoy, 1886-1887). His stratigraphic

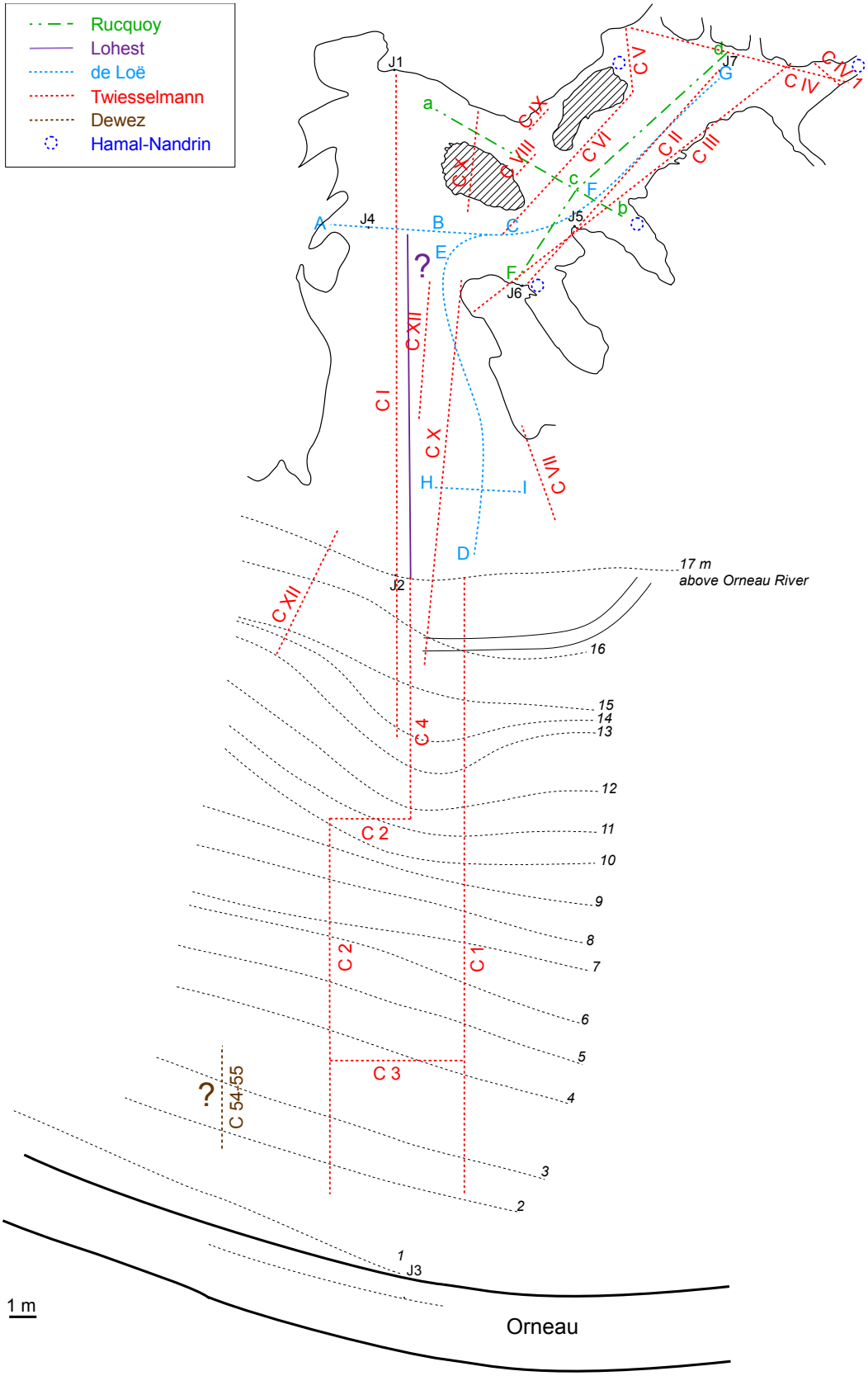


Figure 1. Plan of Spy cave showing the main sedimentary profiles and the four "*emplacements*" excavated by Hamal-Nandrin. "?" indicates sections whose precise position is unknown.

descriptions therefore postdate the publication of the 1885 excavations of De Puydt & Lohest (1886a), as well as the oral presentation of the recovered Neandertal remains at the Namur Congress on the 17th of August 1886 (De Puydt & Lohest, 1887).

Rucquoy wrote that he "tore the ground out right down to the bedrock so as to have a nice large section"[1], from which he started to excavate (Rucquoy, 1886-1887: 319). He recognised four "levels" in the cave's sedimentary sequence, which was described as a "stony silt layer"[2] (Rucquoy, 1886-1887: 319-320).

- The "upper level" (α) was described as a highly bioturbated, approximately 20 cm thick deposit except under a chimney where it reaches 80 cm. Rucquoy mentions the presence of "several flints as well as horse, bear, and rhinoceros teeth"[3] in this deposit.
- The "second level" (β), only a few centimetres thick, was composed of "a less brown silt than that forming the upper level and contained a significant quantity of small rodent and bird bones"[4].
- The following layer (γ), referred to as the "main fauna-bearing level"[5], was thicker (1.5 to 2.25 m), formed by a "brown, stony silt cut horizontally by small, very thin lenses of light yellowish silt. The stratification of the silts seems to result from successive phases of flooding"[6].
- At the bottom of the sequence, the "fourth level" (δ) was described as a lighter coloured and less stony silt. It increased in thickness towards the back of the cave, where it reaches some 50 cm.

Unfortunately, A. Rucquoy failed to connect the archaeological material he recovered with the documented lithostratigraphic sequence, apart from a *phtanite* biface found "in the lower silty level [δ?] of gallery H, lying on the floor"[7] (Rucquoy, 1886-1887: 322) and several flints in the disturbed level α (Rucquoy, 1886-1887: 320). The important thickness of layer γ also poses several important questions. It is possible that Rucquoy, who maintained connections with Dupont and Rutot (e.g. Rucquoy, 1886-1887: 320, 323, 326-327), was influenced by the former's ideas concerning the origin and age of karstic sequences in general. According to Dupont's model, the lower part of a cave's sequence is formed by "rounded pebbles" and "stratified silts" linked with successive flooding events of the nearby river and corresponding to a single prehistoric period. In such a context, Rucquoy might have considered subdividing layer γ unnecessary.

Unlike the 1885-1886 excavations, sedimentary profiles are available for the 1879 excavations. Unfortunately, these profiles, although positioned on a plan of the site, are more rough sketches than an accurate stratigraphic record (Figure 2). The sequence described by Rucquoy differs significantly from the observations of Lohest and his successors. This is particularly true for layer γ, which is described as finely stratified. This could be explained by observations made at different locations; Rucquoy worked inside the cave, while Lohest only investigated the *in situ* deposits on the terrace. At the beginning of the 20th century, de Loë and Rahir described a sequence from within the cave that recalls that described by Lohest on the terrace. However, their profiles likely depict the sedimentary sequence close to the cave's porch. Only the brief and unpublished observations of Twiesselmann concerning a "layer of fine, stratified silt"[8] within the cave would seem to confirm Rucquoy's observations (Twiesselmann, 1950: 4). Taken together, this suggests substantial differences between the sedimentary sequences inside and outside the cave.

[1] Original text: "*défoncé le sol jusqu'au rocher, de façon à avoir une belle et grande coupe*".

[2] Original text: "*couche de limon caillouteux*".

[3] Original text: "*quelques silex ainsi que des dents de chevaux, d'ours et de rhinocéros*".

[4] Original text: "*un limon moins brun que celui du niveau supérieur ; il renferme surtout des quantités d'ossements de petits rongeurs et d'oiseaux*".

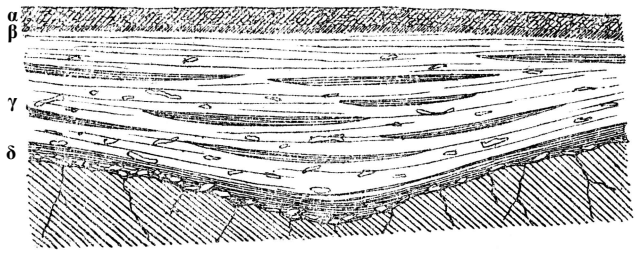
[5] Original text: "*principal niveau ossifère*".

[6] Original text: "*limon caillouteux brun traversé horizontalement par de petites lentilles très minces de limon jaunâtre clair ; cette stratification des éléments du limon semble être la preuve d'inondations successives*".

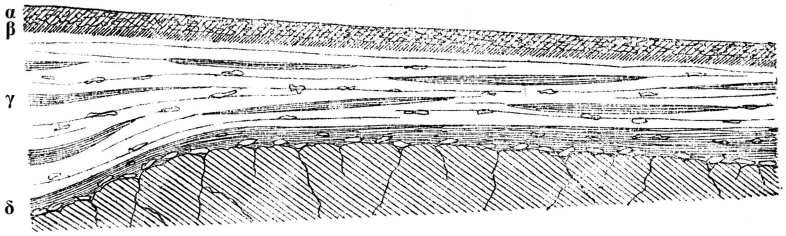
[7] Original text: "*dans la galerie H, dans le niveau limoneux inférieur et reposant sur le sol*".

[8] Original text: "*nappe de limon fin et stratifié*".

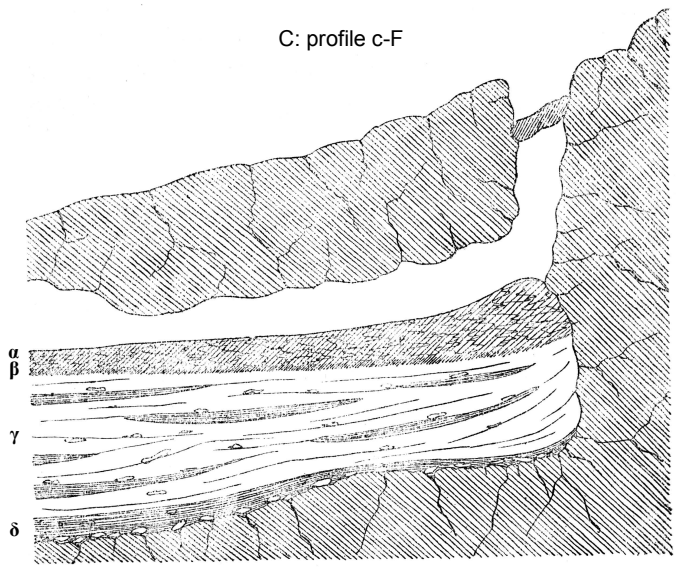
A: profile a-b



B: profile c-d



C: profile c-F



Level α: "The first level starting from the upper part, α (see profiles), is formed of reworked earth that may have been introduced from the lower levels by foxes, badgers, and small rodents. I found several flints in it as well as horse, bear, and rhinoceros teeth. This level is approximately 0.2 to 0.3 m thick, except in one place along the c-F section, where starting from point c, it rises, becomes thicker, reaching a thickness of 0.8 m at point F."
Level β: "The second level β, which is only a few centimetres thick, is composed of a less brown silt than that forming the upper level and contained a significant quantity of small rodent and bird bones."
Level γ: "Below this second level is the main fauna-bearing level γ. The layer is 1.5 to 2.25 m thick and is formed of a brown, stony silt cut horizontally by small, very thin lenses of light yellowish silt. The stratification of the silts seems to result from successive phases of flooding."
Level δ: "Finally, the fourth level δ is thin at the entrance and becomes thicker at the end of chamber H. At the very end it measures 0.5 m due to the slope of the gallery. The silt of the lower level is lighter coloured and less stony than the previous one"

Figure 2. Sedimentary profiles from Rucquoy (1886).
A: profile a-b; B: profile c-d; C: profile c-F. See Figure 1 and Semal *et al.* (this volume: chapter II, figure 3) for location of the profiles. Rucquoy's description of his four layers is also provided (our translation).

However, an alternative explanation could be the weight of Dupont and Rutot's influence on Rucquoy in the context of the somewhat less than cordial relationship that the former enjoyed with Dewalque, who was Lohest and Fraipont's professor. In fact, this cantankerous situation eventually provoked a schism within the Geological Society of Belgium in 1886 (Lohest, 1911; Stockmans, 1965; Boulvain, 1993). Disagreements between Lohest and Dupont concerning the origin of cave deposits, which Dupont interpreted as fluviatile (Dupont, 1872), are also worth mentioning (Fraipont & Lohest, 1887: 680-682; see also the syntheses of Toussaint & Pirson, 2007, and Pirson, 2007). Dupont and Rutot's influence on Rucquoy is also evident in a letter of the 28th of July 1887 sent by E. Delvaux to M. Lohest:

> "You certainly would have read the report of Mr. Rucquoy concerning his exploration of the cave of Spy! Typical Rutot – How nice. In fact, I have seen with my own eyes the sections bearing Rutot's signature at the engraver Malvaux. How narrow-minded one has to be not to acknowledge such base jealousy and disgraceful practice!"[9] (Dallemagne archives).

In such a context, it is impossible to exclude Rucquoy having slightly twisted his descriptions to match Dupont's model, who described numerous stratified cave sequences and used this as a major argument in his theory concerning the age of karstic deposits and associated prehistoric industries (e.g. Dupont, 1866, 1872).

1885-1886 excavations – M. De Puydt and M. Lohest

Two excavation campaigns in 1885 and 1886 were undertaken by A. Orban under the direction of M. De Puydt and M. Lohest (Semal *et al.*, this volume: chapter II). The published stratigraphy from the 1885 campaign made by the team's geologist, M. Lohest, is the first available for Spy. Moreover, De Puydt and Lohest noted that the cave's interior had already been substantially excavated and remained unpublished, most notably the work of Rucquoy in 1879. They therefore focused on apparently intact deposits at the cave's mouth and on the terrace (De Puydt & Lohest, 1886a: 34). Although most of their lithostratigraphic descriptions concern the terrace deposits (Figure 1), some observations also describe the cave's interior: "a single fauna-bearing level under 1.5 m of deposits inside the cave was overlain by a layer of more than 3.5 m of coarse materials in some areas of the terrace"[10] (De Puydt & Lohest, 1887: 208).

Information concerning the excavation conditions is rare and sometimes contradictory, both for the 1885 and 1886 campaigns (Semal *et al.*, 2010, this volume: chapter II). A trench was dug as early as 1885, as were timber-reinforced galleries. Both excavation methods were also probably used in 1886, even if no document clearly confirms this. As the team geologist would later admit, these methods were far from exemplary even for the period, especially the work carried out in the timber-reinforced galleries (Lohest *et al.*, 1925: 145-146; Semal *et al.*, this volume: chapter II).

During the 1885 campaign, under a layer of blocks that occasionally measured several cubic metres, De Puydt and Lohest described a "brownish clay intermixed with limestone blocks"[11] in the bottom part of which was found a "fauna-bearing level"[12] (De Puydt & Lohest, 1886a: 35). Under this "fauna-bearing level" (or FBL) lay either bedrock or a "light-coloured, unstratified sandy-clay that was not very compact"[13]. However, the archaeological, faunal, and human remains found in sediments from the timbered galleries suggest that several other FBLs may have existed, but passed unnoticed (De Puydt & Lohest, 1886a: 35).

Observations made during the 1886 excavations are more detailed than those from 1885. The succession of deposits differs and

[9] Original text: "*Vous aurez lu sans doute le compte rendu de M. Rucquoy sur son exploration de la grotte de Spy ! Procédé Rutot tout pur – C'est gentil. Notez que j'ai vu de mes yeux, les coupes portant la signature Rutot, chez M. Malvaux le graveur. Quelle étroitesse d'âme n'accuse point une aussi basse jalousie et d'aussi inavouables procédés !*".

[10] Original text: "*un même niveau ossifère recouvert d'un mètre 50 de dépôts à l'intérieur de la caverne, était surmonté d'une couche de plus de 3^{m}50 d'éboulis en certains points de la terrasse*".

[11] Original text: "*argile brune entremêlée de blocs calcaires*".

[12] Original text: "*niveau ossifère*".

[13] Original text: "*argile sableuse claire non stratifiée et très peu compacte*".

<table>
<tr><th>Fraipont & Lohest, 1886: 767-769</th><th colspan="2">Fraipont & Lohest, 1887: 663-665</th><th>Minutes of 11/07/86 (De Puydt & Lohest, 1887: 236)</th><th>De Puydt & Lohest, 1887: 209</th><th>De Puydt & Lohest, 1887: profile</th><th>Fraipont, 1895: 36-37</th></tr>
<tr><td>A. Brown clay intermixed with sometimes very large limestone blocks. Thickness: 2.90 m</td><td colspan="2">A. Scree and brown clay. Thickness: 2.90 m.</td><td>A. Brown clay intermixed with sometimes very large limestone blocks. Thickness: ~ 2.90 m</td><td>A. Brown earth with limestone blocks. Thickness varying between 25 cm and 3 m.</td><td>1. Clay and scree.</td><td>A. Scree and brown clay. Thickness: ~ 2.90 m.</td></tr>
<tr><td>B. Yellow clayey tufa containing limestone blocks. This tufa was hard to cut into with the pickaxe. Thickness: 0.80 m. First fauna-bearing level.</td><td colspan="2">B. Yellow clayey tufa containing limestone blocks. Thickness: 0.80 m. This tufa was hard to cut into with the pickaxe. First fauna-bearing level.</td><td>B. Yellow clayey tufa containing limestone blocks. This tufa was hard to cut into with the pickaxe. Thickness: 0.80 m.</td><td>B. Highly calcareous, yellow earth sometimes turning into tufa containing numerous angular limestone fragments. Thickness varying from 80 cm to 1 m. The first fauna-bearing level was found in the upper part of this yellow clay.</td><td>2. Yellow tufa with angular limestone fragments. First fauna-bearing level.</td><td>B. Yellow clayey tufa containing limestone blocks. Hard to cut into with the pickaxe. Thickness: 0.80 m.</td></tr>
<tr><td>C. Heavily reddened zone, consisting of a tufa containing numerous mammoth ivory fragments, charcoal, worked flints, and limestone fragments. Thickness: 0.10 m. Second fauna-bearing level.</td><td colspan="2">C. Fifteen centimetre thick zone, heavily reddened, containing numerous worked flints, angular limestone fragments, charcoal, and mammoth tusks. Second fauna-bearing level.</td><td>C. Heavily reddened zone composed of a tufa containing numerous mammoth ivory fragments, charcoal, worked flints, and limestone fragments. Thickness: 0.10 m.</td><td>C. Between 5 and 30 cm thick bed, almost always red coloured and containing angular fragments of limestone; second fauna-bearing level.</td><td>3. Second fauna-bearing level.</td><td>C. Continuous zone, heavily reddened by oligist and containing – in the form of hard breccia – fragments of mammoth ivory, charcoal, Mousterian worked flints, angular fragments of limestone, worked ivory objects, knapped and engraved bones, with fragments of all the fauna typical of the “Mammoth age”. Thickness: 0.15 m.</td></tr>
<tr><td>D. Yellow clay with limestone blocks and a thin bed of charcoal at its base. Thickness: 0.15 m.</td><td>D. Yellow calcareous clay, changing into a tufa identical to B, with a small vein of charcoal at its base. Thickness: 0.15 m.</td><td rowspan="3">Third fauna-bearing level</td><td>D. Yellow clay with limestone blocks and a thin bed of charcoal at its base. Thickness: 0.15 m.</td><td rowspan="3">D. Yellow earth, sometimes changing into tufa towards the upper part, becoming brown and black-veined towards the lower part. Angular fragments of limestone. Varying thickness ranging from a few cm to 1 m. These latter deposits constitute the third fauna-bearing level, which was only separated from the bedrock by disaggregated limestone.</td><td rowspan="3">4. Brown clay with angular limestone fragments. Third fauna-bearing level.</td><td>D. Yellow calcareous clay, changing into a tufa of the same nature as B. Mousterian flints and fragments of fauna typical of the “Mammoth age”. Thickness: 0.15 m.</td></tr>
<tr><td>(F) Human bones.</td><td>E. Human bones and worked flints.</td><td>E. Human bones.</td><td rowspan="2">E. Brown, sometimes black clay lying directly on the limestone bedrock. Contains pebbles and remains of the same industry and fauna as layer D. Variable thickness. The bones of the two skeletons were scattered on the surface of deposit E and spaced 2.5 m from one another.</td></tr>
<tr><td>G. Brown, sometimes blackish clay containing fairly small limestone pebbles. Third fauna-bearing level.</td><td>F. Yellow clay containing limestone blocks and a thin bed of charcoal at its base. Thickness: 0.15 m.</td><td>F. Very dark brown clay, sometimes blackish, containing rather small limestone blocks.</td></tr>
<tr><td>K. Disaggregated carboniferous limestone.</td><td colspan="2">Below (F.), disaggregated carboniferous limestone (K).</td><td></td><td></td><td>5. Carboniferous limestone.</td><td></td></tr>
</table>

Table 1. Different stratigraphic descriptions from the 1885-1886 team.

appears more complete: a maximum of six layers containing three FBLs is described as overlying the bedrock (layers A to F; Table 1). On the 11th of July 1886, following the discovery of the Neandertal remains, these six layers are briefly described in the minutes recorded by Lohest, De Puydt, Fraipont, and Braconier (De Puydt & Lohest, 1887: 236).

According to the excavators, the single FBL recognised in 1885 would correspond to layer C (i.e. the second FBL) of the stratigraphy published after the 1886 campaign. In fact, De Puydt & Lohest (1887: 213) note that they focused particular attention on this level in 1885. However, the brown colour described in 1885 contrasts with the colour of layer C observed during the 1886 excavations, which was described as "strongly", "ordinarily", or "almost always" red in colour (Table 1). Many years later, Lohest wrote that the most clearly visible component was this red level (Lohest *et al.*, 1925: 145-146). The possible link between the red-stained sediments and the presence of oolithic hematite (oligist) had already been noted following the 1886 excavations (De Puydt & Lohest, 1887: 213).

No section drawing exists for the 1885-1886 excavations. The only available stratigraphic documents are several versions of a sketch portraying the same generalised section of the terrace deposits made after the discovery of the Neandertal remains (Figure 3). This sketch probably illustrates the excavators' understanding of the site's stratigraphy at the time, but in no way represents an accurate stratigraphic record of any given sedimentary profile. Furthermore, the published descriptions appear wanting when compared to the information typically recorded during modern excavations of a cave mouth sequence (e.g. Pirson, 2007).

Several stratigraphic descriptions are available in different publications, either in the texts themselves, versions of the generalised stratigraphic sketch, or in the minutes of 11th July 1886 (Table 1). Several substantial inconsistencies can be noted between the different versions, for instance, the number of layers varies from one publication to the next, ranging from four to six depending on the author, year, or publication (e.g. Fraipont & Lohest, 1886: 767, 1887: 663; De Puydt & Lohest, 1887: 209 vs. enclosed minutes; Fraipont, 1895). In De Puydt & Lohest's (1887) publication, three different descriptions are presented: one in the text, one in the enclosed minutes, and one in the stratigraphic sketch. The nomenclature and/or description of the stratigraphic units vary between publications in much the same way (Table 1). Such inconsistencies, while sometimes problematic, still provide enough information to deduce how the stratigraphy was likely perceived by the excavators.

On the whole, the descriptions of the upper part of the sequence (layers A to C) remain fairly consistent, as does the position of the first and second FBLs: unit A is at the top of the sequence, with the first and second FBLs found in units B and C, respectively (De Puydt & Lohest, 1887; Fraipont & Lohest, 1887; Fraipont, 1895). Additional information concerning the position of the archaeological material inside the first FBL is also available. Fraipont & Lohest (1887: 666) mention that only "the upper part of this fauna-bearing level included a thin bed of knapped flints, which, although discontinuous across the whole surface of the terrace, was particularly apparent in the vicinity of the walls and especially towards the east"[14]. Based on the original descriptions, it seems that the "fauna-bearing level" and the archaeological material were not uniformly present across the site. For example, in the sedimentary profile of the area where one of the Neandertal individuals was discovered, the excavators indicate that unit B yielded "neither knapped flints, nor fossil bones"[15], whereas they were present in adjacent areas (Fraipont & Lohest, 1887: 663).

The situation is more complex for the lower part of the stratigraphic sequence. In their excavation report, De Puydt & Lohest (1887: 209) considered the base of the sequence a single unit (D). This unit is described as a heterogeneous deposit containing the third FBL: "Yellow earth, sometimes changing into tufa towards the

[14] Original text: "*la partie supérieure de ce niveau ossifère renfermait un mince lit de silex taillés, non continu sur toute la surface de la terrasse, mais spécialement apparent au voisinage des parois et surtout vers l'est*".

[15] Original text: "*ni silex taillés, ni ossements fossiles*".

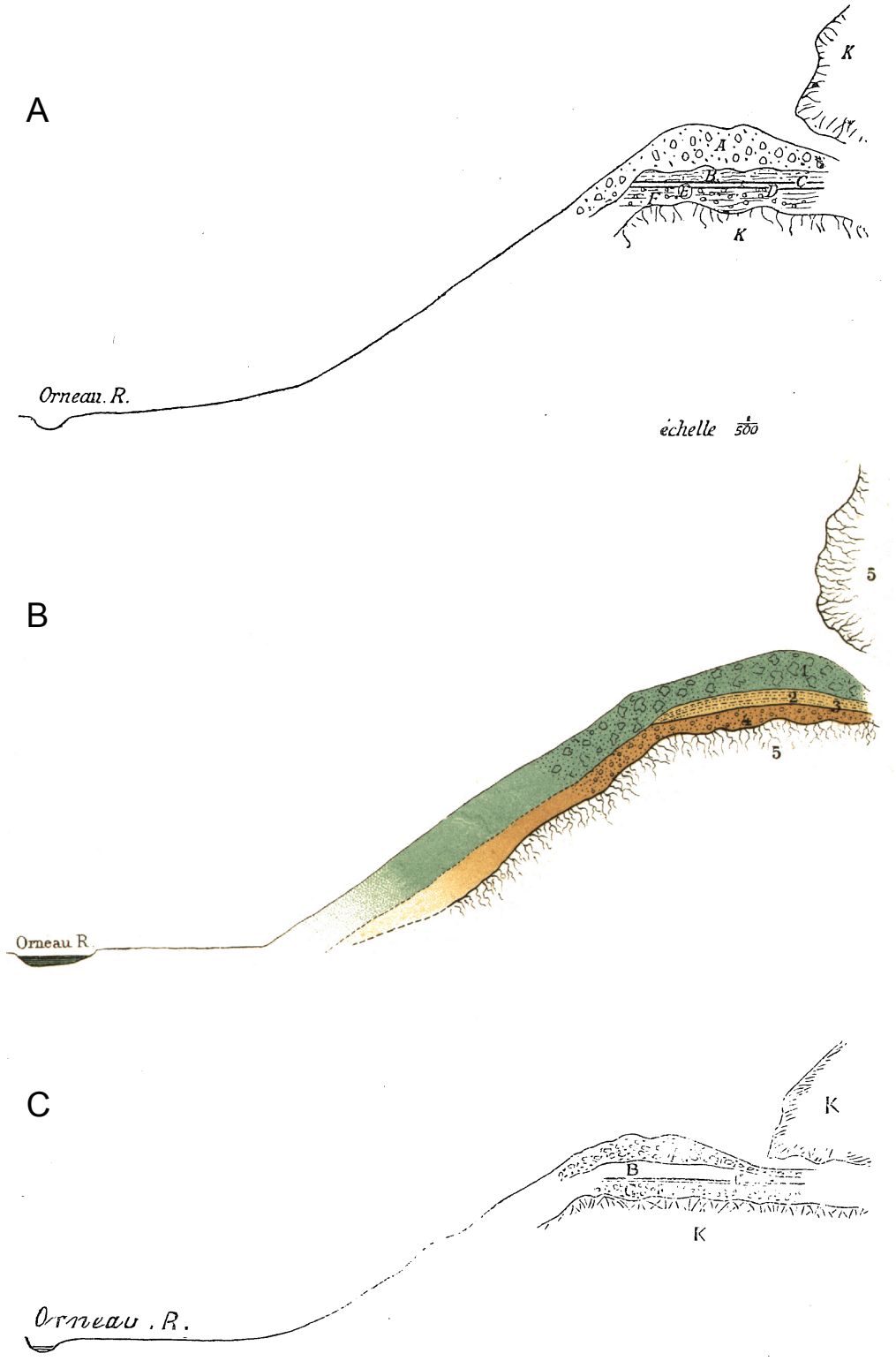


Figure 3. Three different sketches of the terrace profile recorded during the 1885-1886 excavations. A: Fraipont & Lohest (1887: 663); B: De Puydt & Lohest (1887: planche I); C: Fraipont & Lohest (1886). See Table 1 for the descriptions of the layers.

upper part, becoming brown and black-veined towards the lower part. […] These latter deposits constitute the third fauna-bearing level"[16]. A few pages down, the third FBL is again positioned in a sediment darkened by "brown clay and charcoal that was sometimes scattered in small veins"[17] (De Puydt & Lohest, 1887: 228), which corresponds to the lower part of the previously described unit D. This relationship between the third FBL and a brownish sediment also appears in the caption of the stratigraphic sketch published by De Puydt & Lohest (1887: pl. I) as well as in Fraipont & Lohest (1886: 769) (see Table 1). However, the minutes provided by De Puydt & Lohest (1887) present a slightly different version: a distinction was made between the "yellow clay" (their unit D) and the brownish, lower part (their unit F), while the Neandertal bones formed a single independent unit (unit E). In another paper, the third FBL – also referred to simply as the "lower level" – is once again presented as being composed of sedimentary units D and F (Fraipont & Lohest, 1887: 665).

In fact, these different versions of the lower part of the stratigraphic sequence are not that different. They include either a single heterogeneous layer (unit D) or three distinct layers (units D-E-F). The major differences are 1) the presence or absence of knapped flints in the yellow sediment constituting either the top of unit D or unit D itself, and 2) the extent of the third FBL, sometimes including the yellow unit. It is likely that the stratigraphic sequence presented in Fraipont & Lohest (1887) and the minutes included in De Puydt & Lohest (1887) are the most complete.

The layers yielding knapped flints also change from one paper to the next; De Puydt & Lohest (1887: enclosed minutes) mention the presence of knapped flints solely in unit C, Fraipont & Lohest (1887: 663) specify that knapped flints were recovered in units C, E, and F, while Fraipont (1895: 37) also records knapped flints in unit D (Table 1). The association between the Neandertal remains and both the third FBL and knapped flints is, however, made explicitly clear. Several artefacts are described as being found "at the level of and next to the skeletons"[18] (Fraipont & Lohest, 1887: 665).

1903-1909 excavations – A. de Loë and E. Rahir

The 1885-1886 excavations deliberately left intact "important parts of the terrace […] for control"[19] (de Loë & Rahir, 1911: XLIII). Following a visit to the cave in 1902 (Semal *et al.*, 2010, this volume: chapter II), Baron A. de Loë and his colleague E. Rahir of the Royal Museums of Art and History[20] in Brussels decided to finish its exploration. They were afraid, "not without reason, [of] the depredations of overzealous collectors"[21] (de Loë & Rahir, 1911: XLIII). The excavations, carried out by C. Collard, began in the summer of 1903 and continued until 1906 (Semal *et al.*, 2010, this volume: chapter II). Another field season also took place several years later in 1909.

C. Collard initially excavated inside the cave, where he sieved the backfill of previous excavations and explored some still intact zones. From 1905 onwards, he opened a test pit on the terrace, at the limits of the 1886 excavations, near the cave's porch. The following year, he excavated in the western part of the terrace, close to the cave's mouth. Finally in 1909, he explored the eastern part of the terrace and the right gallery of the cave. After their excavations, de Loë and Rahir published a plan of the site indicating not only the areas they explored, but also those excavated by Rucquoy and De Puydt & Lohest (see Semal *et al.*, this volume: chapter II, figure 9).

[16] Original text: "*Terre jaune, passant parfois au tuf vers la partie supérieure, devenant brune et veinée de noir vers la partie inférieure. […] Ces derniers dépôts constituent le troisième niveau ossifère*".

[17] Original text: "*de l'argile brune et du charbon de bois parfois disséminé en veinules*".

[18] Original text: "*au niveau et à côté des squelettes*".

[19] Original text: "*des parties importantes de la terrasse […] pour contrôle*".

[20] Known at the time as the Royal Museums of Industrial and Decorative Arts.

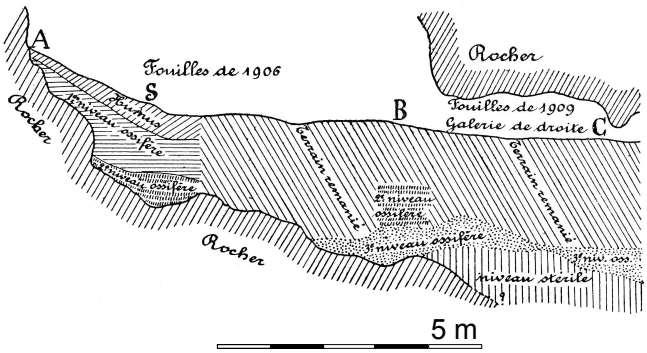
[21] Original text: "*non sans raisons, [des] déprédations des collectionneurs trop zélés*".

The stratigraphic sequence presented by de Loë and Rahir is very similar to that from 1886. It is probable that they were influenced by the work of De Puydt and Lohest, and tried to coordinate their initial stratigraphic sequence. Although they described three FBLs beneath the topsoil, their publication also contained several new and interesting elements including the first credible sedimentary profiles for the site (de Loë & Rahir, 1911: sections I to III; Figure 4) and the description of important lateral variations and a sterile unit below their third FBL. de Loë & Rahir's (1911) sequence is as follows:

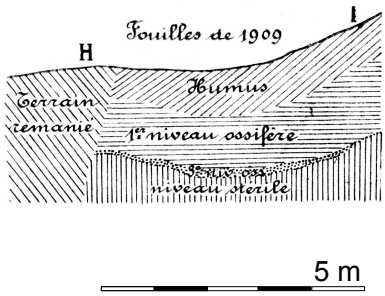
- Topsoil (and/or backfill)
- First FBL: "calcareous and stony, yellow silt, becoming slightly darker at its base and containing fragments of charcoal scattered throughout, but no hearths"[22] (de Loë & Rahir, 1911: XLIV).
- Second FBL: "stony, red silt containing *in situ* hearths with charcoal and the remnants of human meals [...]. The characteristic red colour

[22] Original text: "*limon jaune calcareux et blocailleux, devenant un peu plus foncé à sa base et contenant, éparses dans toute sa masse, quelques parcelles de charbon de bois, mais pas de foyer*".

A: profile A-B-C



B: profile H-I



C: profile D-E-F-G

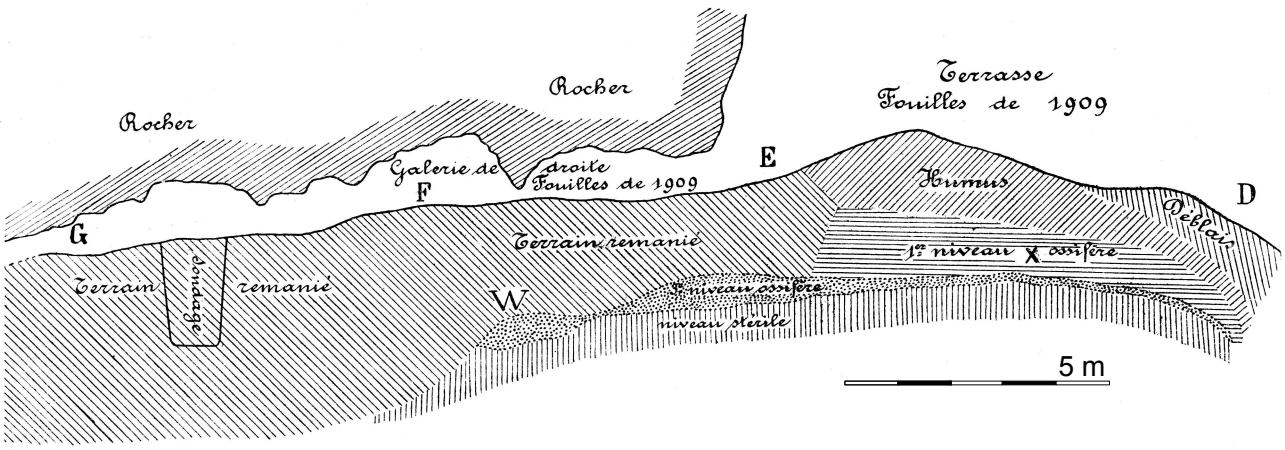


Figure 4. Sedimentary profiles I to III from de Loë & Rahir (1911). A: transverse section of the terrace along A-B-C; B: transverse section of the terrace along H-I; C: longitudinal section of the terrace and the cave's right gallery along D-E-F-G. The location of the profiles is shown in Figure 1.

of this deposit is due to oligist dust and numerous fragments, whose existence we have noted. The charcoal, more abundant than in the first level, also seems to have contributed to its darker colour"[23] (de Loë & Rahir, 1911: XLVI).
- Third FBL: in the porch area (point B in Figure 4A), this FBL is described as a "stony, brown silt mixed with charcoal"[24] (de Loë & Rahir, 1911: L), which becomes a "thin blackish layer" in the eastern part of the terrace (de Loë & Rahir, 1911: LI).
- Sterile level.

A variant of this initial sequence will be presented in subsequent articles (de Loë, 1928: 20, 66-78, 160-162; Rahir, 1928: 58-63) in which four "levels" are indicated, this time numbered from bottom to top with the exception of the figures that retain the nomenclature published in 1911. This regrettable variant is a source of confusion, and probably results from an attempt at combining data from their own excavations with the four cultural groups identified by H. Breuil (1912) in his revision of the Spy archaeological material. Ordered from the oldest to the most recent, Breuil identified two different groups in the third FBL of de Loë and Rahir: an "early Mousterian level"[25] and an "upper Mousterian level"[26] (Breuil, 1912: 129). Following Breuil's revision, de Loë and Rahir would justify their failure to distinguish the lower levels (first and second) claiming that these levels "were almost constantly blended into one another"[27] (Rahir, 1928: 61).

The correlation between the stratigraphic sequence of 1886 and that of 1903-1909 is difficult, especially for the lower part of the sequence. While the two lithostratigraphic sequences seem comparable, a major problem lies in the fact that the "upper Mousterian level" identified by Breuil in de Loë and Rahir's third FBL corresponds to the Mousterian component of De Puydt and Lohest's second FBL (Breuil, 1912).

1927-1933 excavations – J. Hamal-Nandrin and colleagues

After their excavations, de Loë and Rahir wrote: "The excavations at Spy can now be considered finished, at least the undisturbed parts of the cave's floor"[28] (de Loë & Rahir, 1911: 56). Nevertheless, new research at Spy was begun in 1927 under the direction of J. Hamal-Nandrin. These excavations concerned several areas of the cave's interior. Undisturbed deposits, sometimes reaching about 2 m, were identified and excavated in three different "*emplacements*" ("spots") (Figure 1), under some 2 m of backfill from previous excavations (Hamal-Nandrin *et al.*, 1939: 144). In 1933, a fourth "*emplacement*" yielded *in situ* deposits that were only partially excavated (Hamal-Nandrin *et al.*, 1939: 147). Lithic and faunal material was recovered from all the excavated areas.

Unfortunately, no description of the excavated deposits is available, apart from the mention of their being "undisturbed"[29] (Hamal-Nandrin *et al.*, 1939: 144). Moreover, these observations are disconnected from the rest of the stratigraphic sequence. The isolated "*emplacements*", preserved along the cave walls, were surrounded by backfill from older excavations, making it impossible to correlate their stratigraphic position relative to the layers described by previous excavators. The same goes for the stratigraphic position of the deposits from the four excavated "*emplacements*" relative to each other. Based on the nature of the recovered archaeological material, it was nevertheless suggested that these deposits "would seem older than the lower level, or third level, from the terrace, excavated by Marcel De

[23] Original text: "*limon rouge blocailleux contenant des foyers en place avec du charbon de bois et restes de repas humains [...]. La coloration rouge caractéristique de ce dépôt est due à la poussière et aux nombreux fragments d'oligiste dont nous avons constaté l'existence. Le charbon de bois, plus abondant qu'au premier niveau, semble avoir contribué également à lui donner une teinte plus foncée*".

[24] Original text: "*limon brun blocailleux mélangé de charbon de bois*".

[25] Original text: "*niveau vieux moustérien*".

[26] Original text: "*niveau moustérien supérieur*".

[27] Original text: "*se confondaient presque constamment l'un avec l'autre*".

[28] Original text: "*Les fouilles de Spy peuvent être considérées maintenant comme terminées, au moins en ce qui concerne les parties non remaniées du sol de cette grotte*".

[29] Original text: "*non remanié*".

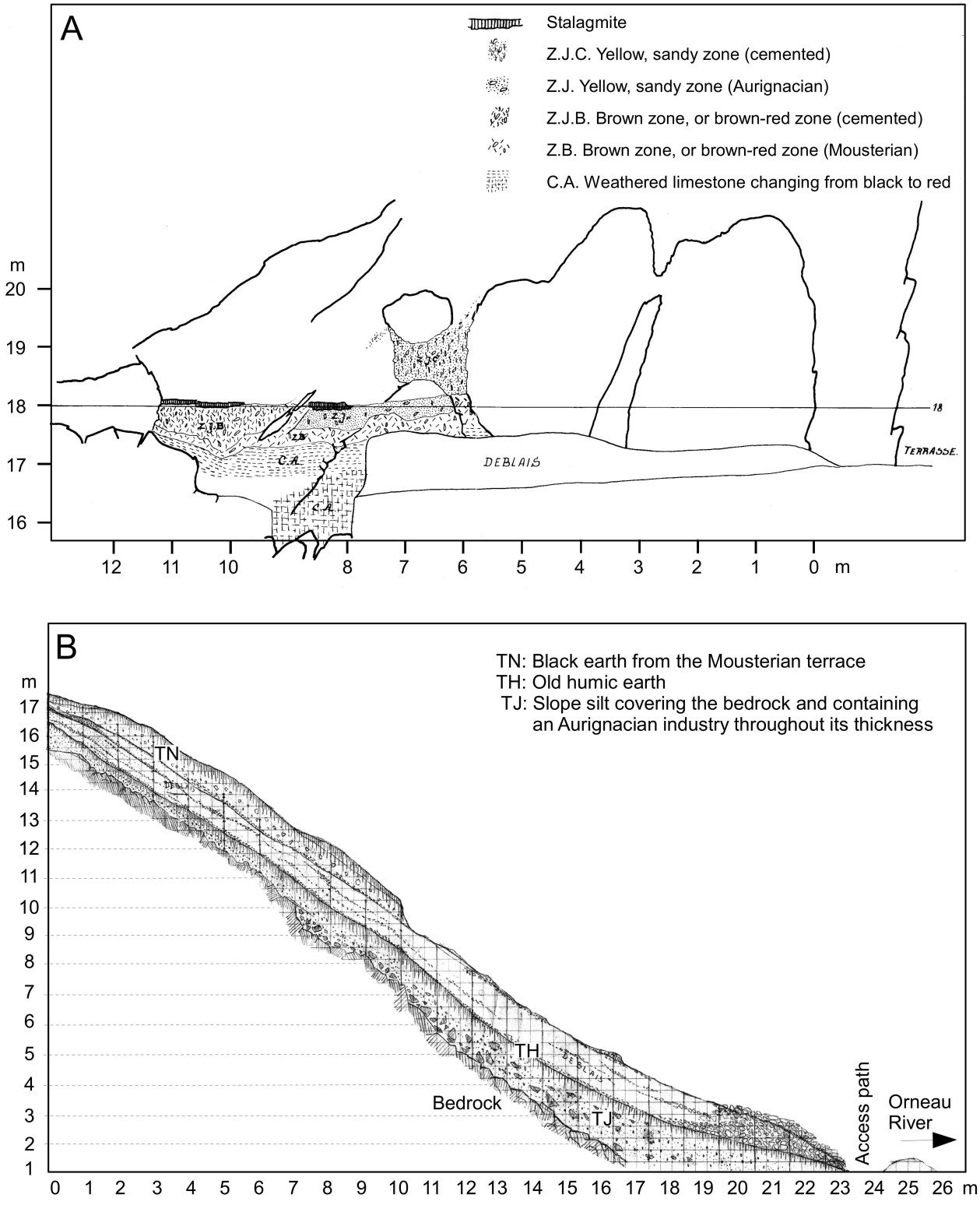


Figure 5. Sedimentary profiles from Twiesselmann (unpublished). A: section III inside the cave; B: section C1 on the slope between the terrace and the Orneau River. The location of the profiles is shown in Figure 1. Twiesselmann's description of the layers is also provided (our translation); note discrepancies exist between the descriptions and abbreviations of the layers indicated on the drawing, and between the drawings made in the field (see SF1) and in ink by Twiesselmann in the lab.

Puydt and Max Lohest"[30] (Hamal-Nandrin *et al.*, 1939: 146). However, no solid arguments support this hypothesis (see also the section "Summary of the archaeostratigraphy").

1948-1954 excavations – F. Twiesselmann

François Twiesselmann directed excavations for the Royal Belgian Institute of Natural Sciences (RBINS) at Spy for several field seasons between 1948 and 1954 (see Semal *et al.*, this volume: chapter II). Apart from an attempt at interpreting the stratigraphy of the slope by Dewez *et al.* (1986), most of Twiesselmann's work remains unpublished (see SI1). Middle Palaeolithic artefacts discovered in several fissures in the cave were also briefly described (André, 1981), however they provide no useful stratigraphic information. Field notes reporting details of the excavations are also almost entirely lacking, with the exception of some brief indications in the exploration and field trip reports in the archives of the Anthropology and Prehistory Section of the RBINS. However, artefact labels do provide information concerning their location, depth, and layer association that have to be correlated with the plan and highly schematic section drawings made by Twiesselmann during his excavations.

In 1948, during a preliminary visit to the site designed to evaluate the archaeological potential of the cave's interior, Twiesselmann opened a test-pit at the rear of the main gallery (see SI1). He collected nine artefacts from a black sediment of which several are clearly attributable to the Middle Palaeolithic. In 1950, he placed several test-pits or trenches on the terrace and inside the cave, mainly at the rear of the right gallery (see Semal *et al.*, this volume: chapter II, figure 12). Twelve sedimentary profiles were drawn (profiles I to XII; Figures 1 and 5A; details can be found in SF3-5). From the sections made inside the cave above the bedrock, it is possible to distinguish the following sequence: a "black zone"; a "brown zone" (or "brown-red zone") sometimes containing Mousterian artefacts; a "yellow sandy zone", at times containing Aurignacian artefacts, and locally covered with "stalagmite" (Figure 5A). In a short note dealing with the excavations carried out in the cave and on the terrace between the 22nd of May and the 27th of June 1950, Twiesselmann wrote that he had identified De Puydt and Lohest's three FBLs as well as recovering archaeological and faunal material, fragments of heavily coloured ivory, breccia (two distinct levels in some places), and a layer of stalagmites. Unfortunately, the very poor quality of the stratigraphic records and lack of contextual information for the recovered objects prevent any reliable interpretation of this material.

Twiesselmann also investigated the slope leading from the terrace to the Orneau River, mainly between 1952 and 1954, where he opened a substantial trench (for details, see SF2). According to his notes and drawings, the stratigraphic sequence of the slope seems quite simple (Figure 5B). First, he looked for artefacts in the backdirt of previous excavations (Semal *et al.*, this volume: chapter II; see also Rougier *et al.*, volume 2: chapter XIX), where he described several stony layers. Underlying this backdirt, he discovered a humic soil (unit TH) that was sometimes referred to as an "old surface". Below unit TH and above the bedrock lay a "yellowish loess/loam layer" (unit TJ). Upslope, near the terrace, a fairly thick deposit of black sediment was interpreted as a product of the Mousterian occupation of the terrace. Several arguments led Twiesselmann to interpret unit TJ as an *in situ* Aurignacian level including the presence of the "old surface" apparently sealing the Pleistocene deposits, the discovery of an "Aurignacian [human] face" on the bedrock, and a "hearth" feature (Dewez, 1980; Dewez *et al.*, 1986) as well as the presence of several Aurignacian artefacts in the loamy layer. However, direct dating of the "Aurignacian face" to the Neolithic (Semal *et al.*, 1996) combined with the recent reappraisal of the stratigraphic and planimetric positions of the material has rejected this. Middle Palaeolithic, Aurignacian, Gravettian, as well as Neolithic and post-Neolithic artefacts, are distributed throughout the whole slope sequence, indicating that Twiesselmann excavated a heavily disturbed sequence containing an accumulation

[30] Original text: "*semblerait plus ancien que le niveau inférieur, ou troisième niveau, de la terrasse, fouillé par Marcel De Puydt et Max Lohest*".

of backdirt from earlier excavations and perhaps prehistoric activity (Neolithic or after). This could explain why De Puydt and Lohest mentioned several thousand flints for the 1885 excavation alone (De Puydt & Lohest, 1886a: 36), while the inventory of the 1885-1886 excavations mentions only a thousand or so (1029 pieces in the inventory of the Marcel De Puydt collection stored at the *Grand Curtius* Museum; see Di Modica *et al.*, this volume: chapter IX).

1979-1981 excavations – M. Dewez

The last official excavations at Spy were undertaken by M. Dewez as part of "SOS Fouilles", then for the "*Société Wallonne de Palethnologie*" (Dewez, 1980, 1981a, 1981b; Semal *et al.*, this volume: chapter II). This research, although primarily concentrated on the slope leading to the Orneau River and the "lower terrace" downslope, also included an investigation of the cave itself. Although a description and section drawing of the stratigraphy was published alongside a Harris matrix (Dewez, 1981a: 59-63), no reliable lithostratigraphic information is available. Clearly Dewez, who was not a field geologist, was not able to interpret his field observations in term of sedimentogenesis. In our view, however, the section published by Dewez (1981a: 60) shows obvious similarities with those drawn by Twiesselmann a quarter of a century earlier (Dewez *et al.*, 1986: 156-157). It confirms that most of the slope deposits and a majority of those on the "lower terrace" are not at all *in situ*, but represent displaced sediments from previous excavations including those of 1886.

SEDIMENTOGENESIS

Although deciphering the genesis of Spy's stratigraphic sequence is difficult given the context of the excavations, several elements can be discussed.

Nature and origin of the sediments

Based on what little information is available from Belgian caves (see syntheses in Pirson, 2007; Toussaint & Pirson, 2007; Pirson & Draily, 2011) and the local geology (Pirson *et al.*, this volume: chapter V), the sediments must have originated from three main sedimentary sources: alluvial deposits from the palaeo-Sambre preserved on the plateau; the area's well-preserved aeolian deposits; and rock-fall from the cave walls, especially near the cave entrance. Biological, anthropic, and chemical components must also be taken into account.

This likely contribution of the factors suggested above is partially confirmed by the original excavators:
"at Spy [the deposits] were found only inside the cave and on the terrace. The hillsides around the cavern are covered with limestone scree. The plateau dominating the cave is carpeted with Hesbayan[31] loam, while the base of the valley, which widens considerably south of the cave, is composed of alluvium"[32] (Fraipont & Lohest, 1887: 664).

The 1885-1886 excavators described the fine fraction of the terrace deposits as "clay" or "clayey"; however, it probably consisted of clayey silt re-mobilised from aeolian loam, as is the case in most of the caves from this part of Belgium (Ek *et al.*, 1974; Chen *et al.*, 1988; Gullentops & Deblaere, 1992; Haesaerts, 1992, 1995; Pirson, 1999, 2007; Pirson & Draily, 2011). Early 20th century excavators described the fine fraction of the three FBLs as "silt"; moreover, they indicated that the fill "originates [from] the disaggregation of the cave's walls and roof as well as the infiltration of sands and clayey silt from the plateau by way of fissures and chimneys"[33] (de Loë & Rahir, 1911: LVII).

[31] This "Hesbayan" loam is actually loess. The term was introduced by A. Dumont in 1839 (see Gullentops, 1954) and is still in use today as a formal lithostratigraphic unit (Hesbaye Member). It refers to the first half of the Weichselian late pleniglacial loessic cover (Gullentops *et al*., 2001; Haesaerts *et al*., 2011).

[32] Original text: "*[les dépôts] ne se sont rencontrés à Spy que dans la grotte et sur la terrasse. Les flancs de la colline, aux environs de la caverne, sont couverts d'éboulis calcaires. Le plateau dominant la grotte est recouvert de limon hesbayen, tandis que la vallée, qui s'élargit considérablement au sud de la grotte, a son sol constitué par des alluvions*".

[33] Original text: "*proviennent [de] la désagrégation des parois et de la voûte de la grotte, comme aussi des infiltrations du plateau ayant amené, par les fissures et les cheminées, les sables et les limons argileux*".

The coarse materials are primarily limestone blocks from the cave walls that are described as "angular" throughout the sequence (De Puydt & Lohest, 1887).

Sedimentary dynamics

According to what we know today of sedimentary processes connected to the infilling of cave mouths (see Ferrier, 2002; Bertran, 2006; Goldberg & Sherwood, 2006; Texier, 2006; Pirson, 2007, 2011; Pirson *et al.*, 2008; Bertran *et al.*, 2009), we can safely assume that these distinct sediments accumulated as a talus under the cave porch from where they were subsequently mixed and redistributed, either into the cave itself or onto the slope leading to the Orneau River. Given the cave's topography and the predominant periglacial conditions that likely governed the major part of the cave's sedimentary history, these re-mobilisations probably involved several processes including solifluxion, run-off, and debris flow (see Bertran, 2004). Some sediment also probably accumulated under several chimneys in the cave's roof that communicate either with the plateau or the cliff overlying the terrace.

A stabilisation phase is made evident by the formation of what are likely Holocene speleothems still locally observable in the cave today. A stalagmitic floor is indicated in several of Twiesselmann's sedimentary profiles (Figure 5A) as well as in a handful of unpublished notes (Twiesselmann, 1950). Finally, Rucquoy notes "some very weakly developed stalactites, but no stalagmites on the floor"[34] (Rucquoy, 1886-1887: 319).

Some post-depositional processes must also have affected the sediments. Calcite cementation is documented in the three FBLs by the mention of "tufa" and "hard breccias" (Table 1) indicating water flow, possibly during periods of climatic amelioration. However, the lack of accurate descriptions prevents any attempt at reconstructing palaeoenvironmental conditions. Other post-depositional features, such as the development of platy structures or stone tilting during cold phases, or soil formations during phases of climatic amelioration, remained unnoticed despite probably being visible in the sediments, as is the case in many Pleistocene cave sequences in Europe (e.g. Texier, 2006; Pirson, 2007, 2011; Bertran *et al.*, 2008, 2009; Pirson *et al.*, 2008; Pirson & Draily, 2011; Lenoble & Agsous, 2012; Ajas *et al.*, 2013). The same is true of bioturbations, sometimes very common in cave sequences such as at Scladina cave (Pirson, 2007), and probably explains the presence of Neolithic material in the second FBL. While Holocene burrows are easily recognisable, this is not always the case for Pleistocene examples, especially without strong artificial light.

Several observations of the 19th century excavators do however shed light on past debates concerning the origin of the deposits. De Puydt and Lohest indicate: "We have distinguished [in the third FBL] neither stratified loam nor rounded pebbles; the only rounded pebbles found from the different levels seem to have been brought by man"[35] (De Puydt & Lohest, 1887: 228), and de Loë and Rahir wrote: "Apart from the few large rounded pebbles introduced to serve as hammerstones or crushers, no other river pebble has been found in any level during our excavations"[36] (de Loë & Rahir, 1911: LVI). These two assertions are probably connected to the quarrel between Dupont and Lohest regarding the alluvial or colluvial origin of cave deposits (Pirson, 2007; Toussaint & Pirson, 2007). This likelihood is clearly hinted at by de Loë & Rahir (1911: LVII).

The shape of the limestone blocks, described as "angular" throughout the sequence, could also be tied to these ongoing disputes. During the same period, M. Lohest maintained that cave entrance deposits resulted from a

[34] Original text: "*quelques stalactites très peu développées, mais sur le sol il n'y avait pas de stalagmites*".

[35] Original text: "*Nous n'avons distingué [dans le troisième niveau ossifère] ni limon stratifié ni cailloux roulés ; les seuls cailloux roulés rencontrés aux différents niveaux, paraissent avoir été apportés par l'homme*".

[36] Original text: "*A part les quelques gros cailloux roulés y apportés pour servir de percuteurs ou de broyeurs, nul autre galet de rivière n'a été trouvé dans nos fouilles à aucun niveau*".

combination of gravitational and wash processes, contradicting the fluviatile origin defended by Dupont. Lohest's arguments principally relied on demonstrating the autochthonous origin of the coarse fraction of several cave mouth sequences such as Trou Al'Wesse (Lohest quoted in Fraipont & Tihon, 1889: 37; see also Pirson, 2007). It is therefore possible that Lohest exaggerated his description of the limestone blocks as being systematically angular. In such a context, and despite the potential interest of the extent to which the blocks were rounded for the genesis and subsequent post-depositional evolution of the deposits (e.g. Pirson, 2007; Pirson & Draily, 2011), these descriptions must be considered with caution.

Position of the porch

The cave porch must have retreated in the course of the site's history. At the time of the Neandertal occupation it probably extended further towards the terrace. The presence of "limestone blocks measuring several cubic metres"[37] (Fraipont & Lohest, 1887: 666) and sealing the first FBL may provide evidence of such an evolution. However, the rate of the porch's collapse is difficult to estimate. Even in sites where the stratigraphy is well understood, such as the caves of Scladina or Walou (Pirson, 2007; Pirson & Draily, 2011), this parameter is very difficult to quantify. At Scladina, the porch stratigraphy documented during the early stages of the excavation, and in particular the drawing of the longitudinal G/H sedimentary profile between metres 1 and 10 (Otte *et al.*, 1983; Haesaerts, 1992; Pirson, 2007), show that during the deposition of sedimentary unit 3 the limit of the porch was situated at metre 3, while today it can be found at metre 10. Given the age of sedimentary unit 3 of between 70,000 and 100,000 BP (Pirson, 2007; Pirson *et al.*, 2008, in press) and the fact that the porch retreated some 7 m during this interval, an average of one metre every 10-14,000 years can be estimated for Scladina. If this estimation can be reliably applied to Spy, the fact that the skeletons were found between 6 and 8 metres from the cave porch (Fraipont & Lohest, 1886: 745) would imply that the Neandertals were buried on the terrace and not inside the cave (see section "Re-evaluation of the stratigraphic position of the Neandertal remains" below and Maureille *et al.*, volume 2: chapter XXI).

The possibility that falling rocks were responsible for the fragmentation of the Neandertal bones (De Puydt & Lohest, 1887: 229) and perhaps even their death (de Mortillet in d'Acy, 1888: 112; Groenen, 1994: 280) seems difficult to accept. The accumulation of large limestone blocks at the top of the sequence (unit A), which were destroyed with black powder (see Semal *et al.*, this volume: chapter II), clearly postdates the Neandertal occupation, and is probably Holocene in age as confirmed by the available descriptions (Table 1).

ARCHAEOSTRATIGRAPHY

Mixing

Shortly after the conclusion of De Puydt and Lohest's excavations, several authors commented on the high quality of their work. For example, de Loë & Rahir (1911: XLII) emphasised that excavations on the terrace had been carried out "with extreme care and first-rate competence"[38], while the Marquis de Nadaillac (1886: 491) claimed that "[…] the explorers identified with great care the various, successively deposited layers […]"[39]. According to M. Delvaux (1887: 236), they "saved from destruction and pulled from nothingness priceless pieces"[40], afterwards

> "our colleagues made a complete study of these remains as well as of the environment in which they were discovered, and a simple reading [of their report] is sufficient for a professional to appreciate that none were better prepared than our learned colleagues to

[37] Original text: "*blocs calcaires d'un volume de plusieurs mètres cubes*".

[38] Original text: "*avec un soin extrême et une compétence de premier ordre*".

[39] Original text: "*[…] les explorateurs ont déterminé avec beaucoup de soins les diverses couches successivement déposées […]*".

[40] Original text: "*sauvé de la destruction et arraché au néant des pièces d'une valeur inestimable*".

successfully complete this venture: they neglected nothing that could render this find fruitful for science"[41].

He added: "It is probably the first time that the exploration of a cavern was accomplished in such favourable conditions, offering all the guarantees of security that our research requires"[42].

On the occasion of his re-examination of the material discovered at Spy, H. Breuil was the first to question the integrity of the stratigraphic sequence. Based on his analysis of material collected inside the cave by J. Hamal-Nandrin, Breuil highlighted a biface associated with several Gravette points, an "indication [that] seems to establish the highly disturbed character of the original stratigraphy inside"[43] (Breuil, 1912: 126). On the terrace itself, this time using the material from De Puydt and Lohest excavations, Breuil combined technological, typological, and taphonomical arguments to demonstrate that the second FBL contained a mix of Mousterian, Aurignacian, and Gravettian artefacts. He also questioned the relevance of the stratigraphic subdivisions. Based on his reading of the material, "the Mousterian assemblage having been attributed the same age as the whole of stratum 2 is in fact proof of a purely Upper Mousterian occupation from which MM. de Puydt [sic] and Lohest have only separated the base"[44] (Breuil, 1912: 127). Therefore, the Mousterian component of the second FBL discovered on the terrace by De Puydt and Lohest on the one hand, and part of the Mousterian from the third FBL excavated by de Loë and Rahir in the cave entrance on the other hand, would form a homogeneous group attributed by Breuil to the "Upper Mousterian level", which he distinguished from the "Early Mousterian level". The mixing of Aurignacian and Mousterian artefacts would be explained by "the hand of prehistoric men themselves, or by the unintentional action of animals"[45] (Breuil, 1912: 129).

Later typological and anthropological studies confirmed mixed material in all the collections from the site. Debates mainly focused on the content of the second FBL from which Mousterian, LRJ, Aurignacian, and even Gravettian elements were progressively identified (Bordes, 1959; Ulrix-Closset, 1975; Otte, 1979, 1981; Flas, 2006; see also Di Modica *et al.*, this volume: chapter X). The most striking examples of these admixtures are the presence of pottery in the second FBL (De Puydt & Lohest, 1887; Fraipont & Braconier, 1887) and new radiocarbon dates obtained on human material demonstrating that some of the bones initially attributed to the Spy I and Spy II Neandertals are in fact Neolithic (Semal *et al.*, 2009, this volume: chapter XVI).

Multiple factors probably contributed to mixing the material from different periods:

a. Excavation quality

It is clear that the different excavations at Spy, especially the earliest ones, were not up to modern standards, thus making it impossible to accurately determine the number of archaeological occupations within the cave and/or on the terrace. This is due to 1) the poor quality of the period's excavation methods, 2) the scarcity of field notes, and 3) the understanding of both Palaeolithic archaeology and the complexity of sedimentary processes typical of karstic contexts. The absence of accurate stratigraphic and planimetric data is frustrating.

The excavation methods, notably the timbered galleries of 1885-1886, are certainly responsible

[41] Original text: "*nos collègues ont fait une étude complète de ces restes, ainsi que du milieu où ils ont été découverts, et une simple lecture [de leur mémoire] suffit pour faire apprécier, à un homme du métier, que nuls n'étaient mieux préparés que nos savants confrères pour mener à fin cette entreprise : ils n'ont rien négligé de ce qui pouvait rendre cette trouvaille fructueuse pour la science*".

[42] Original text: "*C'est peut-être la première fois que l'exploration d'une caverne a été exécutée dans des conditions aussi favorables et offrant toutes les garanties de sécurité qu'exigent nos recherches*".

[43] Original text: "*indication [qui] paraît établir le caractère très bouleversé de la stratigraphie primitive à l'intérieur*".

[44] Original text: "*la série moustérienne attribuée au même âge que l'ensemble de l'assise 2, est en réalité la preuve d'un établissement purement moustérien supérieur dont MM. de Puydt [sic] et Lohest ont seulement séparé la base*".

[45] Original text: "*la main des préhistoriques eux-mêmes, ou par l'action involontaire des animaux*".

for this. Some 40 years after his excavations, M. Lohest confessed that "If we could have foreseen the exceptional interest that our excavations were soon to present, we would have proceeded differently. But we were not rich, and as we were carrying out this work entirely at our own expense, acting with thrift was important"[46]. Further down, he adds: "However, we were striving to proceed methodically. From the end of the gallery, Orban brought us a small basket of earth extracted as far as possible at a well-defined level"[47] (Lohest *et al.*, 1925: 146).

b. The nature of the stratigraphic sequence
The thinness of some layers is probably another source of mixing, especially given the excavation methods of the time. This is likely the case for the approximately 15 cm thick second FBL containing elements of at least four distinct techno-complexes belonging to the Middle Palaeolithic, a "transitional" industry, and the Upper Palaeolithic.

A final source of mixing linked with the nature of the deposits are Twiesselmann's excavations of the backdirt accumulated on the slope leading from the cave's terrace to the Orneau River.

c. Natural disturbances
Natural processes are well known to mix materials from different levels. Debris flows, a sedimentary process frequent in cave entrances (Pirson, 2007; Bertran *et al.*, 2009), and post-depositional processes, such as bioturbation, frequently produce mixed deposits. Badger burrows, typical of cave sites, could be responsible for some of the stratigraphic disturbances documented at Spy, notably the presence of Neolithic ceramics and bones in the Pleistocene deposits (De Puydt & Lohest, 1887: 227; Fraipont & Braconier, 1887; Rougier *et al.*, volume 2: chapter XIX). Given the 19th century excavation conditions, especially the poor lighting, such natural disturbances could easily pass unnoticed.

d. Post-excavation mixing
Some of the flint artefacts from the De Puydt collection bear two labels (in red and black ink), suggesting that some were re-attributed to different layers based on stone tool typology (see Di Modica *et al.*, this volume: chapter IX). This kind of post-excavation mixing also clearly affected the Rucquoy collection, which was subsequently re-assigned to one of De Puydt and Lohest's three FBLs (see Di Modica *et al.*, this volume: chapter IX). Post-excavation mixing is also evident with the Neandertal remains, whose identification and attribution were made upon their study and not during the excavations (Rougier *et al.*, volume 2: chapter XIX).

The analysis of the material from Spy is therefore complicated. The lithostratigraphic data is only of limited help, and it is necessary to keep in mind that the conditions in which the material was collected render isolating homogeneous assemblages impossible. With that said, aspects of the archaeological material (typology, technology, raw material, and taphonomy) nonetheless yield interesting information concerning the site's occupation.

Deciphering Spy's archaeostratigraphy: a historic overview

In addition to the original descriptions and interpretations of De Puydt & Lohest (1886a), several other archaeological syntheses are available; either those of the excavators themselves (De Puydt & Lohest, 1887; de Loë & Rahir, 1911; Hamal-Nandrin *et al.*, 1939) or archaeologists who visited the excavations or studied the collections (e.g. Rutot, 1909, 1910; Breuil, 1912; Delporte, 1956; Bordes, 1959; de Sonneville-Bordes, 1961; Ulrix-Closset, 1975; Otte, 1979; Dewez, 1981b).

During their 1885 excavations, De Puydt and Lohest only recognised a single FBL attributed to the "Moustierian" (De Puydt & Lohest, 1886a). However, the following year they identified "three superposed fauna-bearing levels

[46] Original text: "*Si nous avions pu prévoir alors l'intérêt exceptionnel qu'allaient bientôt présenter nos fouilles, nous aurions procédé différemment. Mais nous n'étions pas riches et, comme nous exécutions ces travaux entièrement à nos frais, il importait d'agir avec économie*".

[47] Original text: "*Cependant, nous nous efforcions de procéder avec méthode. Du fond de la galerie, Orban nous apportait une petite manne de terre recueillie autant que possible à un niveau bien déterminé*".

[noting that] […] in these three levels, the stone tools, worked on only one surface, are connected with the so-called Mousterian industry"[48] (De Puydt & Lohest, 1887: 234-235) according to G. de Mortillet's (1872) classification. The artefacts from the three levels nevertheless revealed an evolution that De Puydt & Lohest (1887: 235) described as portraying "steady progress". They specify that no "*coup de poing chelléen* [Chellean bifaces]" were associated with the Neandertal skeletal material in the third FBL. The Spy discovery therefore weakened G. de Mortillet's theory in which the Neandertals only made bifacially retouched tools (de Mortillet, 1883). De Puydt & Lohest (1887: 235) concluded that "the first, currently known race to have lived on Belgian soil had a Neanderthal-type skull, lived in caves, and used stone tools similar to the so-called Mousterian points"[49]. Moreover, according to De Puydt & Lohest (1887), Spy produced evidence for a developed bone tool industry from the Mousterian onwards. Finally, the presence of ceramic fragments in the second FBL demonstrated the existence of pottery during the "Mammoth age", as early as the recent phase of the Mousterian, which was suggested to possibly have been the work of anatomically modern humans (De Puydt & Lohest, 1887; Fraipont & Braconier, 1887: 402-403).

This generally accepted attribution of the material to the Mousterian prevailed until the beginning of the 20th century. However, the coexistence of several distinct industries was already suspected by the original excavators. A few years after the initial excavations, Fraipont mentions "several Chellean tool types" found during Rucquoy's work at the site (Fraipont, 1891). Additionally, Fraipont & Lohest (1887: 692) noted a resemblance between artefacts from the first FBL and others from the first level of Goyet, at that time attributed to the "Goyet phase" (roughly equivalent to the Magdalenian) of Dupont's classification. In terms of the material from the second FBL, they insist on the absence of any equivalent in Belgium or abroad. According to Fraipont & Lohest (1887: 692), this group "could be assigned to the Magdalenian of M. de Mortillet given its numerous worked bones and ivory pieces and to the Moustierian [sic] in terms of knapped flints"[50].

Rutot's (1904, 1906, 1908) work at the beginning of the 20th century adopted Dupont's (1872) classification system, although he made several slight changes and adjustments. For instance, he placed the entire Spy sequence within the Eburnean as defined by Piette, which Rutot positioned between the Mousterian (lacking bone tools) and the Magdalenian (Rutot, 1904). More specifically, he correlated the third FBL with the lower Eburnean, or "Montaigle type", the second FBL with the middle Eburnean, or "Pont-à-Lesse type", and the first FBL with the upper Eburnean, or "Goyet type".

Shortly thereafter, H. Breuil (1907a, 1907b) defined the Aurignacian for the first time, based in no small part on studies carried out in Belgium by É. Dupont and A. Rutot (see Otte, 1979: 29-39; Groenen, 1994: 162-165). At the time, the term Aurignacian designated a culture situated between the Mousterian and the Solutrean. Breuil (1907a, 1907b) also proposed a new interpretation of the Spy material integrating the Aurignacian, which according to M. Otte (1979: 201) represented the first reliable interpretation of the different Spy "levels". The lower level was attributed to the Mousterian "with worked bones"[51]; the middle level, the "Montaigle type" of Rutot's system, assigned to the Middle Aurignacian; the upper level, "Trou Magrite type" (or "Pont-à-Lesse type"), was placed in the Final Aurignacian that contained evidence for the emergence of the Solutrean (Breuil, 1907a, 1907b; see also Otte, 1979: 36).

A few years later, A. de Loë and E. Rahir concluded their excavation report by mentioning

[48] Original text: "*trois niveaux ossifères superposés [notant que] […] Dans ces trois niveaux, les instruments en pierre retaillés uniquement sur une face, se rattachent à l'industrie dite moustérienne*".

[49] Original text: "*la première race, actuellement connue, ayant habité le sol de la Belgique, avait un crâne du type de Néanderthal, vivait dans les grottes et se servait d'instruments en pierre analogues aux pointes dites moustériennes*".

[50] Original text: "*se rattache au magdalénien de M. de Mortillet par ses nombreux os et ivoires travaillés, et au moustiérien [sic] par la taille du silex*".

[51] Original text: "*avec os utilisés*".

that Rutot was present in 1906 and attributed all the Spy material to his three "Aurignacian" stages (de Loë & Rahir, 1911: 58). The lower level, which contained numerous flakes, some retouched and generally Mousterian in appearance, was assigned to the "lower Aurignacian" or "Hastière level". The extremely rich middle level with "declining Mousterian forms"[52] contained the most typical "Middle Aurignacian" or "Montaigle level" pieces. Finally, the upper level contained all the characteristic tools forms of the Trou Magrite or "Upper Aurignacian" (de Loë & Rahir, 1911: 58; see also Rutot, 1906, 1907). In the same period, Abbé Claerhout (1911-1912) attributed the lower level to "the dawn of the Aurignacian"[53], the middle level to the "full blown Aurignacian"[54], and the upper level to the "Solutrean".

In addition to re-interpreting the Spy sequence, H. Breuil (1912) was the first to highlight the mixing of objects from different periods into a single level (see "Mixing" section above). For the first time, the archaeological material was considered independent of the stratigraphy, assessed solely with reference to typology. Breuil identified several Mousterian and "typical Aurignacian" pieces mixed together in the second FBL of De Puydt and Lohest. Additionally, he distinguished an "early Mousterian level"[55] with bifaces from an "upper Mousterian level"[56] (Breuil, 1912). Consequently, Breuil separated the archaeological material from Spy into four distinct phases (Breuil, 1912). The artefacts from the "upper level" (first FBL) were attributed to the "Final Aurignacian with evidence for the transition to the Solutrean"[57]. Two archaeostratigraphic units were described in the second FBL: an "upper Mousterian" and a "typical Aurignacian". The third FBL identified during De Puydt and Lohest excavations on the terrace comprised the fourth phase attributed to the "early Mousterian" with bifaces: "numerous, very roughly made flakes that resemble a rather early Mousterian, heavily patinated, similar [...] to the *coups de poing* [bifaces] from Hamal's collection and the Cinquantenaire's[58]"[59] (Breuil, 1912: 126). Further on he adds: "In the cave, M. de Loé [sic] found an intact layer with poorly worked flakes and six rather large *coups de poing* beneath 2 m of recently moved earth. In my opinion, it is likely that the lower level of the terrace can be linked with this assemblage"[60] (Breuil, 1912: 129).

These four phases will come to be used systematically when discussing the Spy stratigraphy. Some authors even mentioned four layers, despite the fact that Breuil's four phases were never identified in the field. Moreover, the numbering of the layers was occasionally inverted, creating a source of additional confusion. For instance, in some publications the "first level" designates the third FBL of De Puydt and Lohest, with the "fourth level" referring to the first FBL (de Loë, 1928: 66-78; Rahir, 1928: 61-63).

D. Peyrony (1948) attributed the middle and upper levels to the Aurignacian I and Perigordian IV-V, respectively. In the same paper, he mistakenly attributed the lower level, or "Mousterian with worked bones"[61], to the early Perigordian (or Châtelperronian; see Otte, 1979: 202). The same mistake was made by H. Angelroth (1953). H. Delporte (1953, 1956) eventually corrected both errors, attributing levels 4 and 3 to the Mousterian, level 2 to the typical Aurignacian with Aurignac points, and level 1 to the Upper Perigordian with Font-Robert points. Again, four "levels" were presented as corresponding to four "real" layers that could be observed in the stratigraphy, which is clearly not the case.

[52] Original text: "*des formes moustériennes en décadence*".

[53] Original text: "*l'aurore de l'Aurignacien*".

[54] Original text: "*pleine florescence de l'Aurignacien*".

[55] Original text: "*niveau vieux moustérien*".

[56] Original text: "*niveau moustérien supérieur*".

[57] Original text: "*Aurignacien final avec toute la transition vers le Solutréen*".

[58] The *Musée du Cinquantenaire* is part of the Royal Museums of Art and History.

[59] Original text: "*nombreux éclats très grossiers, d'aspect moustérien assez ancien, très patinés, analogues [...] aux coups-de-poing de la collection Hamal et du Cinquantenaire*".

[60] Original text: "*Dans la grotte, M. de Loé [sic] a retrouvé, sous 2 m. de terre récemment remuée, une couche intacte avec éclats d'aspect général grossier, et six coups-de-poings assez grands. Il est à mon sens probable que le niveau inférieur de la Terrasse se raccorde avec cet ensemble*".

[61] Original text: "*Moustérien à os travaillés*".

Hamal-Nandrin *et al.* (1939) noted the existence of a fifth phase in the form of another Middle Palaeolithic industry at the base of the sequence, which he presumed to be older than the third FBL given the presence of bifaces. However, this was not supported by any stratigraphic evidence since the sediments excavated by Hamal-Nandrin were surrounded by backfill. This differs from Breuil's (1912) view, who (mistakenly) associated the "early Mousterian level" with the third FBL of De Puydt and Lohest. In either case, the distinction between the two Mousterian industries, a "Mousterian of Acheulean Tradition" (MTA) and a "Quina-type Charentian" was eventually made by F. Bordes (1959) based on stone tool typology. At the beginning of the 1960s, D. de Sonneville-Bordes (1961) maintained her husband's view of two distinct facies comprising the lower level, while attributing several pieces from the middle and upper levels to the typical Aurignacian and Upper Perigordian.

The first modern and somewhat exhaustive treatment of the Spy material is the monumental analysis of M. Ulrix-Closset (1975), which included all of the Middle Palaeolithic pieces. Again working within the framework of Bordes' two facies, which she placed in the third FBL, Ulrix-Closset also suggested that the Middle Palaeolithic artefacts from the second FBL be assigned to an "Evolved Mousterian".

A few years later, the Aurignacian material from Spy was studied by M. Otte (1979), the Gravettian material by Otte (1979) and Dewez (1987), and the material from the Late Upper Palaeolithic by Dewez (1987). Otte (1979) also distinguished an "industry with leaf points", which he referred to as "Spy points". This material is today attributed to a Middle-to-Upper Palaeolithic transitional industry known as the Lincombian-Ranisian-Jerzmanowician or LRJ (Flas, 2006).

Summary of the archaeostratigraphy

The 1886 stratigraphy, along with the three "fauna-bearing levels" recognised on the terrace, have often constituted the lithostratigraphic reference for the archaeological sequence documented at Spy. The discovery of the Neandertal skeletons during this same field season, in excavation conditions considered optimal at the time, probably explains why the stratigraphy described on this occasion carried such authority.

Future excavators who uncovered *in situ* deposits primarily attempted to correlate their own stratigraphic observations with those of De Puydt and Lohest. The best example is de Loë and Rahir, who also adopted a tripartite division of FBLs. However, the correlation between their system and that of 1886 is problematic. While the correlation of the lithostratigraphic descriptions is plausible, the situation is very different for the archaeological material. For instance, the numerous Mousterian points attributed to the second FBL of De Puydt & Lohest (1887) come from de Loë & Rahir's (1911) third FBL, as highlighted by Breuil (1912). Similarly, Hamal-Nandrin employed the 1886 stratigraphy to place his discovery of a Mousterian layer with bifaces, considering it "older than the lower level […] excavated by Marcel De Puydt and Max Lohest"[62] (Hamal-Nandrin *et al.*, 1939: 146) based on typology alone and without any stratigraphic evidence.

Subsequent analyses of the archaeological material from Spy also tried to work with this reference sequence despite clear problems in connecting this material with De Puydt and Lohest's stratigraphy. This sometimes led to important errors, a typical example of which is Rucquoy collection, reclassified by A. Rutot with reference to the 1886 stratigraphy and taking into account the newly designated stages of the Aurignacian (see Di Modica *et al*., this volume: chapter IX). This desire to reclassify all the archaeological and anthropological material into the three FBLs of 1886 is evident in several key syntheses, even the most recent examples (Ulrix-Closset, 1975; Otte, 1979; Semal *et al.*, 2011).

Nevertheless, multiple factors (see "Mixing" section above) make it difficult to extend a stratigraphy composed of the three FBLs across the site or, more generally, correlate the archaeological material with a lithostratigraphic sequence. These include the early date and number of times the site was excavated, the complexity and richness of the deposits, as well as different issues tied

[62] Original text: "*plus ancien que le niveau inférieur […] fouillé par Marcel De Puydt et Max Lohest*".

to the material's conservation (e.g. losses, exchanges, reclassifications). Moreover, recent progress in understanding the genesis and stratigraphic complexity of cave entrance sequences (e.g. Texier, 2006; Pirson, 2007; Bertran *et al.*, 2009) shows the 19th century stratigraphy to be overly simplistic.

As a result, the different cultures and/or techno-complexes currently identified at Spy are here considered independently of the three FBLs and any lithostratigraphic context. The detailed correlation between the lithostratigraphic and archaeostratigraphic data requires a critical and detailed reassessment of all the material in order to match its characteristics (typo-technology, raw material, and taphonomy) on the one hand, with its origin (excavator, site sector, and published stratigraphic position) on the other. Presently, only part of the Middle Palaeolithic material has been re-evaluated in such a way (Di Modica *et al.*, this volume: chapter IX).

Given our present understanding, the following techno-complexes have been identified: several Middle Palaeolithic facies, a transitional industry, distinct Aurignacian and Gravettian facies, as well as material belonging to the Late Upper Palaeolithic, Mesolithic, Neolithic, Protohistoric, and historical periods. When stratigraphic or planimetric information is available, whether reliable or not, it will be mentioned.

The Middle Palaeolithic

Immediately following the 1885-1886 excavations, all the lithic material was attributed to the Mousterian (De Puydt & Lohest, 1886a, 1887). However, a portion was quickly re-attributed to what has become known as the Upper Palaeolithic; first the material from the first FBL (Fraipont & Lohest, 1886), followed by part of the material from the second FBL (Breuil, 1912). The work of Breuil (1912) marks the beginning of the steady identification of several different Middle Palaeolithic facies, both within the cave and in the second and third FBLs on the terrace. Some forty or so years after Breuil, the work of F. Bordes (1959), but especially that of M. Ulrix-Closset (1975), would heavily influence the traditional view of Spy's Middle Palaeolithic record. The latter distinguished an "Early Mousterian of Acheulean Tradition" at the base of the deposits, overlain by a "Quina-type Charentian" in the third FBL and an "Evolved Mousterian" in the second FBL (Ulrix-Closset, 1975). The critical revision of the stratigraphic data presented above coupled with a comprehensive re-examination of the lithic material (see Di Modica *et al.*, this volume: chapter IX for more details) have, however, questioned the relevance of these attributions.

An "Early Mousterian of Acheulean Tradition"

Several triangular and flat cordiform bifaces in flint and *phtanite* form part of the Spy collections. Recovered during Rucquoy's (1886), de Loë & Rahir's (1911) and Hamal-Nandrin's (Hamal-Nandrin *et al.*, 1932, 1939) excavations, they are exclusively associated with the interior of the cave. The 1885-1886 excavations, which concentrated primarily on the terrace, yielded material described as being "worked on only one face"[63] (De Puydt & Lohest, 1887: 235). Despite the fact that these bifaces drew attention very early – being one of the characteristics defining Breuil's (1912) "Early Mousterian" – it is only after Hamal-Nandrin's excavations that an archaeological level with a bifacial component older than the third FBL was suggested (Hamal-Nandrin *et al.*, 1932, 1939).

The notion of "Mousterian of Acheulean Tradition", originally introduced by Peyrony (1921), was applied for the first time to the Spy material by F. Bordes who wrote: "It seems certain that this cave contained a Mousterian of Acheulean tradition, several beautiful and absolutely typical *phtanite* bifaces attest to its presence"[64] (Bordes, 1959: 155). In her Ph.D. dissertation, Ulrix-Closset reaffirmed the attribution of the bifaces to the "Early Mousterian of Acheulean Tradition", while also grouping the rare Levallois products found at Spy in this facies (Ulrix-Closset, 1975: 58-59). Although a recent re-examination of the material once again supported the attribution of several bifaces to a Mousterian of Acheulean Tradition (Di Modica *et al*., this volume:

[63] Original text: "*retaillés uniquement sur une face*".

[64] Original text: "*Que cette grotte ait contenu du Moustérien de tradition acheuléenne semble certain et quelques beaux bifaces de phtanite, absolument typiques, l'attestent*".

chapter IX), the lack of sufficient contextual information precludes associating these artefacts with the Levallois *débitage*.

The rare stratigraphic information places these bifaces at the base of the deposits. Rucquoy wrote that a *phtanite* biface was found "in the lower loamy level, lying on the floor"[65] (Rucquoy, 1886-1887: 322), and Hamal-Nandrin found a biface "at the entrance of the cave, at the base of one of the rock walls"[66] (Ophoven & Hamal-Nandrin, 1949-1950: 7). The latter considered the deposits containing the bifaces inside the right gallery to appear older than the third FBL of De Puydt and Lohest (Hamal-Nandrin *et al.*, 1939: 146). This cannot be demonstrated with any certainty as these deposits were surrounded by backfill and could not be directly correlated with the sequence observed on the terrace.

These techno-typologically identical bifaces are comparable to those from other biface industries found in Weichselian Early Glacial deposits across Belgium and Northern France (Di Modica *et al*., this volume: chapter IX). In addition, they present some spatial cohesion having all been discovered at the entrance of the cave and inside the right gallery. The exact stratigraphic position of these bifaces is, however, difficult to deduce with any certainty, and their stratigraphic relationship with the third FBL from the terrace remains unknown.

The absence of a "Quina-type Charentian"

The first mention of a "Quina-type Charentian" at Spy, which corresponds to Breuil's (1912) "Early Mousterian" without the MTA-type bifaces, was made by F. Bordes (1959), followed by Ulrix-Closset (1975). This "Quina-type Charentian", associated by Ulrix-Closset (1975) with the third FBL, was defined by three co-occurring traits: the character of the *débitage* using local flint river pebbles, the presence of scrapers and *limaces*, and the fact that most of the artefacts are "more or less rolled"[67] (Ulrix-Closset, 1975: 65).

A re-examination of this material (Di Modica *et al*., this volume: chapter IX) demonstrated its attribution to the "Quina-type Charentian" and association with the third FBL to be incorrect for several reasons. First, the association of the three different above-mentioned criteria is not demonstrated. Second, the defining traits outlined above apply primarily to the material recovered from within the cave[68], whereas not only is the third FBL known only from the terrace, but no reliable stratigraphic correlation can be made between the two areas. Finally, the technological characteristics mainly result from the morphology of the locally available river pebbles (see Di Modica *et al*., this volume: chapter IX for more details) and do not fit the current definition of the Quina *débitage* (Bourguignon, 1997).

A "Mousterian with small bifaces"

Marguerite Ulrix-Closset also attributed a series of bifaces she considered "*dégénérés*" to the "Quina-type Charentian" (Ulrix-Closset, 1975) based on comparisons with other sites but without any reliable stratigraphic criteria. She associated these small bifaces with the third FBL; like the rest of the material that she attributed to the "Quina-type Charentian", such an association is not demonstrated as they were found exclusively inside the cave.

These irregular bifaces are much smaller than the MTA examples, often have a cortical base, and can best be described as *Fäustel* – an artefact type frequent in the Central European Micoquian (Bosinski, 1967). Their similar taphonomy (patina, lustre, damaged edges) and spatial distribution limited to the cave's interior further support their representing a coherent assemblage (Di Modica *et al*., this volume: chapter IX).

However, the similar spatial distribution of the *Fäustel* compared to that of the cordiform and triangular bifaces raises questions concerning their relationship with the MTA. Regional comparisons reveal that these two artefact types are only associated in sites with poorly understood

[65] Original text: "*dans le niveau limoneux inférieur et reposant sur le sol*".

[66] Original text: "*à l'entrée de la grotte, à la base de l'un des côtés du rocher*".

[67] Original text: "*plus ou moins roulé*".

[68] Amongst the rare artefacts from the De Puydt's collection that are still attributed with certitude to the third FBL, there are neither scrapers nor *limaces*, and the material is relatively "fresh" (i.e. not rolled).

stratigraphies. Similar questions can also be posed regarding the presence of *Keilmesser* at Spy, as these artefacts are commonly associated with the Central European Micoquian industries, where they are found together (Bosinski, 1967). However, both their taphonomy and spatial distribution suggest that the *Keilmesser* and *Fäustel* constitute two distinct groups at Spy (see Di Modica *et al.*, this volume: chapter IX for more details).

A recent re-examination of the Middle Palaeolithic material from Spy (Di Modica *et al.*, this volume: chapter IX), as well as a revision of bifacial artefacts found in Belgium (Ruebens & Di Modica, 2011), raised the possibility that the "degenerated bifaces" from Spy form part of a vast Central European techno-complex that extends to the Atlantic coast. These pieces, frequent in the Central European Micoquian (Bosinski, 1967; Jöris, 2004, 2006), constitute the defining features of the Mousterian with small bifaces ("*Moustérien à petits bifaces dominants*") documented in Brittany and Normandy (see Di Modica *et al.*, this volume: chapter IX), where the rare available chronostratigraphic data place it in a period encompassing MIS 5 and the beginning of MIS 4 (Molines *et al.*, 2001).

From an "Evolved Mousterian" to one or several Late Middle Palaeolithic facies

The notion of an "Evolved Mousterian" introduced by Ulrix-Closset (1975) concerned lithic material she attributed to the second FBL. This material, in fact, corresponds to Breuil's (1912) "Upper Mousterian" composed of artefacts from both De Puydt and Lohest's second FBL and de Loë and Rahir's third FBL. This "Evolved Mousterian" is exclusively represented on the terrace and under the current cave porch. The material is "fresher" compared to the rolled "Quina-type Charentian" and is characterised by numerous Mousterian points, bifacial foliates, *Blattspitzen*, and bifacial scrapers.

According to Ulrix-Closset (1975: 65), this facies is "probably contemporaneous with the Upper Palaeolithic"[69]. This probably explains the use of the somewhat loaded term "Evolved Mousterian" in the context of the Middle-to-Upper Palaeolithic transition. It was later replaced by the term "Recent Mousterian with leaf points" (Ulrix-Closset, 1995), more descriptive and hence more appropriate.

The extremely well-preserved "Evolved Mousterian" artefacts are limited to the terrace. However, a combination of petrographical and techno-typological traits allows at least two groups to be distinguished: one formed by Mousterian points made on *phtanite*, lustred sandstone, and fine-grained flint varieties; the other by the bifacially retouched tools made from coarser-grained flint river cobbles. Given the early date of the excavations, a clear association of these two groups, while plausible, is impossible to verify. Accordingly, they will be presented separately.

Mousterian points

The numerous Mousterian points recovered from Spy have drawn the attention of researchers ever since the original excavations of De Puydt and Lohest (see Jungels *et al.*, this volume: chapter X for a more detailed analysis). Made in better quality flint varieties than those available in the site's immediate surroundings, the scarcity of corresponding *débitage* products suggests that the tool blanks were imported (see Di Modica *et al.*, this volume: chapter IX for more details).

These points are reported as being from the second FBL identified on the terrace during the 1886 excavations (De Puydt & Lohest, 1887); however, a portion comes from the previous year's excavation, before three FBLs were recognised. It seems, therefore, that these pieces were attributed to the second FBL only after the 1886 fieldwork, as suggested by the two sets of labels on several examples (Di Modica *et al.*, this volume: chapter IX). Their clear association with a specific FBL is therefore impossible to establish. Moreover, the De Puydt material from the third FBL (according to the *Grand Curtius* Museum inventory) also contains two Mousterian points similar to those attributed to the second FBL, both in terms of raw materials (flint and *phtanite*) and techno-typological characteristics. In their excavation report, De Puydt and Lohest drew attention to the fact that the *phtanite*

[69] Original text: "*probablement contemporain du Paléolithique supérieur*".

point was found by J. Fraipont "next to the Spy no. 1"[70] (De Puydt & Lohest, 1887: 234), implying its provenience as the third FBL.

Almost all of the points come from the terrace and are unpatinated, while the few examples from within the cave are patinated, lustred, and have damaged edges. The taphonomic aspects of these latter examples are consistent with the remainder of the material recovered from the cave's interior (Di Modica *et al.*, this volume: chapter IX).

Keilmessergruppen types

Ulrix-Closset was the first to highlight the existence of asymmetrical bifacial pieces with plano-convex profiles amongst the archaeological material from Spy. While several are made in *phtanite*, most were manufactured from flint river pebbles as indicated by remnant cortex. Mainly recovered from the terrace and very well preserved, only a single patinated foliate piece was recovered by Twiesselmann in one of the "*fissures*" located close to the cave's entrance (Di Modica *et al.*, this volume: chapter IX). Like the Mousterian points, these artefacts are believed to come from the second FBL. However, their being reassigned to this level following the excavation cannot be ruled out.

In typological terms, this artefact type undoubtedly indicates eastern influences as they show clear affinities with the *Keilmessergruppen* and/or the *Blattspitzengruppen* from Germany (Jöris, 2002, 2004, 2006; Ruebens & Di Modica, 2011). Several arguments suggest they represent a Middle Palaeolithic facies that clearly differs from the cultural facies associated either with the *Fäustel* or the MTA bifaces (Di Modica *et al.*, this volume: chapter IX). If these *Keilmesser* are associated with the Mousterian points, as suggested by Ulrix-Closset (1975), we have to consider that only a single Middle Palaeolithic facies was present on the terrace, bringing the total number identified at Spy to three. On the other hand, if these two groups do not in fact form a single cultural entity, there would be at least four different Middle Palaeolithic facies documented at Spy (Di Modica *et al.*, this volume: chapter IX).

[70] Original text: "*à côté du Spy n° 1*".

Neither stratigraphic arguments nor regional comparisons provide a clear chronology for any of the probable facies. Only an attribution of the *Keilmesser* to the Weichselian can be suggested based on the chronology of the *Keilmessergruppen* and *Blattspitzengruppen* in Germany (Jöris, 2002, 2004, 2006; Richter, 2006). The few radiocarbon dates obtained on the material from the terrace, notably on faunal remains from the third FBL, support the attribution of the entire terrace sequence to MIS 3. This would suggest that the Middle Palaeolithic facies from the terrace also date to MIS 3 and are more recent than the MTA and the Mousterian with small bifaces. However, the small number of dates, together with the absence of any clear association between the dated bones and the Middle Palaeolithic archaeological material, clearly suggests that this chronology should be considered with caution.

The Lincombian-Ranisian-Jerzmanowician (LRJ)

The presence of leaf points with flat, inverse retouch is mentioned by M. Otte, who referred to them as "Spy points" (Otte, 1979: 270; see also Campbell, 1980). Although the precise origin of most of these points is unknown, they sometimes appear to come from disturbed deposits. Descriptions and illustrations provided by M. De Puydt and M. Lohest do indicate that several were found in the second FBL, an association strengthened by their particular patina and surface alterations (Otte, 1979: 273). Attributed to the Upper Palaeolithic by Breuil, these points were initially considered by Otte (1974, 1979) to be Aurignacian. This same author eventually placed them in a techno-complex with "leaf points" distinct from the Aurignacian (Otte, 1981). Today these pieces have come to be known as "Jerzmanowice points", and considered the fossil directors of a Middle-to-Upper Palaeolithic transitional industry: the Lincombian-Ranisian-Jerzmanowician complex (LRJ), identified at more than 30 sites in North-Western Europe (Desbrosse & Kozlowski, 1988; Flas, 2006, 2008, this volume: chapter XI).

Aurignacian

A rich and varied Aurignacian assemblage, including osseous artefacts and personal ornaments (Otte, 1979), is traditionally associated

with the second FBL. The notion of an Aurignacian at Spy was first introduced by Abbé Breuil (cf. supra). However, one has to keep in mind that Breuil's conception of the Aurignacian gathered together both Aurignacian and Gravettian elements. At Spy, it includes carinated endscrapers, angle and busked burins, blades with "proto-Solutrean retouch", Font-Robert points and "proto-Solutrean points" (Breuil, 1912). The characterisation and more precise classification of this material to a particular phase of the Aurignacian remain problematic, mainly due to the absence of a reliable stratigraphic context. It is for this reason that D. de Sonneville-Bordes (1961) provided only a short description of the Spy collection, simply noting typical features such as split-based points and busked burins, which she assigned to the "Typical Aurignacian" without further precision.

A recent revision of most of the Aurignacian material (Flas *et al.*, this volume: chapter XII) based on the chrono-cultural sequences from the Aquitaine Basin (Chiotti, 2003; Bordes, 2006; Pessese & Michel, 2006) indicates several Aurignacian phases to be present. A small Early Aurignacian component (carinated endscrapers, Dufour bladelets, split-based points) and several elements of the Late Aurignacian (nosed endscrapers, but also busked and Vachons burins) were identified (Flas *et al.*, this volume: chapter XII). A new date obtained on a flat, triangular spearpoint fragment, likely a split-based point, found in the faunal collection, may also belong to the Early Aurignacian (32,830 +200/-190 BP; Semal *et al.*, 2009, this volume: chapter XVI). This is likely a minimum age given the C/N ratio of 3.6. A large part of these ivory artefacts and ornaments can also be connected to the Aurignacian occupation(s), both in terms of typology and technology (Khlopachev, this volume: chapter XIV).

Gravettian

The first modern analysis of the Gravettian material from Spy documented a relatively homogeneous assemblage (Otte, 1977, 1979) traditionally associated with the first FBL. A few years later, Dewez divided the material into Maisierian and Gravettian levels (Dewez *et al.*, 1986). A recent revision of the Gravettian material identified three techno-typological components (Pesesse & Flas, this volume: chapter XIII). The Maisierian assemblage, including Font-Robert and Maisières points, likely represents the most important Gravettian occupation at Spy. With that said, some of the Font-Robert points may belong to a second Gravettian phase as they persist in Belgium (Otte, 1977). Based on similarities with the Station de l'Hermitage assemblage, the Spy micrograveltes could also be included in this second assemblage. Finally, a group of truncated backed pieces provides evidence for at least one later Gravettian occupation (Pesesse & Flas, this volume: chapter XIII).

While these three components more or less correlate with the three phases of the Belgian Gravettian (Otte & Noiret, 2007), our overall understanding of the assemblage is limited by our still poor understanding of the Belgian Gravettian sequence (Pesesse & Flas, this volume: chapter XIII). More specifically, the position of several Gravettian pieces, such as micrograveltes, in either the second or the third component, is difficult to discern. Finally, a recent re-assessment of the bone and ivory artefacts suggests that some may belong to the Gravettian (Khlopachev, this volume: chapter XIV).

Late Upper Palaeolithic

The Spy collections also yielded a small number of Magdalenian and Epipalaeolithic pieces (Dewez, 1969, 1981b) representing short occupations or very brief stopovers. Some of the ivory pieces may also belong to this period given the particular *débitage* technique using frozen fresh ivory. This specific technique is characteristic of Epigravettian and Magdalenian sites and provides evidence for a winter occupation of the site, when temperatures could reach -25°C (Khlopachev, this volume: chapter XIV). A fork-based antler artefact can also probably be connected to a Magdalenian occupation (Flas *et al.*, this volume: chapter XII).

The Holocene material

Holocene material is also mentioned as being recovered from Spy, though mainly in the backdirt of old excavations, the lower terrace, or from the wooded plateau overlying the cave (Ulrix-Closset, 1975: 57; Otte, 1979: 309; Dewez, 1981a; Cahen, 1986; Plumier, 1987). The Mesolithic is only represented by several microliths

(Dewez, 1981a; Cahen, 1986), while a Neolithic presence is evident in the form of polished axes, arrowheads, and pottery fragments (De Puydt & Lohest, 1886b: 86; Ulrix-Closset, 1975: 57; Cahen, 1986). Numerous human bones are also related to this latter period as the cave was used as a collective burial (Semal *et al*., 1996, this volume: chapter XVI; Rougier *et al.*, volume 2: chapter XIX).

Protohistoric ceramic fragments were also discovered (Cahen, 1986; Plumier, 1987), as well as a bone fragment engraved with a "swastika" attributed to the Bronze Age by Chalon & De Puydt (1914; see also Dewez, 1981b, and Plumier, 1987). The Gallo-Roman period is represented by a bronze ring with a glass pearl, several coins as well as pottery and tile fragments amongst other things (Dewez, 1981b; Plumier, 1987). Material from the end of the Middle Ages was also documented (Otte, 1979: 309; Dewez, 1981a), as are traces of modern visitors and excavators passing by the site in the form of clay pipe fragments or coins (Cahen, 1986). The presence of Neolithic and Protohistoric material in the reworked top layer of the terrace was also noted (De Puydt & Lohest, 1886a: 35; Ulrix-Closset, 1975: 57).

RE-EVALUATION OF THE STRATIGRAPHIC POSITION OF THE NEANDERTAL REMAINS

The Neandertal remains "lay at a depth of 3.85 m beneath three layers of undisturbed deposits"[71] (Fraipont, 1891: 322). According to the excavators, they came from the third FBL, between layers D and F (e.g. De Puydt & Lohest, 1887: 228; Fraipont & Lohest, 1887: 665). Moreover, they stressed the presence of a calcite-cemented (breccia or tufa) layer sealing the Neandertal bones, thus confirming their antiquity: "Zone C formed a hard breccia above the human bones that was resistant to hammer blows"[72] (Fraipont & Lohest, 1887: 664).

Following the original positioning of the skeletal remains by the excavators, several subsequent interpretations were proposed. Rutot positioned the Neandertal remains either within the third FBL (Rutot, 1904) or the second FBL (Rutot, 1906: 956), but finally associated them with the third FBL like the excavators themselves (Rutot, 1910). Based on the presence of several flints "at the level of the corpses" similar to those from the second FBL, Breuil (1912) considered that the skeletons must be related to the "Upper Mousterian". According to F. Bordes, the skeletons most probably belonged to a "Quina-type Mousterian", basing his argument on 1) the presence of several Charentian-like pieces in the second and third FBLs, and 2) comparisons with other sites with Neandertal burials where they were frequently associated with this facies (Bordes, 1959: 157) but never with the MTA. Although this interpretation was often repeated (e.g. Ulrix-Closset, 1975: 65; Toussaint *et al.*, 2001) it was not based on any objective field data. The first-hand observations of the discoverers remain the only reliable source of information.

The exact stratigraphic position of the skeletons is difficult to determine given inconsistencies in the discoverers' different publications. With that said, several arguments do help clarify this problem: the nature of the archaeological material found near the human remains, their anthropological study, and new radiocarbon dates.

The excavators observed an abundance of knapped flints near the human remains (De Puydt & Lohest 1887: 233). According to Fraipont & Lohest (1887: 665),

> "Two Mousterian points, a lustred sandstone blade, numerous shapeless flakes, and an intentionally used bone splinter were found […] at the level of and near the skeletons. The collection of M. De Puydt also contains several other flint and lustred sandstone instruments from the lower part of the human bones level"[73].

[71] Original text: "*se trouvaient à 3m,85 de profondeur sous trois couches de dépôt non remaniés*".

[72] Original text: "*La zone C formait au-dessus des ossements humains une brèche dure, résistant au choc du marteau*".

[73] Original text: "*Deux pointes moustériennes, une lame en grès lustré, beaucoup d'éclats informes et une esquille d'os intentionnellement usée ont été trouvées […] au niveau et à côté des squelettes. La collection de M. De Puydt contient en outre plusieurs autres instruments en silex et en grès lustré provenant de la partie inférieure du niveau des ossements humains*".

The excavators add that a "coarse flint, probably from the gravel, was particularly abundant at the level of the skeletons"[74] (De Puydt & Lohest, 1887: 234). In regards to one of the two Mousterian points, they specify that "[…] next to Spy no. 1, M. Fraipont extracted a 65 mm long, black *phtanite* point of the purest Mousterian type"[75] (De Puydt & Lohest, 1887: 234).

A recent re-analysis of the material from the De Puydt's collection documented a total of eight artefacts with labels indicating their proximity to the human bones; in addition to the *phtanite* Mousterian point, an elongated, lustred sandstone flake, a large fragment of a Levallois flake made in fine-grained flint, a flint flake, as well as three flakes and a point made on local flint were all noted as coming from near the skeletal material. All of these artefacts discovered not far from the human remains are clearly attributable to the Middle Palaeolithic.

The 1886 excavators add an important element in specifying that no "Chellean *coup de poing*" (biface) was unearthed with the skeletons from the third FBL (De Puydt & Lohest, 1887: 234; Fraipont & Lohest, 1887: 665). This fact, already noted by Bordes (1959), tends to invalidate the association of the skeletons with one of the two Middle Palaeolithic facies with bifaces, either the MTA or the "Mousterian with small bifaces". The fact that these two biface facies were exclusively present inside the cave, while the skeletons were found on the terrace, also contradicts this association.

The presence of a *phtanite* Mousterian point next to "Spy no. 1" (De Puydt & Lohest, 1887: 234) is an interesting element. Attributed to the third FBL by the excavators, this point is very similar to those from the second FBL, as already pointed out by the excavators themselves: "This piece [is] as beautiful as most of the points from the second level"[76] (De Puydt & Lohest, 1887: 234). However, numerous uncertainties concerning the exact stratigraphic origin of the archaeological material suggest that any association with an FBL should be treated with caution.

Several hypotheses concerning the relationship between the human remains and the archaeological material discovered near the skeletons – particularly the *phtanite* Mousterian point – can be advanced:

- The 1886 stratigraphic sequence is wrong, and the archaeological material was incorrectly associated with the skeletons. This is plausible when the inaccuracy of the excavations and the complexity of Palaeolithic sequences in cave entrance environments are taken into account.

- If the 1886 stratigraphic sequence is correct, two hypotheses must be considered. Either the Neandertal remains are contemporaneous with the third FBL, implying that 1) the third FBL contained a genuine Middle Palaeolithic level, and 2) it is distinct from the Mousterian level in the second FBL. In this situation, the third FBL would represent a clear Mousterian context including flakes from local river pebbles associated with Mousterian points. Or the position of the Neandertal remains in the third FBL results from a burial pit cut from a surface contemporaneous with the second FBL. If this second hypothesis is correct, the Mousterian points are uniquely associated with the second FBL.

The burial hypothesis was not favoured by the discoverers:

> "The position of individual no. 1, the only one that was possible to specify, does not allow us to conclude that this man came from a burial. Moreover, it is difficult to accept that the men from the second level, after having buried one of their own in their dwelling and in such conditions that his body was only covered by a few centimetres of earth and stones, continued to tread on him and accumulated on top of him the debris that partially constitute layer C. On the contrary, the most logical interpretation based on the observed profile is that the men of Spy died at the entrance to the cave that had been their home, on the surface partly formed by their

[74] Original text: "*silex grossier provenant probablement du gravier était particulièrement abondant au niveau des squelettes*".

[75] Original text: "*[…] à côté du Spy n° 1, M. Fraipont a extrait une pointe en phtanite noir, mesurant 65 mill., du type moustérien le plus pur*".

[76] Original text: "*Cette pièce [est] aussi belle que la plupart des pointes du deuxième niveau*".

cooking debris"[77] (Fraipont & Lohest, 1887: 668).

This idea of a burial is however suggested by others as early as the discovery itself (de Nadaillac, 1886; see also Maureille *et al.*, volume 2: chapter XXI). A recent anthropological study (see Rougier *et al.*, volume 2: chapter XIX) suggests that the two skeletons were rapidly buried. Several arguments tend to support this suggestion, the most striking of which is the absence of gnawing traces left by scavengers on the Neandertal bones (Maureille *et al.*, volume 2: chapter XXI). A further argument is linked to the small hand bones recently identified from the site's faunal collections, which are usually rapidly dispersed during the body's decomposition (Semal *et al*., 2009; Crevecoeur, volume 2: chapter XXVII). Although this rapid interment of the corpses is consistent with the burial hypothesis, it does not exclude an equally rapid burial by natural sedimentary processes.

Direct radiocarbon dates obtained from the bones of the two Neandertal adults indicate an age of about 36 ky uncal BP (Semal *et al.*, 2009, this volume: chapter XVI). While several millennia younger than the dates obtained from fauna samples attributed to the third FBL (ca. 43 ky uncal BP; Semal *et al.*, this volume: chapter XVI), it is compatible with the available age range of the second FBL (37-29 ky uncal BP; Semal *et al.*, this volume: chapter XVI). This argument is also consistent with the hypothesis of a burial pit cut from the second FBL, even if the small number of available dates from these two FBLs calls for caution.

In such a context, a burial pit cut into the upper part of the third FBL from one of the occupations attributed to the second FBL (Mousterian? LRJ?) seems to be the most parsimonious explanation. In addition to elements supporting a rapid burial, the best argument for an intentional burial is provided by the excavators' description of the discovery itself. In regard to Spy no. 1, they indicate that the individual "seemed to be resting on their right side with a hand leaning against their lower jaw. […] It lay slightly across the axis of the cave with the head towards the east and feet towards the west"[78] (De Puydt & Lohest, 1887: 229).

If there was a burial, it seemed to have been disturbed,

> "In spite of a careful search, many bones were not found. The skull was fractured. Several fractures were very old as some fragments were no longer in anatomical connection and cemented together by calcareous incrustations. […] When we collected the lower jaw of 'Spy no. 1', it was broken along the symphysis, a hand phalanx was inserted in the middle of the fracture, and the whole was re-cemented by a clayey tufa"[79] (De Puydt & Lohest, 1887: 229).

Disturbances affecting the Spy no. 2 remains are even more numerous because they "lay out of their natural connections, and the cranium was fractured into about 40 pieces"[80] (De Puydt & Lohest, 1887: 229). A letter from A. Orban to M. De Puydt (undated, Dallemagne archives) describing the progress of the excavations is even more explicit in mentioning that, "the human limbs are thus scattered across the entire terrace"[81].

[77] Original text: "*La position de l'individu n° 1, la seule qu'on ait pu préciser, ne permet pas de conclure que cet homme provenait d'une sépulture. On acceptera en outre difficilement que les hommes du deuxième niveau, après avoir enfoui l'un des leurs dans leur habitation et dans des conditions telles que son corps n'était recouvert que de quelques centimètres de terre et de cailloux, aient continué à marcher dessus et aient accumulé sur lui les débris qui, en partie, constituent la couche C. L'interprétation la plus logique, au contraire, qu'il soit permis de donner à la coupe constatée, est que les hommes de Spy sont morts à l'entrée de la grotte qui leur avait servi de demeure, sur le sol qu'ils avaient en partie contribué à former par leurs débris de cuisine*".

[78] Original text: "*paraissait couché sur le côté droit, la main appuyée contre la mâchoire inférieure. […] II était placé à peu près en travers de l'axe de la grotte, la tête vers l'est, les pieds vers l'ouest*".

[79] Original text: "*Beaucoup d'os n'ont pas été retrouvés malgré des recherches minutieuses. Le crâne était fracturé. Plusieurs fractures étaient fort anciennes, des morceaux déplacés de leurs connexions anatomiques étant resoudés par des incrustations calcaires. […] Lorsque nous avons recueilli la mâchoire inférieure du 'Spy n° 1', celle-ci était brisée suivant la symphyse, une phalange de la main était engagée au milieu de la fracture, et le tout était resoudé par un tuf argileux*".

[80] Original text: "*se trouvaient déplacés de leurs connexions naturelles et le crâne était fracturé en une quarantaine de morceaux*".

[81] Original text: "*les menbres [sic] humain sont ainsi décimés, parmis [sic] toute la terrastre [sic]*".

The radiocarbon dates obtained from the Spy skeletons provide evidence for the persistence of Neandertal groups in Belgium up until around 36 ky uncal BP, raising questions as to their cultural association. Based on our current understanding, the most recent Mousterian assemblage from Northwestern Europe dates to between 40 and 37 ky uncal BP (Scladina 1A; Pirson *et al.*, 2012). Although the Spy skeletons appear more recent, all of the archaeological material described as close to the human bones is typically Middle Palaeolithic. An association with the LRJ is possible as this cultural facies is dated to between 38 and 35 ky uncal BP (Flas, 2011). However, only a series of six recently obtained dates (~ 38 ky uncal BP from Glaston, UK; Flas, 2011; Cooper *et al.*, 2012) can be considered reliable both in terms of dating methodology (ultrafiltration) and their association with the archaeological material. The possible association with the LRJ must remain a working hypothesis given problems with the chronology of the LRJ in general, the early date of the excavations at Spy, and the absence of any clear link between the human remains and the archaeological material.

SUMMARY OF THE SPY STRATIGRAPHY AND CHRONOSTRATIGRAPHIC CONTEXT

Relevant lithostratigraphic information is available only from the De Puydt and Lohest and de Loë and Rahir excavations. Although general descriptions of the main lithostratigraphic units can be found in the different stratigraphic descriptions they published, a detailed correlation between the two sequences is impossible. Moreover, several discrepancies appear in the distribution of the archaeological material in the sedimentary units. The most telling example is the presence of a Middle Palaeolithic with Mousterian points in De Puydt and Lohest's red layer (second FBL) that de Loë and Rahir place below their red layer (i.e. in their third FBL). The lithostratigraphic description employed here is primarily based on information from De Puydt and Lohest, only occasionally incorporating information from de Loë and Rahir.

Very little chronostratigraphic data is available for the Spy sequence. Several radiocarbon dates help provide a general chronostratigraphy; however, these dates should be considered with caution given 1) the absence of a precise stratigraphic location for the dated material, and 2) the fact that most of the dates were not obtained from culturally attributable pieces, such as bone points. Developing a climatostratigraphy (Haesaerts, 1974; Pirson, 2011) is also impossible due to major problems connected with the palaeoenvironmental interpretation of the sequence. In much the same way, correlations with the Middle Belgian loess sequence, which serves as a reference sequence for the Upper Pleistocene (Haesaerts, 1974, 1984, 2004; Pirson *et al.*, 2009; Haesaerts *et al.*, 2011), is also tricky. This loess sequence has frequently allowed a fairly accurate chronostratigraphic positioning of Palaeolithic assemblages in Belgium (Haesaerts, 1978; Haesaerts *et al.*, 1999; Pirson & Di Modica, 2011). In several specific situations, this has been extended to Middle Pleistocene sequences (Meijs, 2011; Meijs *et al.*, 2012). Although correlations between cave entrance deposits and loess sequences at other sites were possible and useful in terms of chronostratigraphy (Pirson, 2002, 2007, 2011; Pirson *et al.*, 2006, in press) and despite the proximity of Spy cave to a well-preserved loess cover, the poor quality of the stratigraphic information linked to the early date of the excavations prevents any detailed comparison with regional loess sequences. The best chronostratigraphic tool remains an archaeostratigraphy (see the "Archaeostratigraphy" section) built from chronology of archaeological sequences from other sites.

Layer A

The first stratigraphic unit is composed of a brown sediment ("brown clay" of the 1885-1886 excavators) including limestone blocks, which are sometimes numerous and of large size ("scree"). The unit's thickness is highly variable, ranging between 25 cm and 3 m (De Puydt & Lohest, 1887: 209). This uppermost unit was referred to as "humus" by de Loë & Rahir (1911), suggesting the presence of a humiferous component.

From a chronostratigraphic perspective, several elements indicate that unit A can be placed in the Holocene: its brown colour and position at the summit of the sequence combined

with a humiferous component probably referable to pedogenesis. It is likely that the Neolithic human bones and material from historic periods discovered at the site came from this unit. Several burials were probably cut into underlying units from this level, explaining the presence of pottery fragments in the Palaeolithic levels.

Layer B or "first fauna-bearing level"

The second unit, whose thickness varied from 80 cm to 1 m, probably consisted of a hardened yellow silt with limestone blocks (De Puydt & Lohest, 1887: 209). According to de Loë & Rahir (1911), this first FBL became "slightly darker at its base"[82]. This unit seemed particularly indurated as it "was hard to cut into with the pickaxe"[83] (Fraipont & Lohest, 1886: 767-769). The 1885-1886 excavators described this layer as a "yellow clayey tufa" (Fraipont & Lohest, 1887: 663-665) or, "highly calcareous yellow earth sometimes turning into tufa" (De Puydt & Lohest, 1887: 209). The term "tufa" is probably linked with the carbonate cementing of the sediment, which caused its hardening. de Loë & Rahir (1911) describe this unit as a "calcareous yellow silt". Taken together, these elements suggest this unit to have been cemented by secondary carbonates, probably connected to Holocene biological activity, as was observed with the Weichselian Upper Pleniglacial Cycle B deposits of Walou cave (Pirson, 2011; Pirson & Draily, 2011).

From a chronostratigraphic viewpoint, the nature and colour of the matrix, as well as its stratigraphic position, suggest that unit B could equate with the substantial Upper Pleniglacial læss deposit in Middle Belgium positioned between 25 and 20 ky BP (Haesaerts, 1974, 1984, 2004; Pirson *et al.*, 2009; Haesaerts *et al.*, 2011). Similar deposits were also identified in the sequences of several Palaeolithic cave sites from the Meuse Basin: Walou cave (Pirson, 2011), the upper rockshelter of Goyet (Toussaint *et al.*, 1999), Trou Al'Wesse (Pirson, 1999) and perhaps Scladina cave (Pirson, 2007; Pirson *et al.*, 2008). Several arguments (grain-size, heavy mineralogy, dating, archaeostratigraphy) confirm the attribution of these deposits to the Upper Pleniglacial. At Spy, the presence of Gravettian and Epipalaeolithic material in layer B is consistent with this interpretation as is the single available ^{14}C date for the first FBL (25.6 ky BP; Semal *et al.*, this volume: chapter XVI).

Layer C or "second fauna-bearing level"

Although rather thin (varying between 5 and 30 cm), the reddened layer C is the main stratigraphic marker for the Spy sequence (De Puydt & Lohest, 1887: 209). The origin of the red colour has been tied to the presence of hematite (oligist) from the beginning. For instance, already in their excavation report, De Puydt & Lohest (1887: 213) indicate that "the presence of oligist, of which we have collected numerous fragments, might not be foreign to this colouring"[84]. Later, Fraipont (1895: 36-37) indicates that unit C is "heavily reddened by oligist"[85], and de Loë & Rahir (1911) specify that the "red colour […] is due to dust and numerous fragments of oligist whose existence we have noted"[86] (see also Goemaere *et al*., this volume: chapter VIII). Despite layer C being considered a "continuous zone" (Fraipont, 1895: 37), the red colour itself appears discontinuous as the excavators described this layer as "almost always" (De Puydt & Lohest, 1887: 209) or "ordinarily" (De Puydt & Lohest, 1887: 213) reddened.

With the exception of a few artefacts (e.g. pottery fragments) introduced by bioturbations, the second FBL includes Aurignacian, LRJ, and Middle Palaeolithic material. The presence of so many techno-complexes in the very thin unit C is rather surprising. Several, not mutually exclusive, interpretations are possible: the occupation surface remained stable over a considerable period leading to the mixing of material (palimpsests), mixing of different layers

[82] Original text: "*un peu plus foncé à sa base*".

[83] Original text: "*se laissait difficilement entamer à la pioche*".

[84] Original text: "*la présence d'oligiste dont nous avons recueilli de nombreux fragments, pourrait ne pas être étrangère à cette coloration*".

[85] Original text: "*fortement colorée en rouge par de l'oligiste*".

[86] Original text: "*coloration rouge […] est due à la poussière et aux nombreux fragments d'oligiste dont nous avons constaté l'existence*".

during the excavation, sedimentary processes incorporating material from several layers in one single reworked unit, or a partly post-depositional origin of the red colour (infiltrations, bioturbations, etc.) leading to localised red staining of deposits from different ages that were excavated as a single homogeneous red layer. Unfortunately, the lack of accurate stratigraphic informations precludes singling out any of the above possibilities.

Like the overlying unit, this unit also seems to have been hardened, described as "tufa" (De Puydt & Lohest, 1887: 209) or as "hard breccia" (Fraipont, 1895: 36-37). Unfortunately, given the highly simplistic nature of the 19th century lithostratigraphic descriptions, it is not possible to discern which surface was the origin of this hardening. It could be linked either with a Holocene cementation, representing the extension of the cementation affecting layer B, or with another cementation phase. The latter may be related to one of the numerous interstadials documented in the Greenland ice-core (Dansgaard-Oeschger events; Grootes *et al.*, 1993; NorthGRIP-Members, 2004; Svensson *et al.*, 2008), as suggested for some stratigraphic units at Scladina and Walou caves (Pirson, 2007, 2011; Pirson *et al.*, 2008).

Only the ^{14}C dates (37 to 29 ky BP) give some indication of the unit's chronostratigraphic position, notwithstanding reservations outlined above. These dates are consistent with the presence of Aurignacian, LRJ, and Middle Palaeolithic material.

The lower part of the sequence

The base of the Spy sequence, although difficult to understand based on the available information, consists of at least two stratigraphic groups. The first would correspond to the third FBL of De Puydt and Lohest, who described it as a heterogeneous deposit on the terrace. The second would concern the biface-bearing deposits directly overlying the bedrock. These deposits were described by Hamal-Nandrin inside the cave, and also found during de Loë and Rahir's excavations. The stratigraphic relationship between these two groups is unfortunately impossible to verify.

On the terrace, the upper part of De Puydt and Lohest's third FBL corresponds to layer D. Probably composed of yellow silt with limestone blocks, this approximately 15 cm thick layer was locally cemented, "sometimes passing to tufa towards the upper part"[87] (e.g. De Puydt & Lohest, 1887: 209). This tufa was "of the same nature as B"[88] (Fraipont & Lohest, 1887: 663). The yellowish colour of layer D suggests it being a lœssic silt.

Below layer D, layer F (sometimes called G; see Table 1) comprises a brown silt containing relatively small limestone blocks. The matrix is on occasion described as "very dark brown", sometimes changing to a "blackish tint" or becoming "black-veined". The thickness of layers D and F is described as "varying between a few cm and 1 m"[89] (De Puydt & Lohest, 1887: 209). Although impossible to determine the exact significance of the layer's dark colour, it may be tied to 1) the influence of pedological phenomena in an interstadial context, as observed in some Belgian or French caves (Pirson, 2007, 2011; Bertran *et al.*, 2008; Pirson *et al.*, 2008), 2) charcoal concentrations linked with human activity, which could fit with the presence of "charcoal sometimes scattered in small veins"[90] (De Puydt & Lohest, 1887: 228), 3) manganese migrations, 4) or even a combination of several elements. Although in some descriptions the human bones themselves constitute a single unit (layer E; De Puydt & Lohest, 1887), the bones of the two skeletons were also described as "scattered, spaced 2.5 m from one another, […] at the surface of this deposit"[91] (Fraipont, 1895), i.e. at the surface of layer F.

Apart from a few artefacts introduced by bioturbations, the third FBL exclusively yielded Mousterian artefacts among which were Mousterian points similar to those from the second

[87] Original text: "*passant parfois au tuf vers la partie supérieure*".

[88] Original text: "*de même nature que B*".

[89] Original text: "*une épaisseur variant entre quelques cm et 1m*".

[90] Original text: "*charbon de bois parfois disséminé en veinules*".

[91] Original text: "*à la surface de ce dépôt [...] que se trouvaient disséminés les ossements des deux squelettes, placés à 2m50 l'un de l'autre*".

FBL. According to the excavators, this unit contained several thousand lithic elements; however, the available archaeological collection lists *only* 27 lithic artefacts attributed to the third FBL. According to Di Modica *et al.* (this volume: chapter IX), it is impossible to discern whether the material from the third FBL represents a single archaeological horizon with the Mousterian material being intrusive from the second FBL, or if they represent two distinct archaeological levels.

From a chronostratigraphic point of view, the only available data for the third FBL on the terrace are two ^{14}C dates obtained from bone (~ 43 ky BP).

Inside the cave, MTA-type bifaces were discovered in the right gallery by Rucquoy, de Loë and Rahir as well as by Hamal-Nandrin and his team; however, no description of the deposits that yielded these artefacts is available, and it remains impossible to determine their stratigraphic relationship with the terrace deposits. At the time of Hamal-Nandrin's excavations, this biface industry was considered one of the earliest Mousterian occupations known from Belgium based on typological comparisons with assemblages from Sainte-Walburge (Liège) and the Hermitage Cave (Huccorgne). Although they were initially placed in the Last Interglacial (Hamal-Nandrin *et al.*, 1939: 146), recent work suggests their dating to MIS 5 to be more likely. Despite the fact that several other sites yielding bifaces date to MIS 5, bifaces were also discovered in Scladina cave from a context dated to around 40,000 BP and from an MIS 3 context at Saint-Amand-les-Eaux (Inrap, 2007; Ruebens & Di Modica, 2011; Di Modica *et al.*, this volume: chapter IX), suggesting that the chronology of the MTA-type bifaces at Spy be considered with caution.

The cave interior yielded other Middle Palaeolithic artefacts, notably small handaxes comparable with *Fäustels* from the Central European Micoquian. The *Fäustels* from Spy may form part of a cultural facies with eastern influences that extended all the way to the Atlantic. These tool types were previously associated with the Quina-type Charentian from the third FBL (Ulrix-Closset, 1975); however, the preservation of the material (edge-damaged) presents a clear departure from the well-preserved artefacts from the third FBL on the terrace (see Di Modica *et al.*, this volume: chapter IX).

CONCLUSIONS AND PERSPECTIVES

The Betche aux Rotches at Spy is, together with Goyet cave located some 25 km to the east, one of the two major prehistoric caves in Belgium, if not North-west Europe. Both sites yielded Neandertal remains and contained complex stratigraphies, including several Middle and Upper Palaeolithic occupations. Unfortunately, the original excavations carried out during the final decades of the 19th and first years of the 20th century were not of the same modern standards as those used at similar sites such as Walou or Scladina caves in the same karstic area of the Meuse Basin. Furthermore, substantial earthworks carried out during the site's early excavations and clandestine robber trenches made by collectors deprived future researchers almost any possibility of verifying *in situ* deposits, and hence refining previous stratigraphic and archaeological observations.

The fact remains that Spy is one of the most influential European sites for the development of prehistory and palaeoanthropology. Work at the site provided irrefutable evidence as early as 1886 for the existence of a human type antecedent to modern humans, which, although already suspected, lacked any convincing support. Successive revisions of the Spy archaeological material during the course of the 20th century, mainly by Breuil, Bordes, Ulrix-Closset, Otte, and Dewez in terms of archaeology, and Hrdlička and Thoma for physical anthropology, also significantly advanced our understanding of the site's different occupations. All of these attempts prefigured the immense revision project initiated a decade ago by the RBINS, whose results are presented in this monograph.

The early date of the initial excavations at Spy substantially and inadvertently mixed the archaeological material that now comprises the various collections from the site. These admixtures have several origins, notably the poor stratigraphic resolution of the successive excavations,

the absence of information related to the genesis of the stratigraphic sequence (sedimentary and post-depositional processes), and reclassifications of the material during the numerous studies of the collections. Therefore, the above-mentioned revision, and more specifically its lithostratigraphic, archaeostratigraphic, and chronostratigraphic aspects (not to mention palaeoenvironmental) face substantial limitations that should not be underemphasised.

Foremost amongst several problems, poor stratigraphic resolution artificially mixed archaeological material from several occupation phases into a very small number of large stratigraphic units. Moreover, the published stratigraphic sequences portray numerous discrepancies, which, in the best-case scenario, only allow a general comparison between them, but no further detail. In much the same way, no reliable correlation can be made between the cave's interior or the slope leading to the Orneau River and the terrace deposits. The stratigraphic sequence on the terrace described by the 1885-86 excavators composed of five lithostratigraphic units (layers A to D and F) and three "fauna-bearing levels" is the most frequently used. A similar sequence was noted during de Loë and Rahir's excavations at the beginning of the 20th century, both on the terrace and near the cave entrance. The correlations between the FBLs and archaeological material in the lower half of the sequence do, however, differ from those of De Puydt and Lohest's excavations. In such a context, any attempt at correlating the lithostratigraphy and archaeostratigraphy becomes particularly difficult.

Despite these important limitations, combining a typo-technology approach with an appreciation of taphonomic modifications and available artefact spatial distributions does however permit relatively coherent groups to be discerned. Although only three FBLs were distinguished during excavations, today at least 10 Palaeolithic occupation phases have been identified, including at least three or four Middle Palaeolithic and seven Upper Palaeolithic occupations. Similarly, although identifying the exact stratigraphic position of the Spy Neandertal skeletal material is impossible, the combination of available field data, recently obtained radiocarbon dates, and anthropological analyses suggest the existence of a burial in the form of a pit dug from the second into the third FBL.

Are there any prospects left for lithostratigraphic, archaeostratigraphic, and chronostratigraphic studies at Spy? The likelihood of *in situ* sediments remaining to be investigated is extremely slim, and if they do exist, they would be of such a limited nature that they would unlikely improve our understanding of the site's lithostratigraphy substantially.

It seems difficult to further refine the archaeostratigraphic resolution presented here, at least as things stand today. In the future, a thorough analysis of all the available archaeological material aiming at comparing 1) the characteristics of the lithic material (typo-technology, raw material, and taphonomy), and 2) its spatial distribution (e.g. terrace or cave) would certainly help provide a more detailed correlation between the lithostratigraphy and archaeostratigraphy. In parallel, a refitting program focused on the lithic artefacts would certainly be useful. In terms of chronostratigraphy, it appears that only new direct dates obtained on material clearly related to the different human occupations (e.g. human-modified bone or antler) will provide a more complete and refined chronology. However, in order for this to be achieved, a detailed archaeozoological study would first have to be undertaken.

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