Chapter 5

STRATIGRAPHIC ORIGIN OF THE JUVENILE NEANDERTAL REMAINS FROM SCLADINA CAVE: RE-EVALUATION AND CONSEQUENCES FOR THEIR PALAEOENVIRONMENTAL AND CHRONOSTRATIGRAPHIC CONTEXTS

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1. Introduction

The 19[1] remains of the Neandertal child, Scladina I-4A, that have been discovered so far were all unearthed before the recent stratigraphic reappraisal of the cave's sedimentary sequence (see Chapter 3). In the former stratigraphic system, most of the remains were attributed to Layer 4A, more specifically to the part of former Layer 4A situated between stalagmitic floors CC14 and CC4 (Bonjean, 1998; Toussaint et al., 1998; Chapter 3; Figure 1; Appendix A). Three of the discovered teeth (which all belong to the same individual) were originally attributed to former Layer 3 (Otte et al., 1993; Toussaint et al., 1994), but former Layer 4A as their origin was soon suggested as a possibility (Bonjean et al., 1996, 1997).

The progress of excavation during the last decade provided access to new locations in the cave. Throughout this process, careful examination of the numerous available sedimentary profiles was undertaken (Pirson, 2007). This allowed the highly complex stratigraphy to be deciphered more accurately, leading to a better understanding of the succession of the cave's different lithostratigraphic units. Former Layer 4A is one of the former layers that underwent the most important organisational changes following the stratigraphic reappraisal. Instead of one single layer (as it was previously thought to be), about 20 layers have now been recognised, which are now classified as Sedimentary Complex 4A (Chapter 3; Pirson et al., 2005; Pirson, 2007). Furthermore, Stalagmitic Floor CC14 was proven to be a lateral equivalent of Speleothem CC4.

[1] A 20th fossil, from Square B37 and initially labelled Scla 4A-10, was later discarded from the Neandertal remains during taphonomic and anthropological studies. Re-examination of the excavation documents led to the conclusion that this tooth came from a bioturbated context.

The newly defined layers of Sedimentary Complex 4A are grouped into 4 distinct units, each including several layers (Figure 2). These 4 units are, from bottom to top:

— Unit 4A-AP, the lowermost unit, including all the layers within the complex that are older than CC4;
— Unit 4A-IP, including Stalagmitic Floor CC4 and the layers that are contemporaneous with the formation of CC4;
— Unit 4A-CHE, which includes the layers that developed inside a large gully structure that eroded underlying layers, including CC4;
— Unit 4A-POC, the uppermost unit, superimposing both units 4A-IP and 4A-CHE.

The stratigraphic re-evaluation made reconsidering the exact position of the Scladina Neandertal child remains necessary. This reappraisal, only possible because of the rigorous excavation methods used at the site, is the subject of this chapter. Some of the arguments that will be presented have already been published (Pirson et al., 2005; Pirson, 2007), but they will be fully examined in the present work.

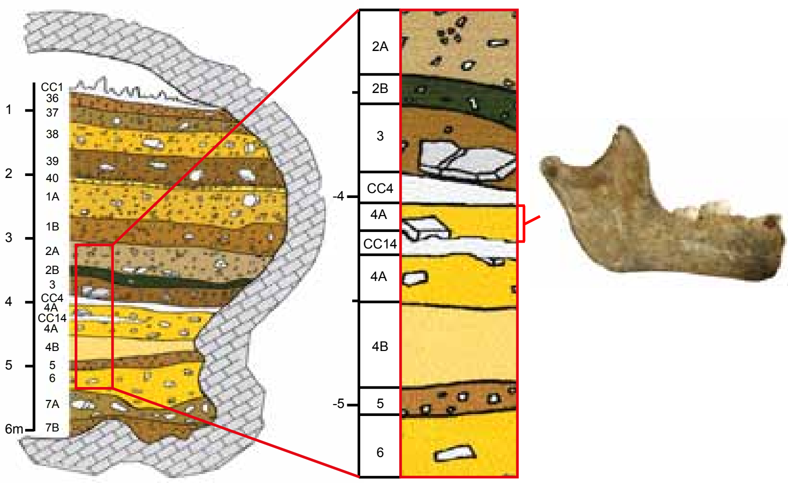

Figure 1: Position of most of the Scladina Neandertal remains in the former stratigraphic record (CC = calcitic crust). Modified after Bonjean, 1998.

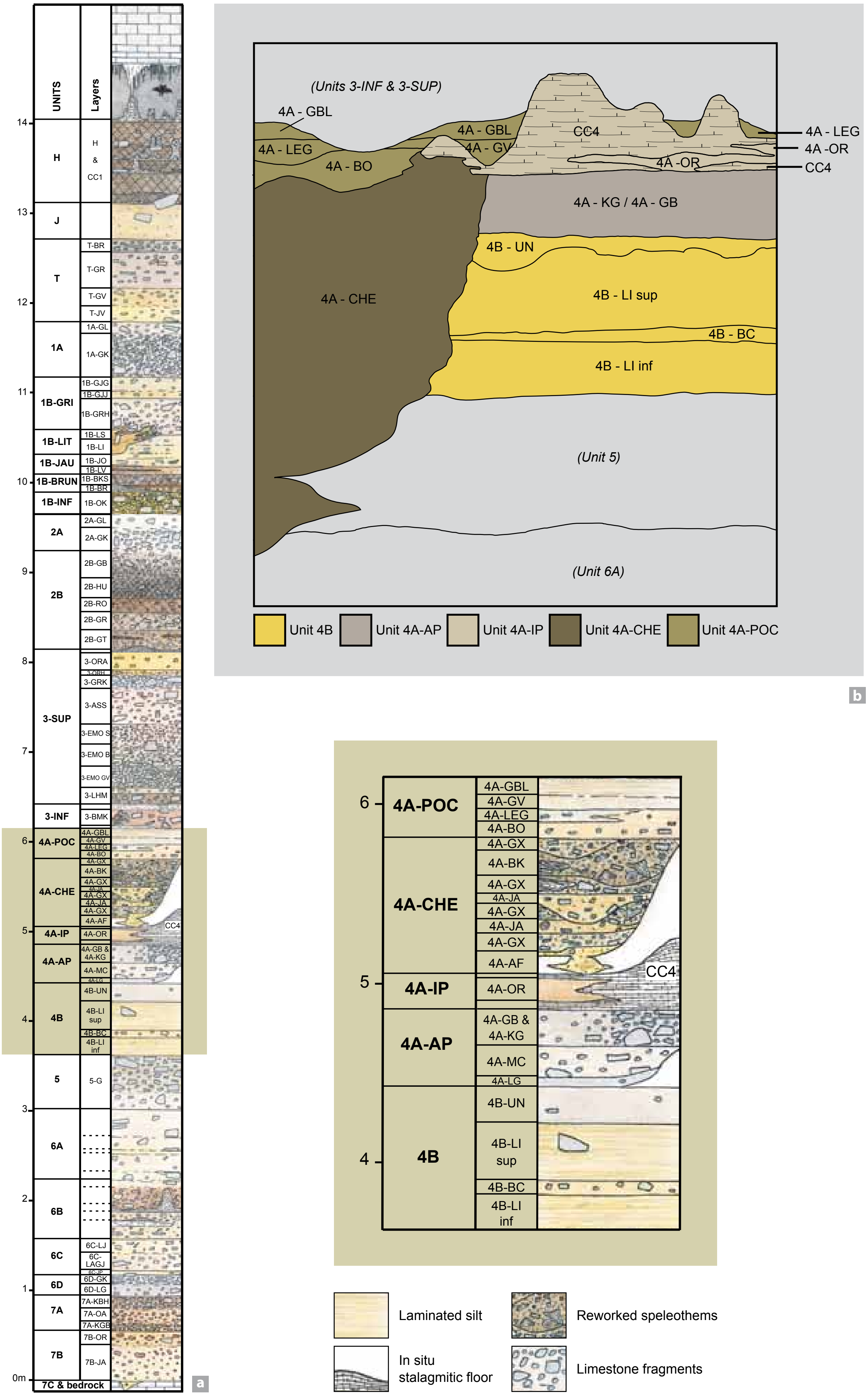

Figure 2: The new stratigraphic record. a. Details of the lithostratigraphic sequence of Sedimentary Complex 4A and Unit 4B in the framework of the global stratigraphy of the site. b. Sketch showing the stratigraphic relationships between the four units defined in the Sedimentary Complex 4A.

Anthropological number	Nature	Square	x (cm)	y (cm)	z (cm)	Former Layer	New stratigraphic record		Unearthed	Identified
							Unit	Layer		
Scla 4A-1	right half of the mandible	D 29	41	13	−484.5	4A	4A-CHE	4A-GX	16/07/1993	20/07/1993
Scla 4A-9	left half of the mandible	C 28	98	75	−478.6	4A	4A-CHE *(4A-POC)*	4A-JA (?)	12/07/1996	12/07/1996
Scla 4A-2	small part of right maxilla	D 30	/	/	−477 to −479	4A	4A-POC *(4A-CHE)*	?	18/02/1992	October 1993
Scla 4A-4	permanent maxillary right first molar	C 30	12	50	−466	4A	4A-POC	4A-BO	14/12/1993	14/12/1993
Scla 4A-3	permanent maxillary right second molar	C 30	/	/	−464 to −470	4A	4A-CHE or 4A-POC	?	15/10/1992	October 1993
Scla 4A-8	permanent maxillary right third molar	C 32	20 to 80	10 to 30	−460 to −462	4A	4A-POC *(4A-CHE)*	4A-LEG *(4A-JA)*	14/07/1995	14/07/1995
Scla 4A-13	deciduous mandibular right second molar	E 38	88	57	−481	4A	4A-POC	4A-LEG	13/11/2001	13/11/2001
Scla 4A-19 (= *Scla 3-4*)	permanent mandibular left lateral incisor	D 34	/	/	−460 to −471,5	3 or 4A	4A-POC or 3-INF *(3-SUP)*	?	08/03/1995	10/04/1995
Scla 4A-18 (= *Scla 3-3*)	permanent maxillary left canine	F 26	/	/	−461 to −471	3 or 4A	4A-POC *(4A-IP, 4A-CHE, 3-INF)*	?	19/11/1991	October 1993
Scla 4A-7	deciduous maxillary right first molar	F 27	/	/	−471 to −481	4A	4A-CHE or 4A-POC *(4A-IP, 3-INF)*	?	12/11/1991	October 1993
Scla 4A-12	permanent mandibular right canine	F 27	/	/	−449 to −461	4A	4A-POC or 3-INF *(4A-IP, 4A-CHE, 3-SUP)*	?	28/03/1990	July 2001
Scla 4A-17 (= *Scla 3-2*)	permanent maxillary left lateral incisor	F 27	/	/	−458 to −470	3 or 4A	4A-POC *(4A-IP, 4A-CHE, 3-INF)*	?	17/10/1991	October 1993
Scla 4A-5	deciduous maxillary right second molar	G 27	/	/	−447 to −462	4A	4A-POC or 3-INF *(4A-IP, 4A-CHE, 3-SUP)*	?	13/03/1990	October 1993
Scla 4A-6	mandibular right first premolar	G 27	/	/	−463 to −477	4A	4A-CHE or 4A-POC *(4A-IP, 3-INF)*	?	04/07/1990	October 1993
Scla 4A-11	permanent maxillary right central incisor	G 27	/	/	−447 to −462	4A	4A-POC or 3-INF *(4A-IP, 4A-CHE, 3-SUP)*	?	13/03/1990	May 2000
Scla 4A-14	permanent maxillary right lateral incisor	H 27	/	/	−445 to −454	4A	4A-POC or 3-INF *(4A-IP, 4A-CHE, 3-SUP)*	?	22/02/1990	14/12/2004
Scla 4A-15	permanent mandibular right central incisor	H 27	/	/	−445 to −454	4A	4A-POC or 3-INF *(4A-IP, 4A-CHE, 3-SUP)*	?	22/02/1990	14/12/2004
Scla 4A-16	permanent maxillary right canine	H 27	/	/	−454 to −463	4A	4A-POC *(4A-IP, 4A-CHE, 3-INF)*	?	23/02/1990	16/12/2004
Scla 4A-20	permanent mandibular right lateral incisor	F35-37	/	/	−350 to −500	/	4A-POC or 3-INF *(3-SUP)*	?	12/07/2006	12/07/2006

Table 1: List of the 19 Neandertal remains discovered so far in Scladina Cave.

Fossil positioned in a specific layer from the new stratigraphic record
Fossil positioned either in 4A-CHE or in 4A-POC
Fossil with a possible origin from several units
Fossil found after the collapse of a profile

Unit or layer xxx = most probable
(*Unit or layer xxx*) = possible but low probability

2. Methods

Several methods have been used in order to determine the exact stratigraphic origin of the hominin remains. They include:

— 3-dimensional positioning of each fossil. This is only possible for 5 out of the 19 remains, because during the early stage of excavation only the objects from former Layer 5 were recorded in 3-dimensions (see Chapter 2). From 1991 onwards, in some areas of the cave, objects from other layers (former layers 1B, 2B, 3, and 4A) were recorded 3-dimensionally in situations where the faunal material was very abundant. However, the Neandertal remains that were unearthed before the 16th of July 1993 (the date that the hemimandible, Scla 4A-1, was discovered) were only recognised later by reanalysing the faunal collections. The coordinates only included 2 pieces of location data: the square (without relative x-y values) and a range of altitudes that are more or less accurate (Table 1);

— projection of the each fossil's 3-dimensional location onto the nearest sedimentary profile(s);

— analysis of some unpublished stratigraphic drawings of the Neandertal remains' immediate surroundings;

— analysis of the field notes (sedimentological descriptions, altitudes of the layer boundaries for each square, maps of the excavated remains, etc.);

— analysis of numerous pictures (photographs and slides) including general views, details of the concerned square in horizontal view, as well as pictures of sedimentary profiles; in some cases, some pictures were taken before, during, and after the discoveries of the fossils. These arguments will be presented for each individual fossil (§3) in order to compare the location data recorded during the excavation of each fossil to the new stratigraphic record. In the discussion (§4), other arguments linked with the sedimentary dynamics or with the anthropological or taphonomic studies will also be considered in order to refine the interpretations presented in this chapter.

3. Reappraisal of the stratigraphic position of the juvenile Neandertal fossils

3.1. The right half of the mandible (Scla 4A-1)

The right half of the mandible was unearthed during excavation on the 16th of July 1993 in Square D29 (Figures 3 & 4), and was formally identified as being Neandertal a few days later in the laboratory (Bonjean et al., 2009[a]). It was attributed in the field to former Layer 4A. Its 3-dimensional coordinates in Square D29 are: x = 41 cm, y = 13 cm, and z = −484.5 cm (Table 1).

3.1.1. Available arguments

In this area of the cave, the transition between former Layer 3 (brownish stony silt with numerous bones) and former Layer 4A (yellowish silt with some bones and calcite fragments) is very well defined. In Square D29, former Layer 4A was excavated between −471 and −510 cm.

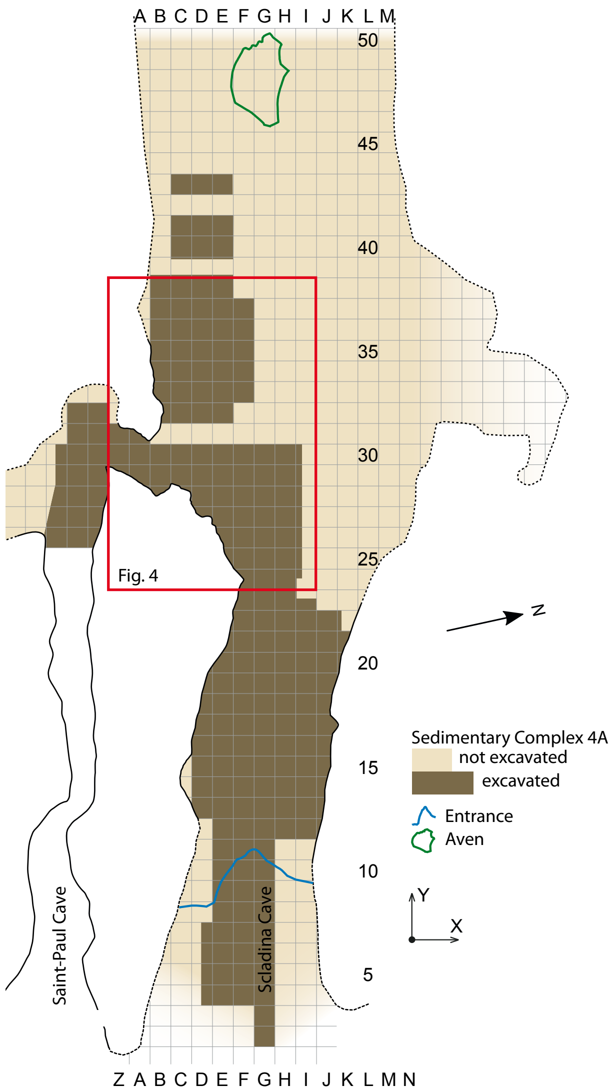

Figure 3: Plan of the cave with location of Figure 4. In dark brown, squares where Sedimentary Complex 4A has already been excavated.

Closest sedimentary profile

Among the available sedimentary profiles studied in the framework of the stratigraphic reappraisal, the profile that is the closest to fossil Scla 4A-1 is Cross-Section 30/31. However, it is still 187 cm away. Given the stratigraphic context (and the presence of the gully in Unit 4A-CHE), the use of such a distant projection must be approached carefully. The orthogonal projection of the fossil onto this sedimentary profile points to Unit 4A-IP, and more specifically to Layer 4A-OR (Figure 5). Laterally, both south and north of where the object projects onto the sedimentary profile the layers change drastically. Toward the south, about 60 cm away from the projection, Unit 4A-CHE is visible. Toward the north, the gully is farther away, but about 60 cm away from the projection, Unit 4A-POC is present. Consequently, on the basis of the orthogonal projection alone, the possible stratigraphic position of the fossil Scla 4A-1 remains uncertain; it could be from units 4A-IP, 4A-CHE, or 4A-POC.

Sedimentary Profile E/D in 28-29-30 (Figure 6), perpendicular to Profile 30/31, is closer (~60 cm). However, it was drawn before the stratigraphic reappraisal (Bonjean et al., 1997). The projection of the fossil on this profile points to former Layer 4A7; following the reinterpretation of this profile using photographs and the course of the gully (Figure 9), this former layer is probably part of Unit 4A-CHE gully structure.

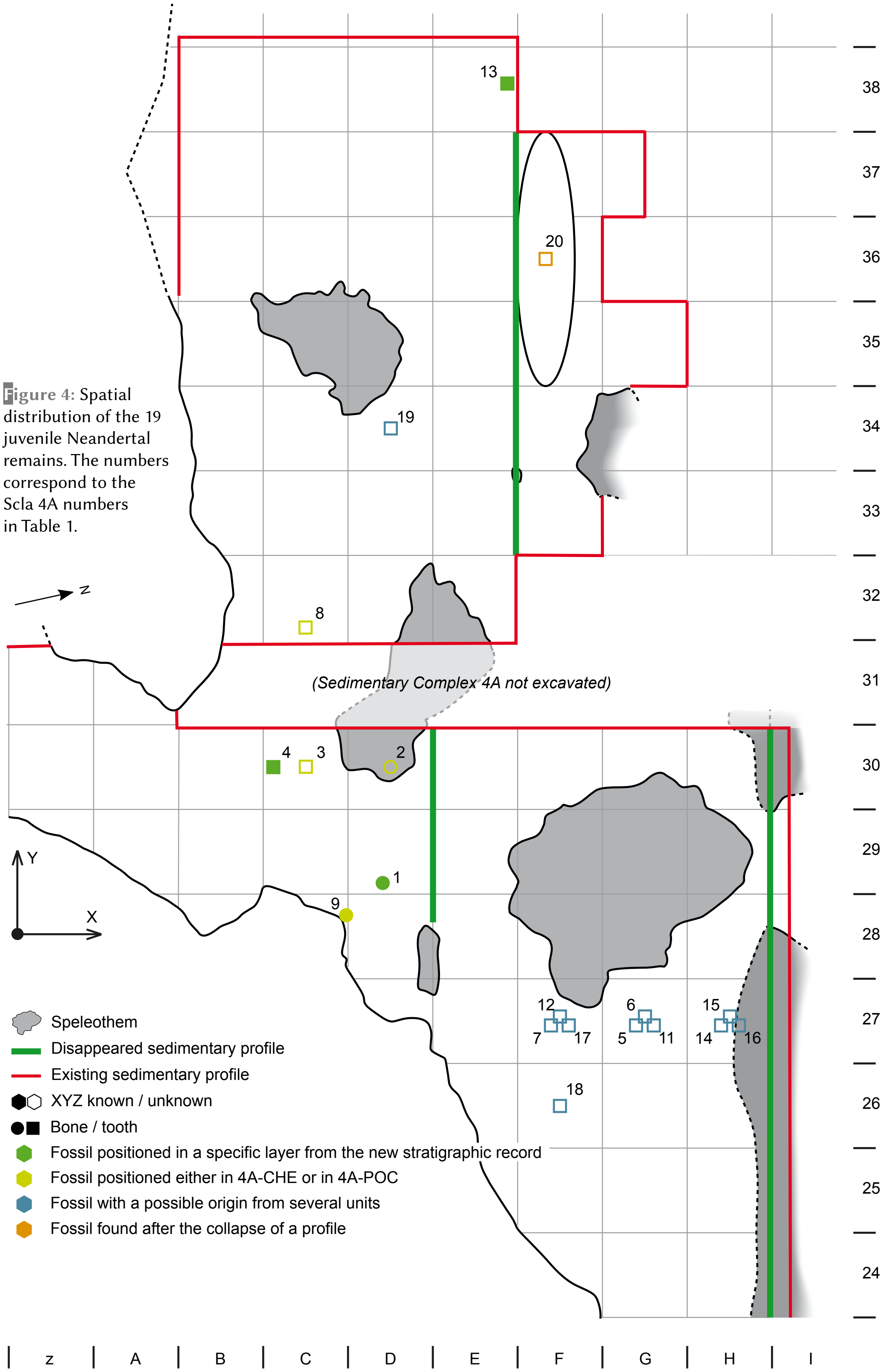

Figure 4: Spatial distribution of the 19 juvenile Neandertal remains. The numbers correspond to the Scla 4A numbers in Table 1.

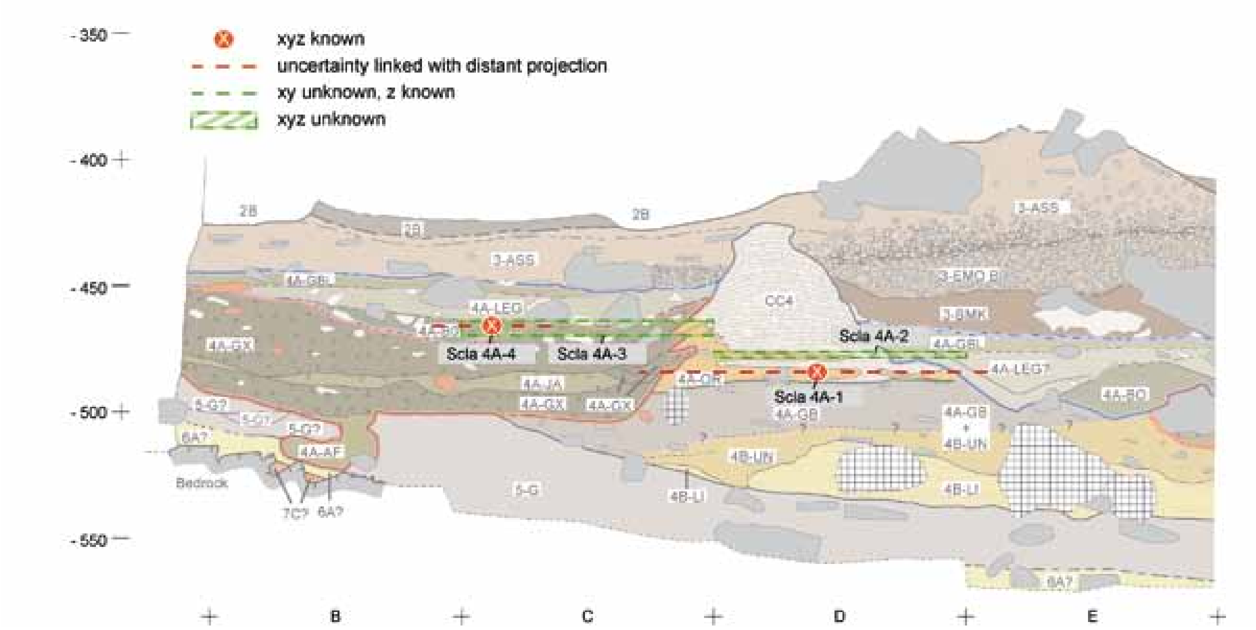

Figure 5: Orthogonal projections of the Neandertal remains Scla 4A-1 to 4 on Cross-Section 30/31 B-E (the complete section, from B to H, is presented in Chapter 3).

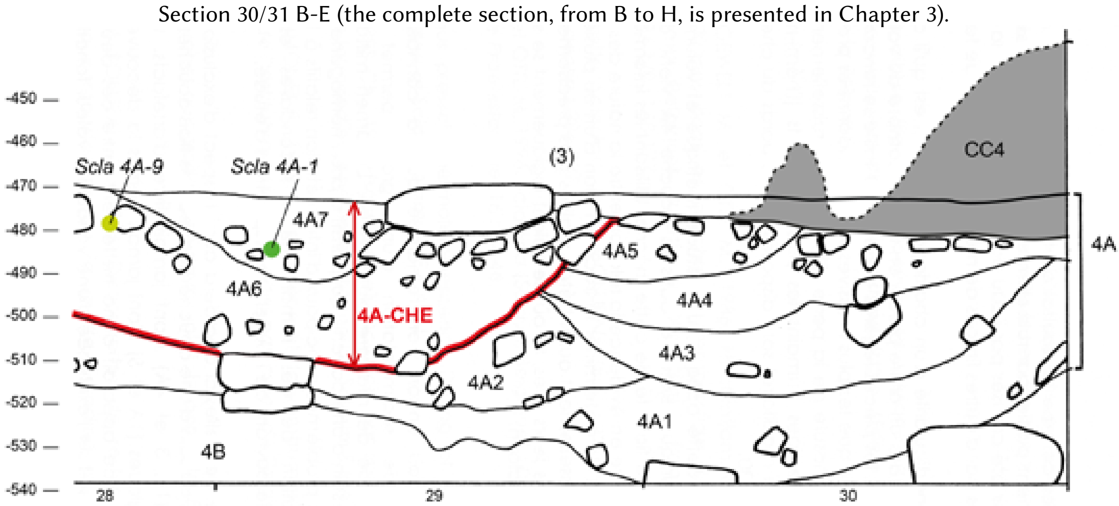

Figure 6: Orthogonal projections of the Neandertal remains Scla 4A-1 and 9 on Cross-Section E/D (modified after Bonjean et al., 1997). This profile is a sketch drawn long before the stratigraphic reappraisal, and the exact correlations with the new stratigraphic record are difficult to make. The two CC4 stalagmites are not in the same plan than the section but about 25 cm behind (in E).

Pictures

The examination of the numerous pictures taken during the discovery of the fossil facilitated a major observation: fossil Scla 4A-1 was surrounded by speleothem fragments (Figure 7). This allows units 4A-IP and 4A-AP to be discarded as candidates, and units 4A-CHE or 4A-POC to become the likely origin for this fossil.

Some of the pictures show Square D29 shortly after the discovery of the right half of the mandible. A blue cast of the fossil is seen placed in its exact discovery position (Figure 8). These pictures permit observations of the underlying sediment on a horizontal surface, but also observations of two surrounding vertical profiles, which are within close proximity to the object (13 and 41 cm, respectively). The lithofacies 4A-JA and 4A-GX, typical of the gully from Unit 4A-CHE, are recognisable in these images. In this situation, the right half of the mandible is from 4A-GX.

Another interesting aspect of these pictures is that they allow the course of the gully to be reconstructed in this area of the cave, especially when considering the observed structures and stratigraphic sequence documented on Profile 30/31 (Figures 5 & 9).

3.1.2. Synthesis

Observations of sedimentary profiles 30/31 and E/D, when combined with the numerous available pictures, allowed for a 3-dimensional reconstruction of the area to be created. This also allowed the course and the extent of the left branch of the gully to be reconstructed (Figure 9).

Figure 7: Pictures of the right half of the mandible (Scla 4A-1), represented by a blue cast in the discovery position: left, vertical view of Square D29; right, Sedimentary Profile 29/28 in D. Numerous speleothem fragments (in white) are recognisable around the fossil.

Figure 8: Pictures of the right half of the mandible (Scla 4A-1), represented by a blue cast in the discovery position: left, general view of Square D29; right, detail of the angle between profiles 29/28 and D/C. The greyish and yellowish facies are probably related to lithofacies 4A-GX and 4A-JA, respectively.

On these grounds, the stratigraphic context of the right half of the Scladina Child's mandible can accurately be established as one of the 4A-GX lithofacies in Unit 4A-CHE. Some pictures show that at this particular location, this Lithofacies 4A-GX superimposes one of the Lithofacies 4A-JA. Since the fossil must be from the left branch of the gully, it is confirmed to be from the upper Lithofacies 4A-GX in the gully structure seen on Sedimentary Profile 30/31 (Tables 1 & 2). This complements the results of the projection of the fossil onto Profile 30/31.

3.2. The left half of the mandible (Scla 4A-9)

The left half of the mandible (Scla 4A-9) was found and recognised in situ on the 12th of July 1996 in Square C28 (Figure 4), during the excavation of a

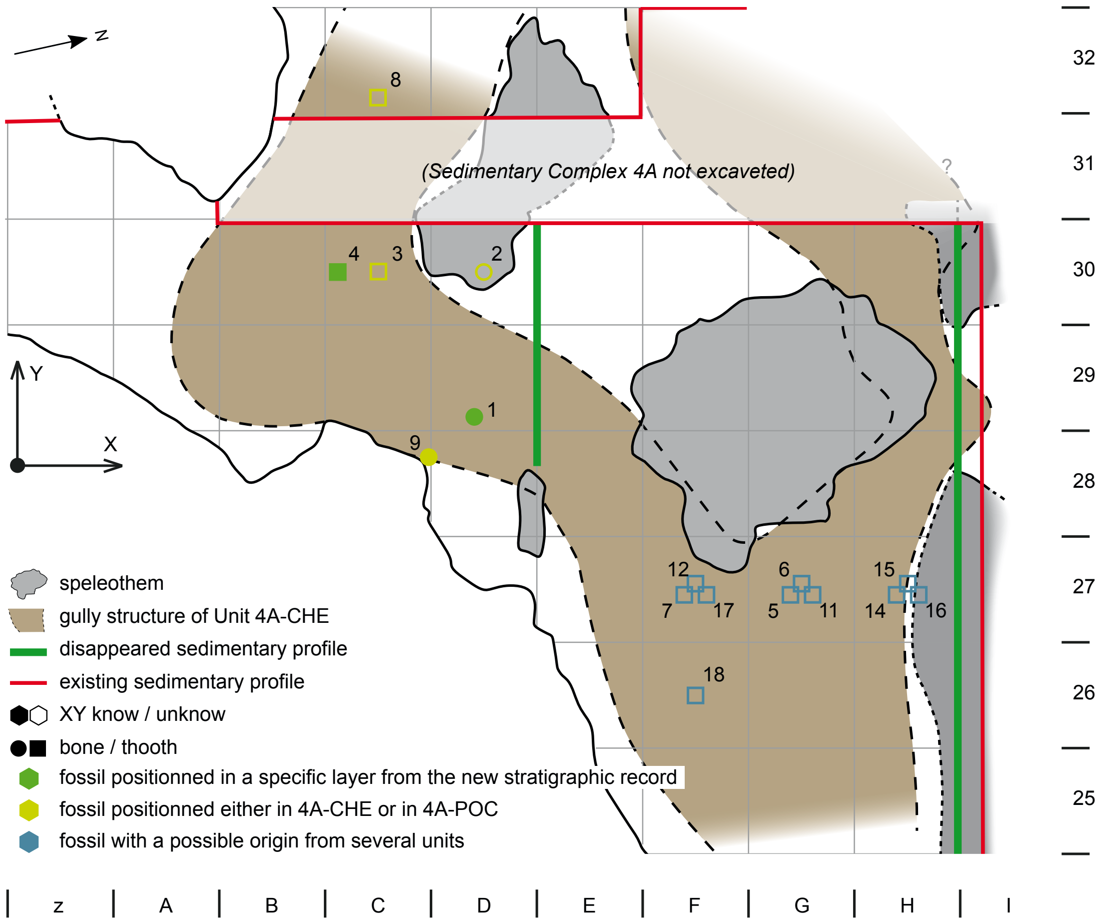

Figure 9: Course and extent of the gully structure of Unit 4A-CHE, reconstructed according to direct observation on sedimentary profiles, analysis of pictures and analysis of field notes.

Figure 10: Small sedimentary profiles threatened by the collapse of large stone slabs from the wall. The symbol positions the location where the left half of the mandible has been found during the rescue excavation of this area.

Fossil nº	4A-IP	4A-CHE	4A-POC	3-INF	3-SUP
Scla 4A-1		v			
Scla 4A-9		v	(v)		
Scla 4A-2		(v)	v		
Scla 4A-4			v		
Scla 4A-3		v	v		
Scla 4A-8		(v)	v		
Scla 4A-13			v		
Scla 4A-19			v	v	(v)
Scla 4A-18	(v)	(v)	v	(v)	
Scla 4A-7	(v)	v	v	(v)	
Scla 4A-12	(v)	(v)	v	v	(v)
Scla 4A-17	(v)	(v)	v	(v)	
Scla 4A-5	(v)	(v)	v	v	(v)
Scla 4A-6	(v)	v	v	(v)	
Scla 4A-11	(v)	(v)	v	v	(v)
Scla 4A-14	(v)	(v)	v	v	(v)
Scla 4A-15	(v)	(v)	v	v	(v)
Scla 4A-16	(v)	(v)	v	(v)	
Scla 4A-20			v	v	(v)
v	0	5	17	7	0
(v)	10	10	1	5	7

Fossil positioned in a specific layer from the new stratigraphic record

Fossil positioned either in 4A-CHE or in 4A-POC

Fossil with a possible origin from several units

Fossil found after the collapse of a profile

Table 2: Possible stratigraphic origin of the 19 Scladina Neandertal juvenile remains. v = most probable candidate(s); (v) = unlikely candidate, but possible; (empty cell) = impossible.

small area threatened by the collapse of a stone slab from the wall (Figure 10). This fossil was attributed to former Layer 4A in the field. Its coordinates in Square C28 are: x = 98 cm, y = 75 cm, and z = −478.6 cm (Table 1).

3.2.1. Available arguments

Closest sedimentary profile

The closest profile is Cross-Section 30/31, which is more than 2 m away. From such a long distance, any projection is difficult to use, especially with the complex geometries linked with the unit 4A-CHE gully. From an altimetric point of view, on the basis of the comparison with Profile 30/31, the fossil could have originated from units 4A-IP, 4A-CHE, or 4A-POC.

Pictures

Many pictures of both horizontal and vertical views of the area around where the left hemi-mandible was discovered are available. About 10 cm under the fossil on a small sedimentary profile, an equivalent of Layer 4B-LI (Unit 4B) is visible (Figure 11); the upper limit of this layer is eroded by what seems to be a 4A-JA lithofacies (Unit 4A-CHE). The left half of the mandible is pictured in a yellowish sediment (Figure 11) that contains laterally some speleothem fragments. This sediment closely resembles the appearance of a 4A-JA lithofacies from Unit 4A-CHE.

3.2.2. Synthesis

From an altimetric point of view, comparing the depth of the fossil with the stratigraphic context of the area and with Sedimentary Profile 30/31, the left half of the mandible could originate from units 4A-IP, 4A-CHE, or 4A-POC. The presence of calcite fragments allows Unit 4A-IP to be discarded. The possible candidates are thus units 4A-CHE or 4A-POC; on the basis of the photographic analysis, fossil Scla 4A-9 is probably from a facies of Unit 4A-CHE, likely 4A-JA (Tables 1 & 2).

3.3. The right maxilla fragment (Scla 4A-2)

The small part of the right maxilla was unearthed from Square D30 on the 17th of February 1992 (Figure 4). It was not assigned any 3-dimensional coordinates. This fossil was not identified until October 1993 during a re-analysis of the faunal collection. Its coordinates are thus inaccurate: x and y unknown, and z = −477 to −479 cm (Table 1). It was attributed to the top of former Layer 4A.

3.3.1. Available arguments

Closest sedimentary profile

The nearest useable sedimentary profile is transversal Cross-Section 30/31. The distance between the fossil and the profile is less than 1 m, although the exact distance remains unknown in the absence of x and y coordinates. When projecting the objects onto Profile 30/31 with its range of possible altitudes (−477 to −479 cm), 2 scenarios seem possible (Figure 5). If the fossil was lying in the southern half of the square (towards C), the projection points to Layer 4A-OR (Unit 4A-IP); however, the course of the gully in this area (cf. §3.1) indicates that an origin from lithofacies

Figure 11: Left half of the mandible (Scla 4A-9) in its discovery position on Profile D/C 28. The finely laminated yellowish sediment at the bottom of the picture on the right corresponds to Layer 4B-LI.

4A-GX (Unit 4A-CHE) is also possible. If the fossil was found in the northern half of the square (towards E), layers 4A-GBL or 4A-LEG (Unit 4A-POC) seem like more likely candidates. Based on these observations, the right maxilla fragment could come from units 4A-IP, 4A-CHE, or 4A-POC.

At the time of the discovery, the large stalagmite situated in Square D30 was attributed to Speleothem CC14, and overlying Unit 4A-POC was attributed to former Layer 4A. As the fossil was found close to the boundary between former layers 3 and 4A, and as the bottom of the stalagmite was not yet reached by the excavation at that time, an attribution to Unit 4A-IP can be excluded. The hypothesis of an attribution to Unit 4A-POC is the most probable, given the extent of the layer in the square. However, an origin from the top of Unit 4A-CHE cannot be totally ruled out.

Pictures

No pictures exist of the right maxilla fragment in situ. However, the numerous pictures of the area near its place of discovery (squares C29, C30, D29, and D30) allow observations to be made regarding the exact course of the Unit 4A-CHE gully (left branch; cf §3.1). This can help to evaluate the importance of Unit 4A-CHE in Square D30, showing that most of the square was not affected by the gully structure (Figure 9).

3.3.2. Synthesis

The projection of the fossil onto Sedimentary Profile 30/31, the available pictures, and the position of Unit 4A-CHE in the area all indicate that most of Square D30 was outside the influence of the gully. Positioning the right maxilla fragment in Unit 4A-POC seems the best hypothesis, but an origin from the top of Unit 4A-CHE cannot be totally ruled out (Tables 1 & 2).

3.4. The permanent maxillary right first molar (Scla 4A-4)

3.4.1. Available arguments

The Scla 4A-4 molar was identified during excavation on the 14th of December 1993, in Square C30 (Figure 4). It was attributed to former Layer 4A in the field. Its 3-dimensional coordinates in Square C30 are: x = 12 cm, y = 50 cm, and z = -466 cm (Table 1).

Closest sedimentary profile

The nearest cross-section is Profile 30/31, which is 50 cm away. The projection of the molar onto this profile points to the bottom of Unit 4A-POC (Layer 4A-BO; Figure 5). Given the stratigraphic context and because the tooth is 50 cm away from the profile, the object may have come from the top of Unit 4A-CHE.

Pictures

Numerous pictures of the molar were taken in situ (Figure 12). They show that the fossil was unearthed from beige-orange sediment rich in small calcite fragments. The presence of calcite fragments suggests either Unit 4A-CHE or Unit 4A-POC. The comparison between the lithofacies on the pictures and the lithofacies of the layers on Sedimentary Profile 30/31 (still visible), together with the well-known stratigraphic relationships between the layers in this part of the sequence, indicate that the tooth Scla 4A-4 was found in Layer 4A-BO (Unit 4A-POC).

3.4.2. Synthesis

The pictures of tooth Scla 4A-4 in situ clearly show the lithofacies in which the tooth was found. This beige-orange sediment corresponds to Unit 4A-POC, and more specifically to Layer 4A-BO (Tables 1 & 2). These arguments allow this molar to be precisely and accurately positioned in the new stratigraphic record.

3.5. The permanent maxillary right second molar (Scla 4A-3)

The molar Scla 4A-3 was collected during sieving on the 15th of October 1992, from Square C30 (Figure 4). It was identified as a Neandertal tooth in the laboratory in October 1993. Its 3-dimensional coordinates are rather inaccurate: x and y are unknown, and z = −464 to −470 cm (Table 1). In the field, the tooth was exhumed from the boundary between former layers 4A and 3; the fossil was therefore attributed to the top of former Layer 4A.

3.5.1. Available arguments

Closest sedimentary profile

The closest cross-section is Profile 30/31. As this tooth was found during sieving, the exact distance between the fossil and the profile is unknown

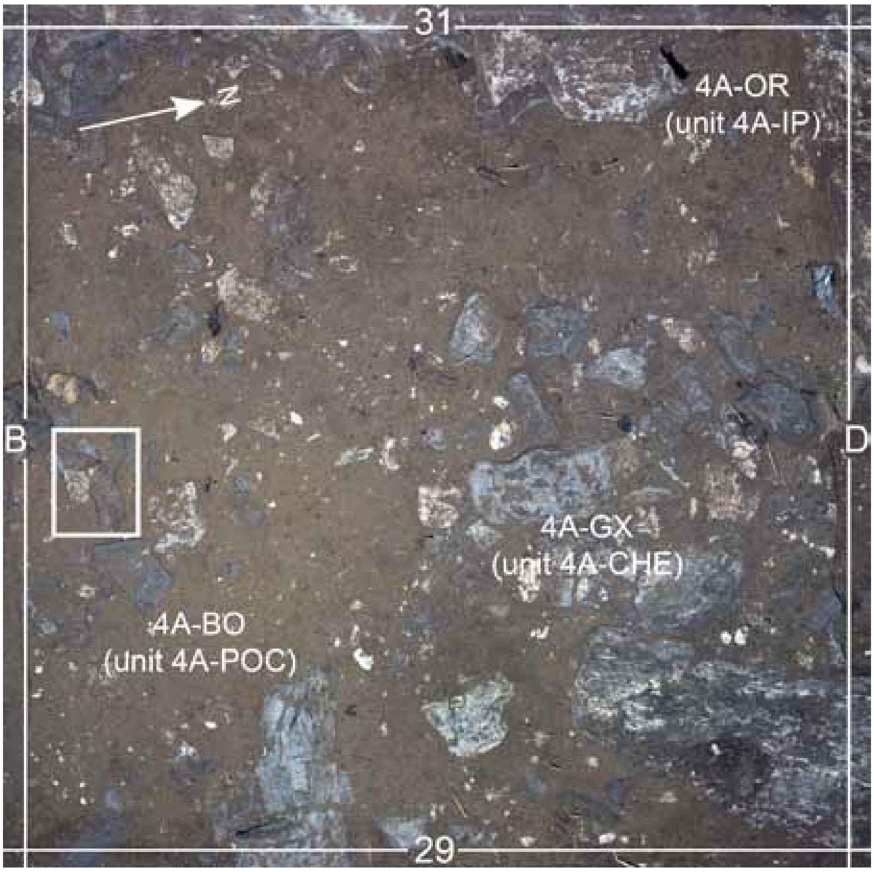

Figure 12: The permanent maxillary right first molar (Scla 4A-4) in situ in Square C30.

(but is a maximum of 1 m). The projection of this tooth onto Profile 30/31 suggests its origin as the top of Unit 4A-CHE or the bottom of Unit 4A-POC (Figure 5). If this molar was unearthed in the northern part of the square, it could also have been exhumed from Layer 4A-OR (Unit 4A-IP).

Pictures

No pictures of this tooth were taken in situ, as its discovery precedes the identification of the Neandertal child at Scladina. However, numerous pictures of the square were taken during the next stage of excavation, when the permanent maxillary right first molar (Scla 4A-4) was found (Figure 12). These pictures show the nature of the sediment that molar Scla 4A-4 was found in. The same sediment covered almost the entirety of Square C30: a silt rich in limestone and calcite fragments, attributable to units 4A-CHE or 4A-POC. Only a narrow band of sediment (10 cm wide and 40 cm long) situated in the northern part of the square contains no calcite fragments; this sediment corresponds to Layer 4A-OR (Unit 4A-IP).

Field notes

The information collected in the field clearly indicates that the narrow band of Unit 4A-IP in the northern part of Square C30 contains no bone or tooth remains. This situation suggests eliminating Unit 4A-IP from the possible candidates for the sedimentary context of Scla 4A-3.

3.5.2. Synthesis

The stratigraphic context of molar Scla 4A-3, deduced from the study of both the very close Sedimentary Profile 30/31 and the sediments visible in the pictures that show the discovery of molar Scla 4A-4 (found immediately after Scla 4A-3), suggests that this tooth likely originates either from Unit 4A-CHE (facies 4A-GX) or from Unit 4A-POC (Table 1 & 2). An origin from Layer 4A-OR (Unit 4A-IP) can be discarded, as this unit is very poorly represented in this square and contains no remains.

3.6. The crown of the permanent maxillary right third molar (Scla 4A-8)

The molar Scla 4A-8 was unearthed on the 14th of July 1995 in Square C32 (Figure 4). It was identified immediately after, during sieving. The field observations made during the discovery restrict the range of the object's x and y coordinates. Its 3-dimensional coordinates in Square C32 are thus: x = 20 to 80 cm, y = 10 to 30 cm, and z = −460 to −462 cm (Table 1). It was attributed to the top of former Layer 4A.

3.6.1. Available arguments

Closest sedimentary profile

The nearest profile is Cross-Section 32/31 (Figure 13). It is a maximum of 30 cm away from where the molar crown was discovered. The projection onto the northern half of Square C32 (towards D) points to Layer 3-LHM (Unit 3-INF), while the projection onto the southern half of the square (towards B) points to Layer 4A-LEG (Unit 4A-POC) or, less likely, to the upper 4A-JA facies (Unit 4A-CHE). However, an attribution to Layer 3-LHM (Unit 3-INF) can be ruled out because the sediment of this layer is brownish and could not have been confused with former Layer 4A; besides, according to the data collected in the field, former Layer 3 was completely excavated in this square by the 25th of March 1995.

Position in comparison with Speleothem CC4

The depth of Speleothem CC4 in Square D32 (−480 cm at the deepest) confirms that the molar Scla 4A-8 (z = −460 to −462 cm) must be from above the bottom of Speleothem CC4.

Field notes

An examination of the spatial distribution maps of the remains shows that the map concerning the tooth Scla 4A-8, at a depth of ~−460 cm, indicates the presence of calcite fragments. Therefore, the object must originate from units 4A-POC, 4A-CHE, or 3-INF, all of which contain calcite fragments.

3.6.2. Synthesis

The combination of all the available arguments suggest that the tooth originates from Unit 4A-POC, and more likely from Layer 4A-LEG, considering the position of the tooth in comparison with the Profile 32/31 (Tables 1–2). However, an origin from the top of Unit 4A-CHE (Facies 4A-JA) cannot be totally ruled out.

3.7. The deciduous mandibular right second molar (Scla 4A-13)

The Scla 4A-13 deciduous molar was found on the 13th of November 2001 in Square E38 (Figure 4).

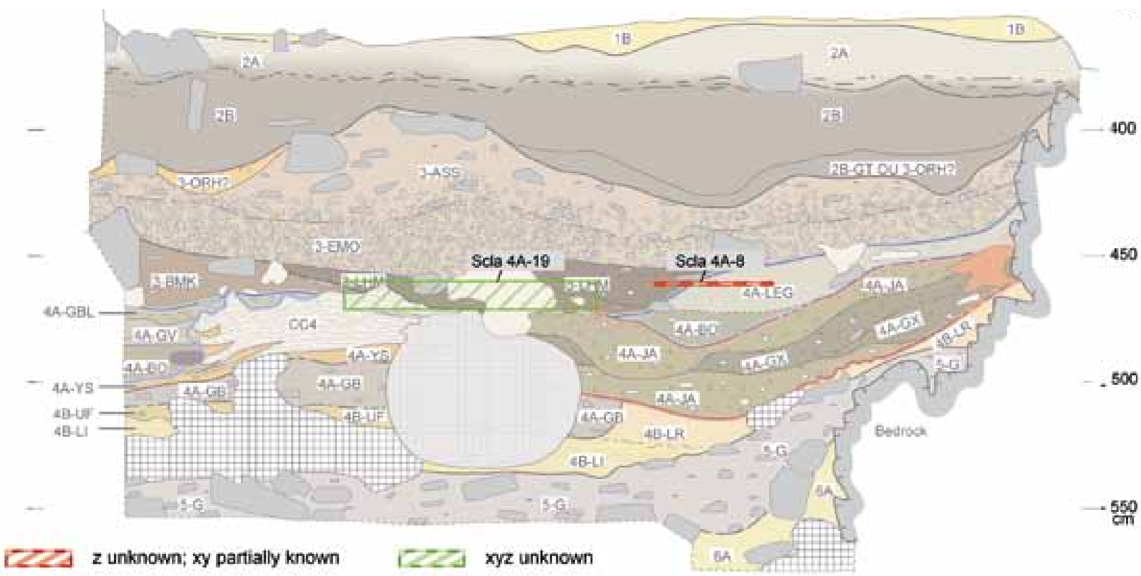

Figure 13: Orthogonal projections of the Neandertal remains Scla 4A-8 (C32) and 19 (D34) on Cross-Section 32/31.

Figure 14: The deciduous mandibular right second molar (Scla 4A-13) in situ in Square E38. Left, angle between profiles E/F and 38/39; right, close up of the tooth surrounded by an orange-brown and grey sediment corresponding to Layer 4A-LEG.

It was identified in situ. Its 3-dimensional coordinates in Square E38 are: x = 88 cm, y = 57 cm, and z = −481 cm (Table 1). It was attributed to former Layer 4A in the field.

3.7.1. Available arguments

Closest sedimentary profile

Sedimentary profiles E/F 38 and E 38/39 are the closest to where the molar was found (12 and 43 cm, respectively). The projection of the molar clearly shows that it is from Unit 4A-POC, and more precisely from layers 4A-BO or 4A-LEG.

Pictures

Several pictures of the area are available, including pictures with the tooth in situ. They show the junction between sedimentary profiles E/F and 38/39 (Figure 14). In these pictures, the molar can be positioned in comparison with the large speleothem fragment present at the corner of the two profiles. The tooth appears to be from sediment with grey and orange-brown lenses, corresponding to Layer 4A-LEG (Unit 4A-POC).

3.7.2. Synthesis

All the arguments, especially the pictures of the tooth in situ, demonstrate that the fossil Scla 4A-13 is from Unit 4A-POC, and more specifically from Layer 4A-LEG (Tables 1 & 2).

3.8. The permanent mandibular left lateral incisor (Scla 4A-19)

The tooth Scla 4A-19 was found during sieving on the 8th of March 1995. It is from Square D34 (Figure 4). It was attributed to former Layer 3, at the boundary with former Layer 4A. However, as it came from the last stage of excavation in former Layer 3, it is quite possible that a small part of the top of former Layer 4A was also accidentally excavated during the process.

The 3-dimensional coordinates are not accurate given the conditions of the object's discovery: the x and y values are unknown, and z = −460 to −471.5 cm (Table 1).

3.8.1. Available arguments

Closest sedimentary profile

The 2 available sedimentary profiles for provenancing this incisor are rather far away. The first one is Profile E/F 34, which is 1 to 2 m away (the absence of x-y coordinates prevents an accurate measurement). The projection (Figure 15) suggests a possible origin in Layer 4A-LEG (Unit 4A-POC), Layer 3-BMK (Unit 3-INF), or less likely from layers 4A-BO (Unit 4A-POC), 3-ASS, or 3-EMO (Unit 3-SUP).

The second profile is Cross-Section D 32/31 (Figure 13). It is even farther away from the fossil than E/F 34 at between 2 and 3 m, preventing any reliable projections. Regardless, the projection

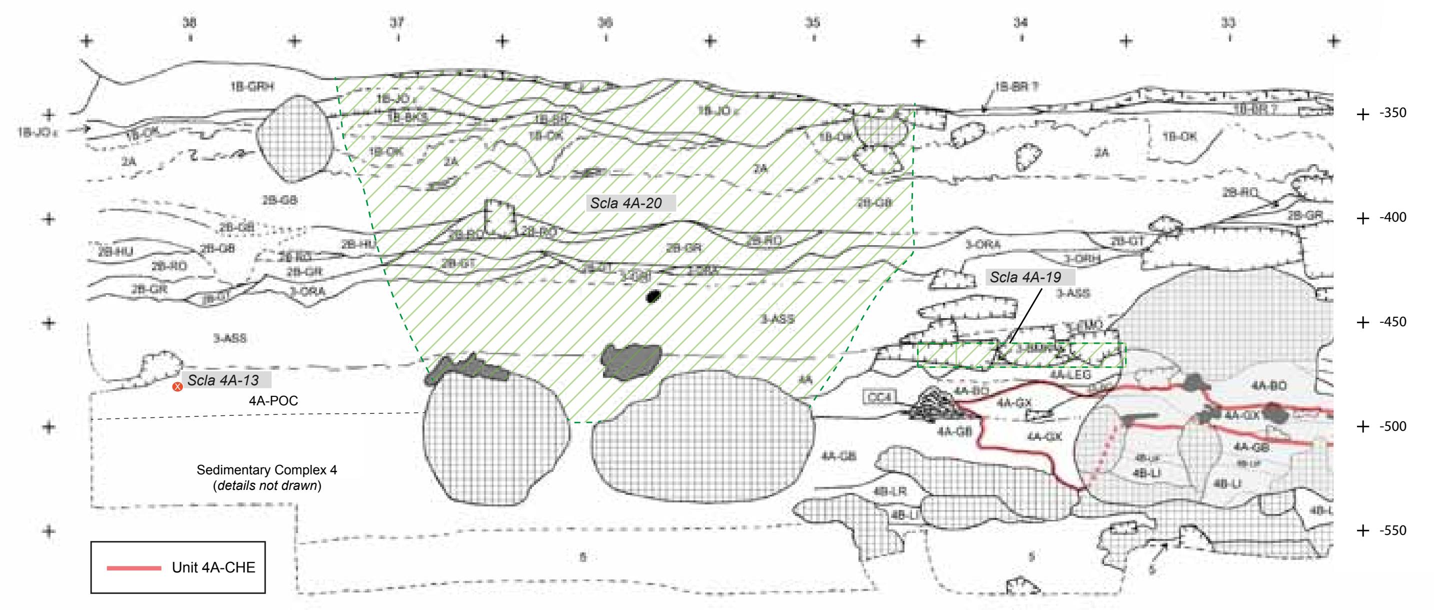

Figure 15: Orthogonal projections of the Neandertal teeth Scla 4A-13 (E38) and Scla 4A-19 (D34) on Sedimentary Profile E/F (after Pirson, 2007). The area of this profile affected by the collapse (squares 35–37) that led to the discovery of the permanent mandibular right lateral incisor (Scla 4A-20) is also shown.

suggests Unit 3-INF (layers 3-LHM or 3-BMK), Unit 4A-POC (Layer 4A-GBL), or Unit 4A-IP (Speleothem CC4). However, taking the apparent dip observed on Profile E/F into account, an attribution to Unit 4A-IP seems unlikely and can be ruled out.

Position in comparison with Speleothem CC4

Near Square D34, Stalagmitic Floor CC4 has been observed at several locations in situ (Figure 4). In D34, Speleothem CC4 was reached during the stage of excavation following the discovery of the tooth (at an altitude of around −480 cm), which automatically implies that this fossil came from a layer overlying CC4. Units 4A-CHE and 4A-IP can therefore be discarded as candidates.

3.8.2. Synthesis

All the available arguments indicate that tooth Scla 4A-19 was excavated from a layer overlying Speleothem CC4 (i.e., postdating Unit 4A-IP). The available sedimentary profiles are too far away to allow any firm attribution to be made. Given the stratigraphic context, however, several units are possible candidates: units 4A-POC, 3-INF, or, less likely, Unit 3-SUP (Tables 1 & 2).

The fact that tooth Scla 4A-19 came from above Speleothem CC4 could explain that this fossil was attributed in the field to former Layer 3. At this time, Speleothem CC4 was understood to seal former Layer 4A. Therefore, it was thought that an object from any sediment above CC4 had to belong to former Layer 3. In the new stratigraphic record Unit 4A-POC is understood to superimpose Speleothem CC4, so the fossil could either belong to 4A-POC or to former Layer 3 (i.e., to one of the layers of Unit 3-INF or to layers 3-ASS or 3-EMO of Unit 3-SUP).

3.9. The 10 teeth from squares F26, F27, G27, and H27

The squares F26, F27, G27, and H27 yielded 10 teeth belonging to the Scladina Neandertal child between the 22nd of February 1990 and the 19th of November 1991: Scla 4A-5, -6, -7, -11, -12, -14, -15, -16, -17, and -18 (Figure 4). These teeth were all collected before the identification of Neandertal remains in July 1993. At this time, the excavation in former Layer 4A was conducted by square metres and by ~10 cm thick levels (see Chapter 2). Their x and y coordinates inside the square are therefore unknown, while the z coordinate corresponds to an altitude range of between 9 and 15 cm (with extreme z values of −445 and −481 cm for all the 10 teeth; Table 1).

Eight of these teeth were attributed in the field to former Layer 4A. The 2 others (Scla 4A-17 and -18) were initially attributed to the bottom of former Layer 3 and published as such (e.g., Otte et al., 1993; Toussaint et al., 1994). Soon after, these teeth were suggested to belong to former Layer 4A (Bonjean et al., 1996, 1997; Pirson et al., 2005). The situation will be re-examined here.

3.9.1. Available arguments

Each of the squares F26, F27, G27, and H27 include at least some of the Unit 4A-CHE gully structure (Figure 9). This probably explains why Speleothem CC4 is mainly absent from these squares. However, in the absence of x-y coordinates for the 10 teeth, and as the exact course of the gully in this area remains unknown, it cannot be excluded that some of the fossils may be from an area unaffected by the gully. In such a context, all the available arguments have been used in order to try to limit the uncertainty of the stratigraphic location for each of the 10 Neandertal teeth.

Position in comparison with Speleothem CC4

In the 4 squares listed above, Stalagmitic Floor CC4 (Unit 4A-IP) is only present in the north-western quarter of Square F27 and in the northern border of Square H27. However, it has been regularly observed in the surrounding area to the west and to the north (Figure 4). Because of the apparent dips observable on Sedimentary Profile H/I (Figure 16), and more specifically the apparent dip of the planar boundary between units 4A-AP and 4A-IP, extrapolating the position of the bottom of Unit 4A-IP is possible in the squares where the speleothem was not observed. Most of the time, the bottom of Unit 4A-IP corresponds to the bottom of Speleothem CC4.

On Sedimentary Profile H/I, the apparent dip of the planar limit at the bottom of Unit 4A-IP has a value of about 4° (~7 cm/m) between metres 23 and 28, then tends to be almost horizontal between metres 29 and 30. This value (7 cm/m) corresponds to the planar limit's average apparent dip because the bottom of Unit 4A-IP regularly deviates from this mean value by only a few centimetres. The maximum observed deviation on Profile H/I is close to 10 cm, but most of the time the deviation is less than 5 cm. This extrapolation has to be used carefully, given the important lateral variations regularly observed in the cave; however, it remains one of the main arguments for the reattribution of these 10 teeth to the new stratigraphic record.

Based on this extrapolation, the estimated depth of the bottom of Unit 4A-IP in the squares F26 and F-G-H27 is indicated on Figure 17 (values between brackets). The implications for the 10 teeth are listed below, square by square:

- F26: the extrapolated bottom of Unit 4A-IP is at -473 cm. The tooth Scla 4A-18, with an altitude value of between −461 and −471 cm, would thus be situated above this limit;
- F27: the extrapolated bottom of Unit 4A-IP is at −480 cm and the measured depth of the portion of the in situ Speleothem CC4 is at −482 cm.

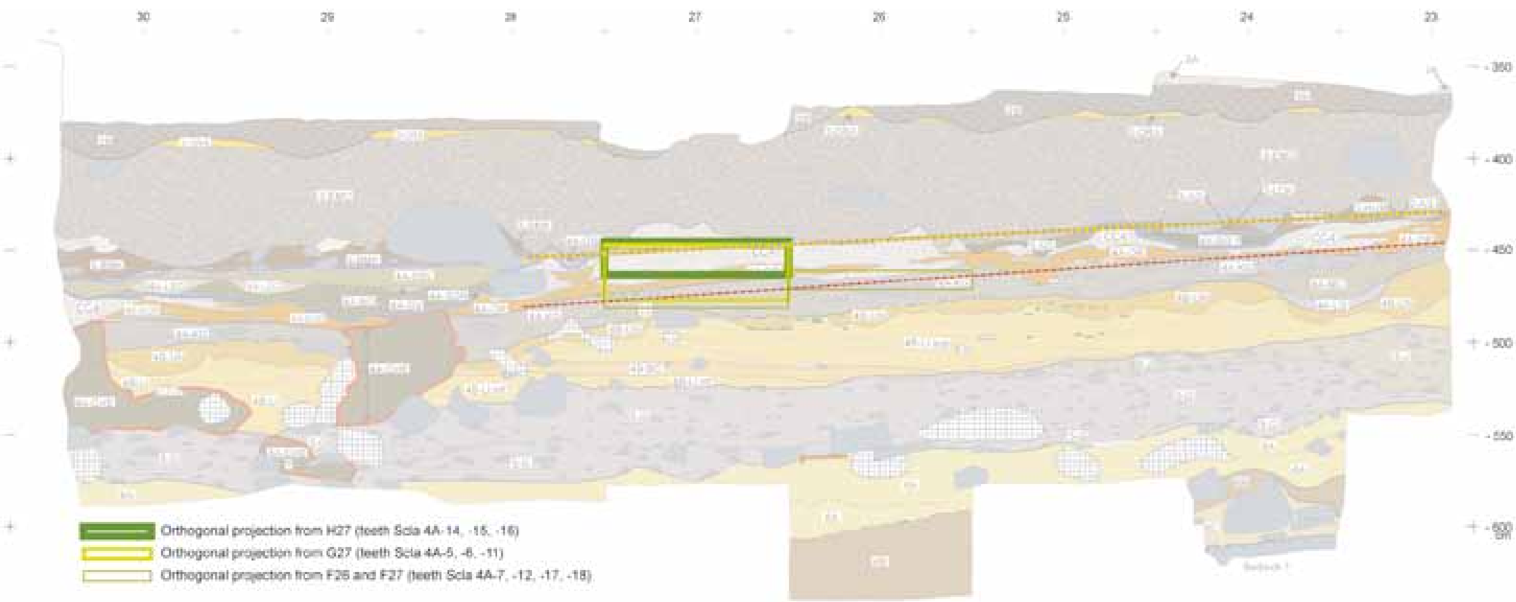

Figure 16: Orthogonal projections (rectangles) of the 10 Neandertal teeth from squares F26 and FGH-27 on Sedimentary Profile H/I. The apparent dips of the bottom of Unit 4A-IP (red; ~7cm/m) and Layer 3-EMO (yellow; ~5cm/m) are also shown.

This reinforces the reliability of these extrapolations. The teeth Scla 4A-12 (z = −449 to −461 cm) and Scla 4A-17 (z = −458 to −470 cm) are clearly situated higher; the tooth Scla 4A-7 (z = −471 to −481 cm) is situated slightly above or immediately below the bottom of Unit 4A-IP;
- G27: the extrapolated bottom of Unit 4A-IP is at −477 cm. The teeth Scla 4A-5 and -11 (z = −447 to −462 cm) would thus be situated above this limit; the tooth Scla 4A-6 (z = −463 to −477 cm) would also be above this limit or at the boundary between units 4A-AP and 4A-IP;
- H27: the extrapolated bottom of Unit 4A-IP is at −475 cm. This value is comparable to what was observed on Sedimentary Profile H/I 27 (−465 to −473), which again reinforces the reliability of these extrapolations. The teeth Scla 4A-14 and Scla 4A-15 (z = −445 to −454 cm), as well as Scla 4A-16 (z = −454 to −463 cm) are thus situated above the bottom of Unit 4A-IP.

As a result, 8 out of 10 teeth are clearly situated above the lower limit of Unit 4A-IP, which means that they are contemporaneous with or were deposited after Unit 4A-IP. The 2 remaining teeth are also probably above this limit, even if a position immediately below cannot be totally ruled out by this analysis.

Position in comparison with Unit 4A-CHE

Unit 4A-CHE is a gully structure that developed downwards from the top of Unit 4A-IP into subjacent layers. Most of the time, Unit 4A-CHE extends below the bottom limit of Unit 4A-IP, despite it being younger (Figure 2). However, the top of Unit 4A-CHE is sometimes situated higher than the bottom of Unit 4A-IP (e.g., on profiles 30/31 in C or 32/31 in B-C-D; Figures 5 & 13).

In this context, the 8 teeth situated above the bottom of Unit 4A-IP are most likely not from 4A-CHE, but this latter hypothesis cannot be totally ruled out. The 2 other teeth, Scla 4A-7 (z = −471 to −481 cm) and Scla 4A-6 (z = −463 to −477 cm), might originate from below Unit 4A-IP (extrapolated bottom of Unit 4A-IP at −480 and −475 cm, respectively); they could therefore belong to Unit 4A-CHE.

Unit 4A-IP vs. Unit 4A-CHE

Often where the 4A-CHE gully is present Unit 4A-IP has been completely eroded. As the squares F26, F27, G27, and H27 are most probably affected by the Unit 4A-CHE gully, Unit 4A-IP has probably been eroded from most of these squares. As a result, an origin of the teeth in Unit 4A-IP itself seems unlikely. However, Unit 4A-IP was present on a small portion of F27 and H27 where Speleothem CC4 was recorded (Figure 9); small parts of the other squares were also potentially not affected by Unit 4A-CHE. In such conditions, an origin from Unit 4A-IP cannot be totally ruled out; however, it is unlikely.

Position in comparison with units 3-SUP and 3-INF

Given the local stratigraphic context deduced from sedimentary profiles H/I and 30/31, as well as from field data, the 10 teeth are not from a layer that superimposes Layer 3-EMO (Unit 3-SUP).

Concerning Unit 3-SUP itself and its main Layer 3-EMO, the same method as for Speleothem CC4 was applied: the apparent dip of the lower boundary of Layer 3-EMO observable on Sedimentary Profile H/I was used (Figure 16). This dip has a value of between 3–3.5° (~5 to 6 cm/m) when viewed on this profile. On Sedimentary Profile 30/31, the altitude of Layer 3-EMO varies between −470 cm in column F and −441 cm in column H due to the presence of a small gully in column F (Figure 18). In such a stratigraphic context, the use of average dip is difficult. Therefore, only the minimum dip will be taken into account (5 cm/m). Furthermore, the minimum dip will be applied to the lowest point of Layer 3-EMO on Profile 30/31, at the bottom of the small gully (−470 cm), in order to take the probable meandering course of this gully into account when going updip from metre 30 to metres 26-27. As a result, the extrapolated depth of the lower limit of Layer 3-EMO for squares F-G-H 26-27 will represent the lowest possible values for this limit.

Following this reasoning, the lowest possible depth of the bottom of Layer 3-EMO (Unit 3-SUP) ranges from -450 cm to −445 cm for metre 26, and from −455 cm to −450 cm for metre 27 (Figure 17). When comparing these values with the depth range of each Neandertal tooth, it appears that the tooth from Square F26 (Scla 4A-18; z = −461 to −471 cm) is clearly below Layer 3-EMO and thus cannot be from this layer. The same goes for 4 teeth from metre 27 (Scla 4A-6, -7, -16, -17). The lowest value of the depth range of the 5 remaining teeth (Scla 4A-5, -11, -12, -14, -15) is close to the limit: between −445 and −449 cm. Therefore, for these 5 teeth, Layer 3-EMO cannot be totally ruled out as their sedimentary context (Table 2).

The same method was applied to Unit 3-INF and indicated that the 10 teeth could be from this unit, even if it seems unlikely for 5 of them.

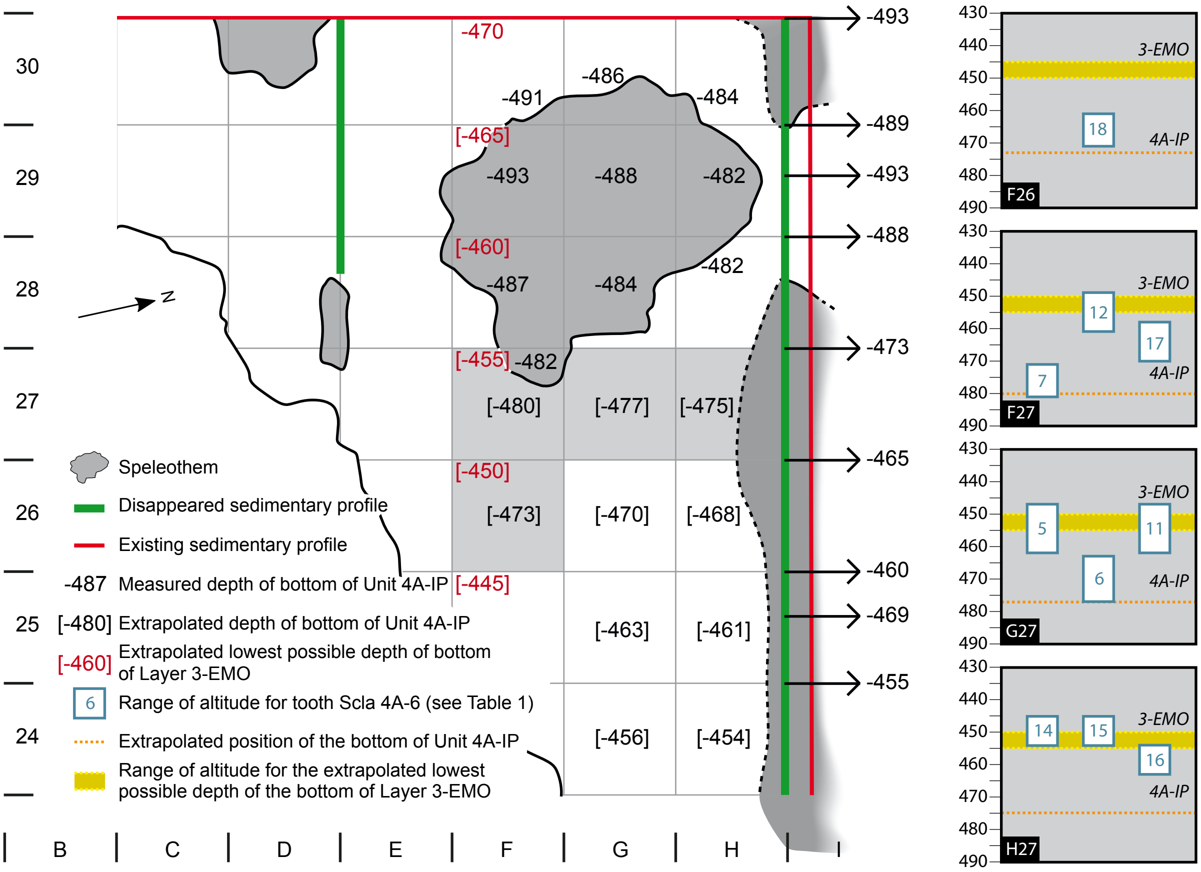

Figure 17: The extrapolated depth (see text) of the bottom of Unit 4A-IP as well as the extrapolated lowest possible depth of the bottom of Layer 3-EMO. These extrapolated depths helped reconstruct the stratigraphic position of the 10 teeth from squares FGH 27 and F26 relatively to 3-EMO and 4A-IP (see boxes at the right).

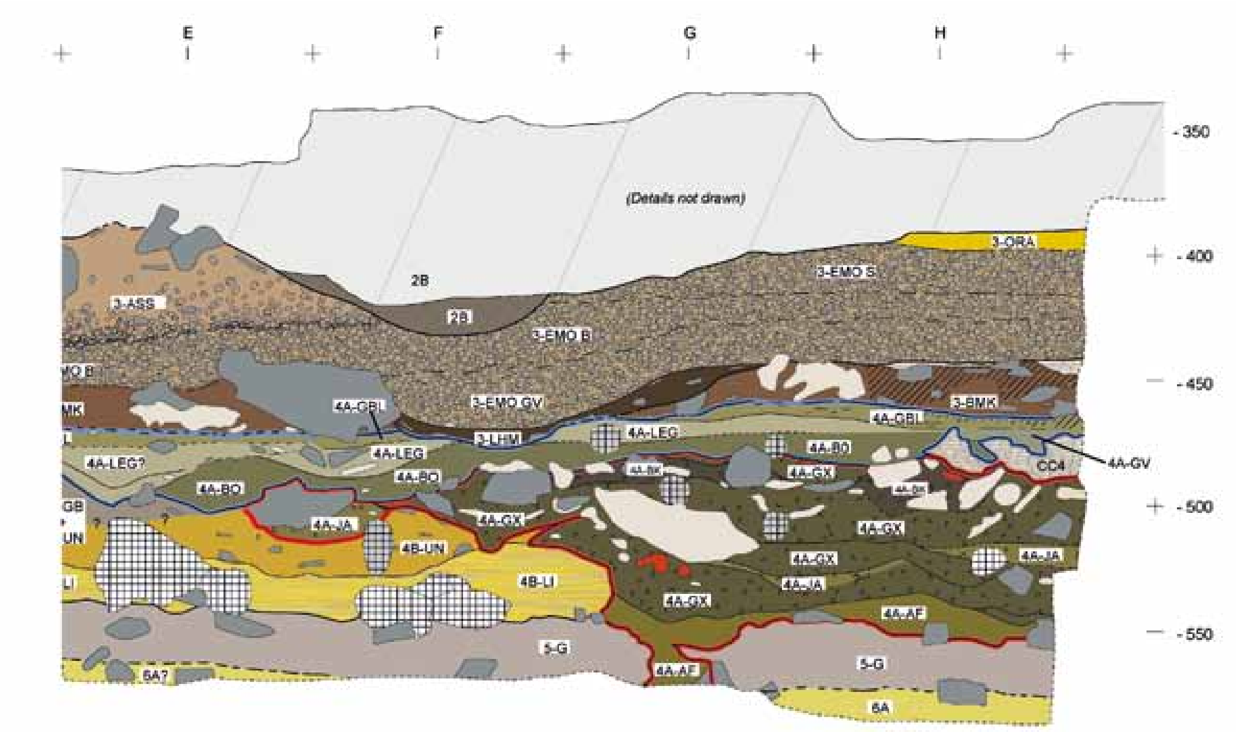

Figure 18: Sedimentary Profile 30/31 showing the concave aspect of the bottom of Layer 3-EMO (gully; the complete section, from B to H, is presented in Chapter 3).

Closest sedimentary profile

The nearest cross-section is the longitudinal Sedimentary Profile H/I. However, the orthogonal projections are not useful for several reasons: the complexity of the attitude of structures in this area, especially with the gully of Unit 4A-CHE; the concave shape of the lower limit of Speleothem CC4 on the transverse axis (Figure 17); and the irregular lower boundary of Layer 3-EMO (Unit 3-SUP) due to small gullies. The projections will therefore not be taken into account. For information only, the projection of the fossils from Square H27 (which are less than 1 m away) point to the following layers (Figure 16): Speleothem CC4 (Unit 4A-IP) or Layer 4A-OR (Unit 4A-IP) in the case of tooth Scla 4A-16; Speleothem CC4 (Unit 4A-IP) or Layer 3-EMO (Unit 3-SUP) in the case of teeth Scla 4A-14 and -15. The projections of the teeth from squares F26, F27, and G27 (Figure 16) point to Layer 4A-KG (Unit 4A-AP), Layer 4A-OR or CC4 speleothem (Unit 4A-IP), or Layer 3-EMO (Unit 3-SUP).

3.9.2. Synthesis

The 10 teeth found in squares F26, F27, G27, and H27 are the first human remains discovered at Scladina. They were unearthed between 1990 and 1991, i.e., before the identification of the Neandertal child. For these reasons, the available data is less numerous and less precise. The stratigraphic context of the objects is therefore much more difficult to establish.

The main arguments concern the stratigraphic sequence in the area, deduced from the reference sections H/I and 30/31, and the comparison between the altitude of the teeth and the altitude of the lower limit of units 4A-IP, 3-INF, and 3-EMO. A first limitation of using these arguments is the lack of precision of the altitude values given to the teeth, as they were found during sieving. A second limitation is that the altitude of units 4A-IP, 3-INF, and 3-EMO can only be obtained following an extrapolation based on an average longitudinal dip determined on the reference Sedimentary Profile H/I. Caution is therefore particularly advised here.

Taking all of this into account, suggesting that the teeth are from units 4A-IP, 4A-CHE, 4A-POC, 3-INF, and/or 3-SUP is possible, with a different combination of potential units for each tooth (see Tables 1 & 2 for the details). An origin from Unit 3-SUP or Unit 4A-IP is unlikely in all cases. Among 4A-CHE, 4A-POC, and 3-INF, the best hypothesis would be an origin from Unit 4A-POC because it is the common possibility between all the 10 teeth.

3.10. The permanent mandibular right lateral incisor (Scla 4A-20)

The tooth Scla 4A-20 was discovered on the 12th of July 2006 during the sieving of sediment from a collapse of Sedimentary Profile E/F 35-37 (Figure 4), in an area bioturbated by 2 large badger burrows (Figures 15 & 19). The 3-dimensional coordinates of this incisor are therefore unknown (Table 1).

3.10.1. Available arguments

Closest sedimentary profile

Two sedimentary profiles influence the interpretation of this tooth's context: Profile E/F (Figure 15) and Profile F/G. The careful examination of the collapse area in 2006 indicates that only some units have been affected by this collapse: Sedimentary Complex 1B, as well as units 2A, 2B, 3-SUP, 3-INF, and 4A-POC (Figure 15). An origin from a unit older than Unit 4A-POC can therefore be discarded, allowing units 4A-AP and 4A-IP to be excluded. In addition, Unit 4A-CHE can also be ruled out because this unit does not exist in the area affected by the profile collapse (E/F 35-37) and is only visible between metres 34 and 32 on Profile E/F.

3.10.2. Synthesis

The units affected by the collapse of the Sedimentary Profile E/F in 2006 allow the sedimentary context of the tooth Scla 4A-20 to be restricted to a small number of candidates: Sedimentary Complex 1B, as well as units 2A, 2B, 3-SUP, 3-INF, and 4A-POC. An origin from Unit 4A-CHE is not possible because the unit is absent from the squares affected by the collapse. Given the available data on the stratigraphic origin of the other Neandertal child remains, an origin from units 4A-POC or 3-INF seems the most likely, but an origin from Unit 3-SUP (mainly Layer 3-ASS) cannot be ruled out (Tables 1 & 2).

4. Discussion

4.1. Where did the Scladina Child remains come from? A summary of the stratigraphic origin of the Neandertal remains

The re-examination of all the available arguments allowed all of the Neandertal remains

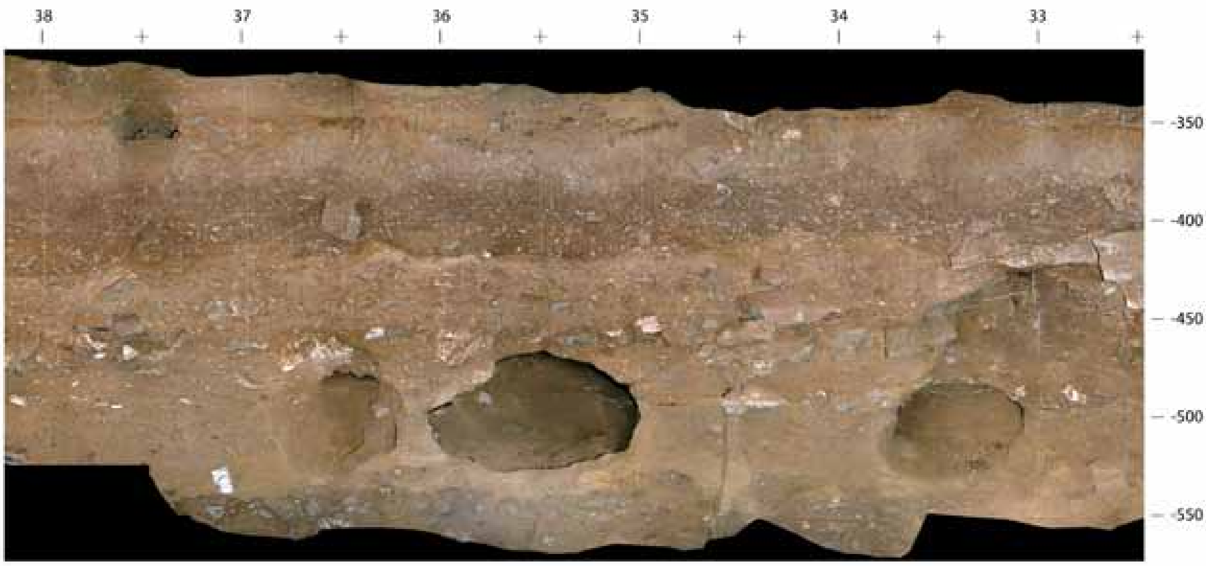

Figure 19: Sedimentary Profile E/F showing the two large badger burrows responsible for the accidental collapse of a portion of the profile (35-37; Figure 15). The sieving of sediments from this collapsed area led to the discovery of the permanent mandibular right lateral incisor (Scla 4A-20). This figure corresponds to the assemblage of several pictures; some errors are thus expected (photographs: Archéologie Andennaise; photomontage: K. Di Modica).

to be organised into the new stratigraphic record, sometimes with accuracy, sometimes with a rather high uncertainty (Tables 1 & 2; Figure 20).

Most of the time, the comparison between the 3-dimensional coordinates of the Neandertal remains and the available sedimentary profiles was insufficient for positioning the fossils with accuracy through orthogonal projections. This is due to the high complexity of this part of the stratigraphic sequence, particularly the presence of the Unit 4A-CHE gully. On the other hand, the comparison of these projections with the analysis of the available pictures often turned out to be a determining factor, especially thanks to the presence of speleothem fragments in units 4A-CHE and 4A-POC. The altitude of the Neandertal remains, when compared with the major stratigraphic marker represented by Speleothem CC4, is also an argument that is important for most of the fossils.

When taking all the arguments into account, 3 of the 19 remains could be positioned with absolute certainty in a specific layer from the new stratigraphic record. These fossils belong to 2 distinct units postdating the Speleothem CC4: units 4A-CHE and 4A-POC. The first of these fossils is the right half of the mandible (Scla 4A-1). It is from the top of Unit 4A-CHE, and more specifically from the uppermost 4A-GX lithofacies. This unit corresponds to a large gully, which suggests that the right half of the mandible is in secondary spatial position. The 2 other fossils (Scla 4A-4 and -13) are teeth from Unit 4A-POC: the first is from Layer 4A-BO, the other is from Layer 4A-LEG. These 2 teeth are likely in tertiary spatial position because they belong to the same individual as the right half of the mandible (see Chapters 10, 12 & 13), which was exhumed from an older unit (Unit 4A-CHE, which immediately predates Unit 4A-POC). Therefore, these 2 teeth underwent a reworking phase from the top of Unit 4A-CHE.

Four other fossils are either from Unit 4A-CHE or from Unit 4A-POC: the fragment of right maxilla (Scla 4A-2), the left half of the mandible (Scla 4A-9), and 2 additional teeth (Scla 4A-3 and -8). Therefore, despite the possibility of an origin from 2 distinct units, the stratigraphic context of these 4 fossils is similar to that of the first 3.

Eleven other teeth (Scla 4A-5, -6, -7, -11, -12, -14, -15, -16, -17, -18, and -19) could originate from several units. All in all, 5 units are possible candidates: 4A-IP, 4A-CHE, 4A-POC, 3-INF, and 3-SUP (Table 1).

- Unit 4A-POC is systematically present as a possible candidate for each fossil, each time either as the most probable (3 out of 11) or as one of the most probable (8 out of 11).
- Unit 3-INF is also systematically a possible candidate for each of the 11 fossils; it is one of the most probable candidates in 6 cases and an unlikely candidate in 5 cases.
- Unit 4A-CHE is a candidate for 10 fossils out of 11; it is one of the most probable candidates in

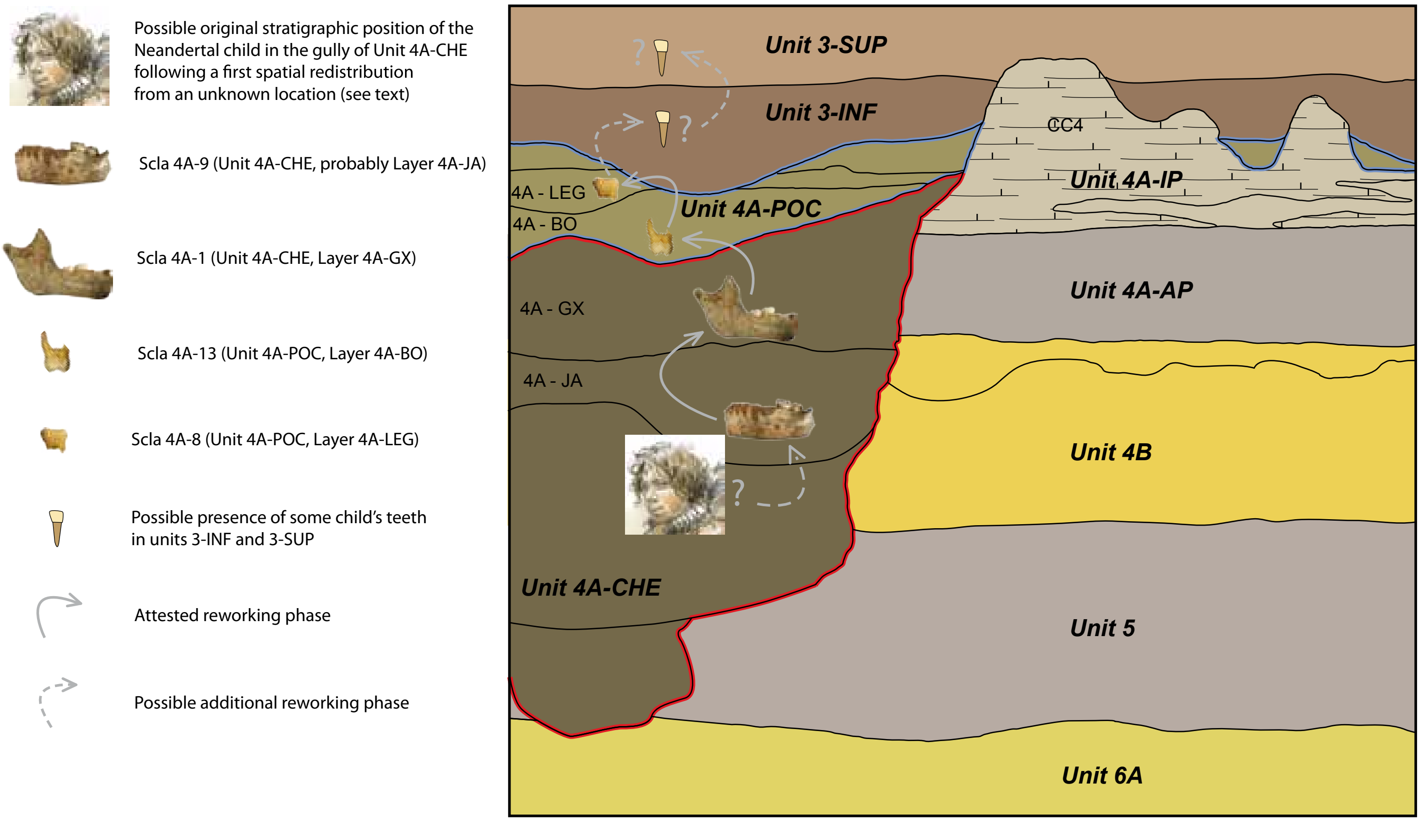

Figure 20: Sketch evoking the complex depositional history of the Neandertal child remains. This is illustrated through 4 remains: the 3 fossils that could be positioned with certainty in a specific layer from the new stratigraphic record (Scla 4A-1, -4, and -13), and the left half of the mandible (Scla 4A-9).

only 2 cases, being an unlikely candidate in the 8 other cases. In each situation, only the top of this unit is concerned.

- Unit 4A-IP is candidate for 10 fossils out of 11 but it is always as an unlikely candidate.
- Unit 3-SUP, and in particular Layer 3-EMO, is only candidate in 6 cases out of 11. It is always an unlikely candidate.

The last fossil, the tooth Scla 4A-20, is in a similar situation as the 11 above mentioned teeth, despite having been found after the collapse of Sedimentary Profile E/F 35-37. When taking into account both the stratigraphic context of all the other Neandertal remains and the layers affected by the collapse, an origin from units 4A-POC or 3-INF seems to be the best hypothesis, while an origin from Unit 3-SUP (mainly Layer 3-ASS) is unlikely.

The anthropological study of the Neandertal remains has clearly demonstrated that all the 19 fossils are from a single individual (Chapters 10, 12 & 13). These 19 objects were therefore initially deposited within the same stratigraphic unit. Two distinct stratigraphic units yielded 7 fossils out of 19: units 4A-POC and 4A-CHE. The best hypothesis would suppose that the other 12 remains also come from one of these 2 units. This hypothesis is strengthened by the fact that Unit 4A-POC is the only unit systematically represented as one of the most probable, if not the most probable, candidates for these 12 remains.

An origin from units 3-INF or 3-SUP is a possibility for 11 fossils out of 19. This would not drastically change the outcome of the analysis. These 2 units have an erosive lower boundary on Unit 4A-POC, and the concerned fossils could originate from the reworking of material from 4A-POC. In this situation, a second and possibly a third reworking phase would have to be considered. However, this is unlikely as several successive reworking phases would have diagenetically altered the Neandertal remains, and the taphonomic study highlighted their relative unaltered state. The remains were said to have a low degree of abrasion of edges for the 3 osseous fragments, and an exceptional state of preservation of the 16 isolated teeth of the Neandertal child, with little alteration (see Chapters 7, 10 & 13). In such conditions, an origin of some fossils from Layer 3-EMO (Unit 3-SUP), laid down through high energy dynamics (torrential flow; see Chapter 3), seems very unlikely.

In fact, only an origin from Unit 4A-IP would really change the situation, as some fossils would then be from a unit older than 4A-CHE, implying that all of the Neandertal remains were originally located in that unit. However, each time the origin from Unit 4A-IP is considered (10 isolated teeth out of the 19 remains) Unit 4A-POC is a much more probable candidate. In addition, Unit 4A-IP is almost completely deprived of any bone remains.

When taking all the elements into account, Unit 4A-POC is the most probable sedimentary context for the isolated teeth. This interpretation is strengthened by the taphonomic study, which indicates that Unit 4A-POC yielded the most animal teeth that have the strongest taphonomic correlation with the isolated Neandertal teeth (see Chapter 7). On the other hand, the 3 bone fragments offer the strongest taphonomic similarities with animal bone remains from Unit 4A-CHE. This appears to be very consistent as the right half of the Neandertal mandible is effectively from Unit 4A-CHE, while Unit 4A-CHE is the most probable context for the left half of the mandible. Regarding the small fragment of the Neandertal maxilla, it most probably came from Unit 4A-POC, but an origin from Unit 4A-CHE is not impossible.

4.2. Implications for the depositional history and the origin of the Neandertal remains

Stating that the Neandertal remains were originally deposited in Unit 4A-CHE and were subsequently reworked into one (or several) younger unit(s) is reasonable considering the data provided. Because of the sedimentary depositional dynamics of Unit 4A-CHE, all the Neandertal remains are in secondary spatial position.

The secondary spatial position of the Neandertal fossils, as well as associated high energy sedimentary dynamics, were already suggested before the stratigraphic reappraisal because of several arguments: the presence of broken speleothem fragments, the occurrence of bones and limestone blocks in a very oblique or vertical positions, a large longitudinal dispersion (several metres) of the anthropological remains, and the variable depths of the different Neandertal remains (Bonjean et al., 1996, 1997; Toussaint et al., 1998). The integration of these elements led researchers to suggest that a thick mud flow[2] transported the remains. The occurrence of cut-and-fill structures was also recorded on a sedimentary profile (Profile D/E 28-30; Bonjean et al., 1997; see Figure 6). However, before the stratigraphic reappraisal, the mud flow event was thought to have deposited the entire former Layer 4A.

The new stratigraphic record, when combined with the reappraisal of the stratigraphic position of the Neandertal remains presented in this chapter, indicates a much more complex situation.

It is now well established that the Neandertal remains were disturbed by an event that created an important erosional structure in the form of a large and deep gully (Unit 4A-CHE). On its course, this gully eroded Speleothem CC4 and underlying layers down to Unit 6A (see Chapter 3). In such a context, is it possible to establish the primary stratigraphic position of the Neandertal child osseous fragments and teeth?

Given the sedimentary dynamics of Unit 4A-CHE, the remains could have been buried long before the gully episode and then reworked from their initial sedimentary context(s) by the gully during its initial high-energy stages. The hypothesis of the child being contemporary with Stalagmitic Floor CC4 (Unit 4A-IP) or with the underlying units (Unit 4A-AP or even units 4B, 5 or 6A) is conceivable, as the gully reworked all of these units. A much older origin cannot be totally ruled out either, especially if one takes into account an origin from another area of the cave, or even from outside the cave. However, there is no evidence that the remains were reworked into the 4A-CHE gully from another, previously deposited context. On the contrary, all the available data points to Unit 4A-CHE being the original sedimentary context of the Neandertal remains:

- The oldest stratigraphic unit that have yielded some of the Neandertal remains is Unit 4A-CHE; none were found in any subjacent layers.
- All of the Neandertal remains possibly unearthed from 4A-CHE are always from the top of the unit, suggesting that these objects were incorporated during the last stages of the gully's formation; if they were reworked by the gully from a subjacent unit, they would probably be at least partly incorporated during the initial, high-energy stages of the gully structure.
- Their spatial distribution, restricted to the course of the 4A-CHE gully, suggests they are strictly associated with this structure, even if they were later slightly reworked from the top of Unit 4A-CHE in the low-energy Unit 4A-POC, probably through run-off.

[2] "*coulée boueuse épaisse*"

- The results of the taphonomy study (see Chapter 7) do not suggest any high energy reworking; the relative unaltered state of the fossils discovered so far, notably the good preservation state of the tooth roots (see Chapter 16), suggests they were not strongly reworked.
- When all of the physical taphonomic attributes are combined, bones and teeth from units 4A-CHE and 4A-POC yield the strongest correlation to the Neandertal child (see Chapter 7); this suggests that the child remains are part of the objects deposited during the gully event.
- The right hemimandible was unearthed from Unit 4A-CHE, while the left hemimandible is likely also from 4A-CHE, but from another layer within the unit; the fact that they have been differentially fossilized suggests that the Neandertal remains were not yet completely fossilized or recrystallised when they were incorporated into different layers within Unit 4A-CHE (see Chapter 7), which strengthens the hypothesis of sedimentary Unit 4A-CHE being the primary sedimentary context of the child.

After the spatial redistribution of the Neandertal child remains through the gully episode, they were later affected by at least one reworking phase, some of the remains initially present in Unit 4A-CHE being reworked in Unit 4A-POC. If some of the teeth were really excavated from units 3-INF and/or 3-SUP, however unlikely it may be, a second or a third reworking phase would have to be considered.

In this context of complex subsequent redistribution and reworking phases, the important spatial distribution of the remains along the longitudinal axis of the cave makes particular sense.

In the present stage of research, the exact primary spatial position of the Neandertal fossils is still unknown. As the oldest stratigraphic unit that yielded some fossils is Unit 4A-CHE, its attitude gives some indications: the direction of the redistribution of the Neandertal remains is from the entrance to the back of the cave.

Whether the process that brought the Neandertal child remains into the cave was anthropogenic, biological (bioturbation or carnivore activity), or sedimentary, is still unknown. If the influence of the gully is proven to be the cause of the spatial redistribution of the fossils, there is still no evidence to suggest that the event which created this gully is related to the process that first brought the child remains into Scladina Cave. In the present state of research, however, no arguments support either the hypothesis that the child was brought into the cave by an animal, or that it was brought in by anthropological activity, for instance in the form of a burial that was later reworked by the gully.

4.3. Implications for the chronostratigraphic context of the Neandertal remains

The review of the Scladina sequence led to a better understanding of the stratigraphic context of the Neandertal remains, and therefore determined the relative chronology of the events, including the relative antiquity of the child.

In the present state of understanding, the minimum age of the Neandertal child corresponds to the time the objects were deposited. Therefore, the hominin remains are, at the youngest, contemporary with the deposition of sediment in the 4A-CHE gully and thus postdate Stalagmitic Floor CC4. The proposed chronostratigraphic positioning for Unit 4A-CHE, however, is not that accurate; following the arguments developed in Chapter 4, it would span between MIS 5b (if the end of CC4 coincides with the end of MIS 5c) and early MIS 4 (if the end of CC4 coincides with the end of MIS 5a). The best hypothesis is nevertheless an age somewhere inside MIS 5b or MIS 5a, as Unit 2B best corresponds to the end of MIS 5a (see Chapter 4 & Appendix B).

However, as the bones are in secondary spatial position in the gully, the age of the deposit must theoretically be distinguished from the age of the hominin remains. That means that the maximum age of the child cannot be firmly established by stratigraphy. Despite the wide time span involved when taking 2σ into account, the direct dating by gamma spectrometry (127 +46/-32 ka BP; Yokoyama & Falguères in Toussaint et al., 1998) offers a useful maximum age for the fossils.

It has nevertheless been shown that the best hypothesis is that the Neandertal child is contemporaneous with Unit 4A-CHE (§4.2). If this is correct, then the age of the Scladina Neandertal remains would correspond to the age of the 4A-CHE gully structure. Therefore, in the present stage of research, the best two hypotheses are positioning the Scladina Neandertal remains in either MIS 5b or in the beginning of the second part of MIS 5a (see Appendix B).

4.4. Implications for the palaeoenvironmental context of the Neandertal remains

Despite the good palaeoenvironmental data from Scladina (see Chapter 4), direct consequences for the Neandertal child must be considered with caution, as these hominin remains were found in secondary position. If the contemporaneousness of the Neandertal remains with Unit 4A-CHE is correct, this would point to a relative cold and open environment, as the gully of Unit 4A-CHE is interpreted as a melting gully related to the degradation of a deep frozen soil (see Chapter 4).

5. Conclusions and prospects

Among the 19 juvenile Neandertal remains unearthed to date, 7 could be repositioned with accuracy inside the new stratigraphic record based on several arguments, including: their spatial distribution, projections on the closest sedimentary profiles, study of photographs taken in the field, and their position in relation to Speleothem CC4. Each of these 7 fossils is either from Unit 4A-CHE gully or from the directly overlying deposits (Unit 4A-POC). Three of these 7 fossils were even repositioned into a specific layer with certainty.

The results of the re-evaluation of the 12 other remains are still uncertain, as several sedimentary units are still possible candidates. However, an attribution to units 4A-POC and 4A-CHE is most likely when taking all elements into account, i.e., the most probable candidates combined with the results of the taphonomic study and with the fact that all the remains belong to a single individual.

All the Neandertal remains discovered so far are in secondary spatial position. A first spatial redistribution phase is linked with the development of the large gully of Unit 4A-CHE, while during the deposition of Unit 4A-POC some of the fossils were reworked from the top of Unit 4A-CHE. At least two spatial redistribution phases are therefore attested. The fact that the Scladina Child remains were displaced has been acknowledged since the first in situ discovery in 1993. Due to recently establishing a higher resolution stratigraphic sequence, a better understanding of the sedimentary dynamics, and a more accurate positioning of the Neandertal remains in the new stratigraphic record, part of their complex history is now better understood; this process led to a clarification of the remains' mode of deposition and a better explanation of their spatial distribution. However, as they are in a secondary spatial position, neither their initial spatial origin nor the exact process that first brought the remains into the cave could be determined. Given the course of the gully from Unit 4A-CHE, the fossils must be from somewhere closer to the entrance of the cave.

The relative age of the child is difficult to establish because all the discovered fossils were spatially redistributed and the chronostratigraphic context of the sequence is not accurately understood. Their good state of preservation, however, does not suggest the strong reworking of material under high-energy circumstances. This, together with several other arguments, suggests that the Neandertal child is probably contemporaneous with their deposition in the Unit 4A-CHE gully. If this is correct, the age of the child would be close to the age of Unit 4A-CHE. Given that units 6B to 2B are positioned in MIS 5, and that the palaeoenvironmental interpretation of the genesis of Unit 4A-CHE points to cold conditions (melting gully), the most probable chronostratigraphic positioning of Unit 4A-CHE is one of the cold phases at the end of the Weichselian Early Glacial. Therefore, the two best hypotheses in the present stage of research would place the Scladina Neandertal remains in either MIS 5b or in the intra-MIS 5a cold episode. Compared with the Greenland reference sequence, this points to either GS 22 or the cold episode in the beginning of the second half of GI 21, which are respectively dated to approximately 87,000 BP and 80,000 BP according to the NorthGRIP chronology (NorthGRIP-Members, 2004).

The prospects about the Scladina Neandertal child are promising. Thanks to the use of an excavation method adapted to the high complexity of the stratigraphic context of Sedimentary Complex 4A (see Chapter 2; Bonjean, 2009; Bonjean et al., 2009[b]), future fieldwork should make it possible to test several hypotheses, even if no new Neandertal remains are discovered. The origin of the 4A-CHE gully, its flow direction, and its spatial extent could notably be improved, leading to better deciphering the origin of the hominin remains. On the other hand, additional remains of the child will also possibly be discovered in the areas where the gully has not been excavated yet. This would allow testing the hypothesis — however unlikely — of the possible presence of new remains of the child in pre-gully deposits, possibly even in the form of a burial cut and partially reworked by the gully of Unit 4A-CHE.

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Appendix A

Evolution of the understanding of the stratigraphic position of the Scladina I-4A Neandertal remains

The understanding of the stratigraphic position of Scladina I-4A, exhumed from Sedimentary Complex 4A, can be summarized in four phases, reflecting both the establishment of the stratigraphic sequence and the growing importance of multidisciplinary research at Scladina Cave.

1. Phase 1 (until 1994)

The initial phase started at the beginning of excavations in 1978 and ended with the first identification of Neandertal remains around 1993/1994.

The archaeologists in charge of excavation completed the first descriptions of the Scladina Cave stratigraphic sequence (Otte et al., 1983; see Chapter 3). It was soon complemented by the work of geologists P. Haesaerts (1992) on the cave terrace and F. Gullentops and his student C. Deblaere inside the cave (Deblaere & Gullentops, 1986; Gullentops & Deblaere, 1992). During this period, the stratigraphic interpretation of about 10 sedimentary profiles within the cave led to the definition of a synthetic sequence (Otte et al., 1983; Deblaere & Gullentops, 1986; Gullentops & Deblaere, 1992), comprised of some 20 main layers that are quite thick and mainly arranged subhorizontally on transverse sections, while the longitudinal sections yielded concordant layers, gently dipping towards the back of the cave.

In the stratigraphic system defined inside the cave at the time, the part related to the Neandertal juvenile included the following succession, from bottom to top:

Layer 4B
Layer 4A
Speleothem CC4
Layer 3

In such a context, two remains found in situ (Scla 4A-1 and -4) and two that were rediscovered in the collections (Scla 4A-2 and -3) were attributed to former Layer 4A (Otte et al., 1993). However, two other teeth found in the collections (Scla 3-2 and -3) were originally attributed to the lower part of former Layer 3 (Otte et al., 1993; Toussaint et al., 1994). Three additional teeth (Scla 4A-5 to -7), also attributed to former Layer 4A, were identified in October 1993 after the information provided in the above-mentioned papers was already delivered. They were published for the first time at a later date (Toussaint et al., 1998).

2. Phase 2 (1995-2003)

Additional Neandertal remains were found in former Layer 4A in situ (Scla 4A-8, -9, and -13) and in the collections (Scla 4A-11, -12, and -14 to -16)[1]. A third tooth was found in former Layer 3 in 1995 (Scla 3-4). However, the possibility was suggested that the three teeth attributed to former Layer 3 might be from former Layer 4A, given the fact that the limit between these layers was not always precisely identified during excavation in the 1990s (Bonjean et al., 1996: 42, 1997: 22; Toussaint et al., 2001: 27). After a careful anatomical study, the three teeth originally assigned

[1] A tooth found in July 1998 in Square B37 was initially labelled Scla 4A-10 (Pirson et al., 2005). It was later discarded from the Neandertal remains during taphonomic and anthropological studies. It came from a bioturbated context.

to former Layer 3 were reattributed to former Layer 4A (Toussaint & Pirson, 2006) and renamed following the Scla 4A- nomenclature, becoming Scla 4A-17 to -19 (Pirson et al., 2005).

Another change of the stratigraphic position of the Neandertal remains concerns the identification of a stalagmitic floor inside former Layer 4A, called Speleothem CC14. The succession of layers then became:

Layer 4B
Layer 4A (lower)
Lower Speleothem CC14
Layer 4A (upper)
Upper Speleothem CC4
Layer 3

The Neandertal remains were found in the upper part of former Layer 4A, situated between stalagmitic floors CC14 and CC4 (Bonjean et al., 1996; Bonjean, 1998).

The secondary spatial position of the anthropological remains, deduced from their wide horizontal dispersion combined with the presence of broken stalagmites and the occurrence of bones and limestone fragments in very oblique or vertical positions, was interpreted as resulting from a thick mudflow (Bonjean et al., 1996, 1997). A sedimentological study of a profile located near the Neandertal remains suggested the colluvial nature of Layer 4A (Benabdelhadi, 1998). However, Layer 4A was still understood as a single, subhorizontal layer (Benabdelhadi, 1998; Bonjean, 1998) despite the observation of cut-and-filled gullies on a small sedimentary profile not far from the Neandertal remains (Bonjean et al., 1997).

3. Phase 3 (after 2003)

Between 2003 and 2007, the detailed stratigraphic recording of around 70 sedimentary profiles took place in the context of a PhD study (Pirson, 2007), leading to the definition of about 120 layers grouped into 30 distinct stratigraphic units. A continuous geological survey of the archaeological excavation also took place on a regular basis and is currently still on-going. This approach allowed a great variety of lithofacies as well as numerous depositional and post-depositional processes to be observed (Chapter 3). Complex geometries were also identified. During this period an additional tooth was found (Scla 4A-20), on 12 July 2006.

Following this stratigraphic reappraisal, former Layer 4A became 'Sedimentary Complex 4A', comprised of about 20 layers grouped into 4 units (Pirson et al., 2005; Pirson, 2007). From bottom to top these were:

— **Unit 4A-AP**, the lowermost unit, including all the layers within the complex that are older than Speleothem CC4 (= pre-floor layers);
— **Unit 4A-IP**, including Stalagmitic Floor CC4 and the layers that are contemporaneous with the formation of CC4 (= syn-floor layers);
— **Unit 4A-CHE**, which includes the layers that developed inside a large gully structure that eroded underlying layers, including CC4 (= post-floor and syn-gully layers); and
— **Unit 4A-POC**, the uppermost unit, superimposing both units 4A-IP and 4A-CHE (= post-gully layers).

A key element was the identification of the important gully structure of Unit 4A-CHE in the upper part of Sedimentary Complex 4, which locally reworked Speleothem CC4 and eroded underlying layers down to Unit 5, sometimes even down to Unit 6A. Furthermore, Speleothem CC14 was proven to be a lateral equivalent of CC4.

This new stratigraphic record is important for understanding the Neandertal fossils. In a first attempt of reinterpreting the stratigraphic position of the child remains, 6 out of the 19 fossils were positioned in Unit 4A-CHE and/or Unit 4A-POC (Pirson, 2007), or their former equivalents ("couches 4A-chenal" in Pirson et al., 2005). At this time, the attribution of the 13 other remains was unclear within Complex 4A. The depositional history and origin of the Neandertal remains were also briefly discussed in connection with the gully (Pirson et al., 2005).

4. Phase 4

More recently, during the preparation of this monograph, all the available arguments were re-examined in order to try to refine the stratigraphic position of the Neandertal remains. They are discussed in Chapter 5.

Appendix B

Evolution of the chronostratigraphic interpretation of the Neandertal remains

In the first few years after the discovery of the Neandertal remains, the chronostratigraphic interpretation of the Scladina sequence referenced the results presented in the first monograph that dealt with contextual data (see Otte (ed.), 1992). More specifically, former Layer 4A was dated to approximately 70,000-80,000 BP and the Saint-Germain II episode according to climatostratigraphy based on palaeontological data, even if TL and U/Th dates obtained on Speleothem CC4 (supposed at that time to be younger than the Neandertal remains) were older, with a mean of approximately 110,000-114,000 BP. In this context, the Neandertal remains were dated to around 70,000-80,000 BP (Otte et al., 1993; Toussaint et al., 1994).

A few years later, two distinct scenarios suggested different ages for the Neandertal remains: a young age (72,000-85,000 BP) based on palaeontological climatostratigraphy, and an older age (between 100,000 and 120,000 BP) based on the acquired numerical ages, either U/Th or TL dates on calcite, or TL dates on sediment (Bonjean, 1995; Bonjean et al., 1996, 1997). At the same time, direct gamma spectrometry dating was performed on the mandible (Yokoyama & Falguères in Toussaint et al., 1998; see Chapter 6). The result (127 +46/−32 ka BP) was the most reliable information available for estimating the age of the Neandertal remains, even if has a large range. Based on this, the remains were positioned somewhere between MIS 6 and MIS 4 taking the standard deviation into account. This high uncertainty did not help resolve the discrepancy between the youngest and the oldest chronological scenarios.

Following the stratigraphic reappraisal of the Scladina sequence (2003-2007), the stratigraphic position of the Neandertal remains was re-evaluated. This clarified the relative chronology of the events inside Sedimentary Complex 4A, including the relative age of the child (Pirson et al., 2005; Pirson, 2007). Two scenarios were possible. In the first one, the Neandertal remains were contemporaneous with the age of the oldest Neandertal-bearing deposit, the gully sequence in Unit 4A-CHE. This was the scenario that prescribed the youngest age to the Neandertal juvenile. In the new stratigraphic situation, the child would then postdate Speleothem CC4, which yielded a variety of dates that were mainly related to MIS 5. The second scenario considered that the Neandertal remains were reworked from older deposits eroded by the gully. In such a situation, a maximum age could not be suggested on the basis of stratigraphy. The available direct gamma spectrometry dating was again the most reliable information available about the age of the Neandertal child, which positions the child between MIS 6 and MIS 4.

During the preparation of this monograph, all the available information was re-examined, leading to the present interpretation that is summarised in Chapter 5. Several observations made during the taphonomical study of the Neandertal remains are very important (Chapter 7), especially the conclusion that the Neandertal remains are contemporaneous with the gully of Unit 4A-CHE. Due to the reappraisal of the palaeoenvironmental data and chronostratigraphy of the Scladina sequence (Pirson, 2007; Pirson et al., 2008; see Chapter 4), a reconsideration of the age of the gully episode was possible, with major implications for the antiquity of the Scladina Neandertal juvenile. The main results are summarised below.

The new palaeoenvironmental framework is mainly based on new results from palynology, anthracology, and climatic signals recorded in the sediments themselves through the observation of sedimentary dynamics and post-depositional processes. These results correlate with the data from literature based on the former stratigraphic record (e.g., Cordy & Bastin, 1992). Overall, the palaeoenvironmental results from all the available disciplines agree. The data for Unit 4A-CHE indicates cold conditions, as the gully is interpreted as a result of the degradation of a deep frozen soil (melting structure).

The chronostratigraphic framework of the entire Scladina sequence was also reconsidered, based on all the available data sets: numerical dates (luminescence, radiocarbon), biostratigraphy, archaeostratigraphy, comparison with the loess reference sequence from Middle Belgium (heavy mineralogy, lithological, and pedological markers), and climatostratigraphy. This reappraisal concludes that most of the Scladina deposits can confidently be positioned in the Upper Pleistocene. However, the chronostratigraphic framework of Scladina is still quite imprecise. Several situations still need more attention, such as the location of the beginning and end of MIS 5 in the sequence. Interpreting the age of the Unit 4A-CHE gully relies on the integration of climatostratigraphy and heavy mineralogy, especially comparing green amphibole content with data from the loess reference sequence (see Chapter 4). The main arguments are:

— in the lower half of the sequence, from units 7A to 2B, strong green amphibole values (ca. 20%) were recorded, suggesting the reworking of either MIS 6 loess or MIS 4-2 loess;
— between units 7A to 2B, two units (Unit 6B, former Layer 6; Unit 4A-IP, former Layer 4A) indicate temperate forest conditions, compatible with an interglacial or an early glacial interstadial, notably through palynological and macrofaunal data as well as the presence of major stalagmitic floors;
— combining the first two arguments allows the reworking of MIS 4-2 loess to be discarded as a hypothesis and supports the reworking of MIS 6 loess during MIS 5 in the sequence from Unit 6B to Unit 4A-IP. The available U/Th and TL dates obtained on Speleothem CC4 (Unit 4A-IP) are in agreement with the MIS 5 interpretation. As Unit 6B was a strong climatic improvement in MIS 5, Unit 4A-IP (and Speleothem CC4) must be positioned in either MIS 5c and/or MIS 5a; and
— higher up in the sequence, Unit 2A is interpreted as the first allochthonous loess input of MIS 4, and Unit 2B is best interpreted as representing the end of MIS 5a (see Chapter 4).

Following these arguments, and integrating them in the complexity of the Scladina sequence, there are several possible interpretations for the chronostratigraphic positioning of the cold episode represented by Unit 4A-CHE (see Chapter 4) and the associated Neandertal remains, the most probable being the following (Figure 21):

— if CC4 corresponds to MIS 5c temperate conditions, 4A-CHE would belong to MIS 5b colder conditions (GS 22 of the Greenland record, between GI 22 and GI 21, around 87,000 BP; NorthGRIP-Members, 2004) and by comparison with the loess sequence, 4A-CHE would then be an equivalent of the cold episode separating the last two pedogeneses of the Rocourt pedocomplex, i.e. Villers-Saint-Ghislain-A (VSG-A) and VSG-B (cf. Pirson et al., 2009; Haesaerts et al., 2011). The Scladina Child would then be contemporaneous with the Remicourt lithic assemblage (Bosquet et al., 2011; Pirson & Di Modica, 2011);

— if CC4 corresponds to the 'warmer' first half of MIS 5a, 4A-CHE would belong to the intra-MIS 5a cooling (intra-GI 21, around 80,000 BP); by comparison with the loess sequence, 4A-CHE would then correspond to the cold episode situated between the VSG-B Soil of the Rocourt pedocomplex and the Humic Complex of Remicourt (cf. Pirson et al., 2009; Haesaerts et al., 2011); and

— if the end of CC4 coincides with the end of MIS 5a, 4A-CHE would belong to one of the cold phases inside the first half of MIS 4. In this latest hypothesis, Unit 2B would not belong to MIS 5a but to one of the interstadials during the first part of MIS 4 (GI 19 or 20), which is not the best current hypothesis.

Since the part of Scladina sequence from Unit 6B to Unit 2B is best attributed to MIS 5, the best two hypotheses for the chronostratigraphic positioning of the gully from Unit 4A-CHE are to place this unit in either MIS 5b or MIS 5a. Therefore, the Scladina Child would have lived either some 87,000 years ago or some 80,000 years ago (Figure 21). These two chronostratigraphic hypotheses for the Neandertal juvenile are consistent with the morphometrical studies of the fossils (see Chapters 13, 15 & 16).

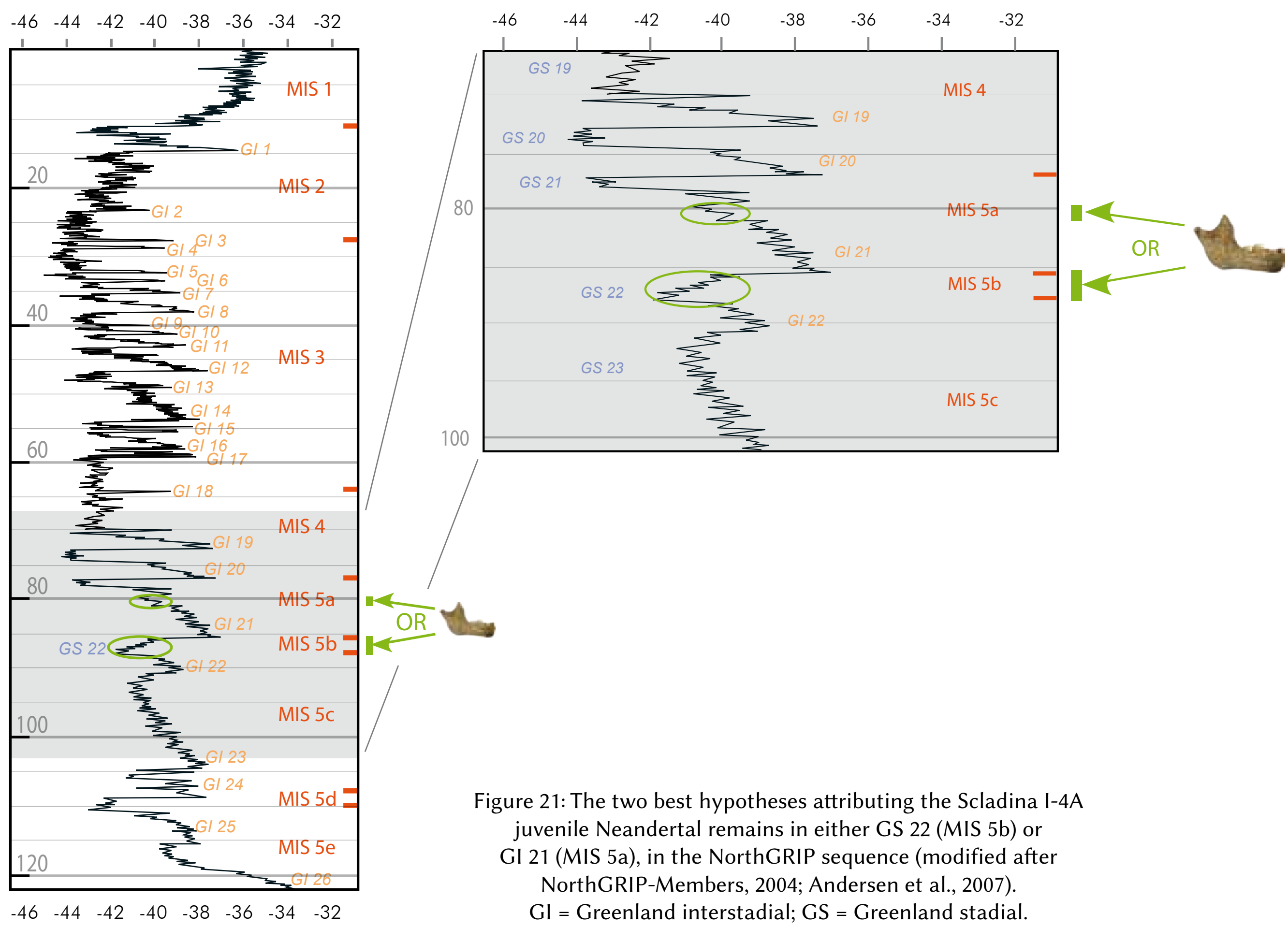

Figure 21: The two best hypotheses attributing the Scladina I-4A juvenile Neandertal remains in either GS 22 (MIS 5b) or GI 21 (MIS 5a), in the NorthGRIP sequence (modified after NorthGRIP-Members, 2004; Andersen et al., 2007). GI = Greenland interstadial; GS = Greenland stadial.

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