Close encounters of the third kind? Neanderthals and modern humans in Belgium, a bone story

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Chapter 2

The Middle Palaeolithic from Belgium: Chronostratigraphy, territorial management and culture on a mosaic of contrasting environments

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Contribution of G. Abrams: collaboration on the research programme, collection of all the data related to zooarchaeology, analysis and interpretation of data, writing the manuscript.

ABSTRACT

The Lower and Middle Palaeolithic in Belgium are represented in 442 find-sites dispersed across a small territory with contrasting geographical and geological characteristics. The proximity of caves and open-air sites, as well as the variable access to good sources of flint between regions are of special interest. The dataset is composed primarily of lithic assemblages, rich palaeontological and archaeozoological documentation as well as Neandertal remains from 8 cave sites. This large amount of data facilitates the development of a chronostratigraphic framework from the very beginning of the Middle Palaeolithic (onset of MIS 8) to the end (within the MIS 3, around 36 ka uncal BP). This archaeological documentation also reveals that lithic production variability is multifactorial and includes site function, cultural perspectives, and mobility patterns related to the exploitation of natural resources in contrasting environments.

1. Introduction

Since the early 19th Century, abundant archaeological data related to the Lower and Middle Palaeolithic periods has been recovered in Belgium. The territory from which this documentation derives is characterized by contrasting geographical and geological characteristics over a limited area. Of particular importance, are the non-uniform distribution of natural resources and the presence of cave sites located close to the loess plain. The combination of this rich archaeological documentation and the characteristics of the natural environments makes Belgium a favourable place for studying Middle Palaeolithic settlements.

FIGURE 1. Location map of Belgium in North-West Europe. The dashed line indicates the limit between the European Plain and more elevated landforms.

Numerous studies have already been devoted to the Middle Palaeolithic in Belgium and regional-scale syntheses have been produced since the end of the 19th Century (Bordes, 1959; Breuil and Koslowski, 1934; Dupont, 1872a; Ulrix-Closset, 1975). These works have mainly highlighted some typological aspects of lithic production based on which cultural facies were defined. The few available contextual data and inter-regional comparisons helped to build a chrono-cultural system comparable to the one developed by F. Bordes (Ulrix-Closset, 1975, 1981, 1990).

Recently, a database of 442 Belgian Middle Palaeolithic find-sites ranging from isolated artefacts to locations comprised of multiple sites (sensu Depaepe, 2010) has been established (Di Modica, 2010). The quality of the dataset varies greatly from one location to another due to a combination of factors such as the antiquity of the excavations, the depositional environment, or the post-depositional history of the concerned sequences. The development of this database led to critical reviews focusing on the chronological distribution of sites (Di Modica, 2010; Pirson and Di Modica, 2011), on aspects of culture (e.g., Di Modica, 2010; Ruebens and Di Modica, 2011) and on lithic raw material management (Di Modica, 2010, 2011b).

This paper provides an overview of the Belgian Middle Palaeolithic archaeological and anthropological dataset through the integration of information from various disciplines and through a critical review of the available documentation.

2. Geographical and geological background

Belgium is located at the heart of Northwest Europe (Fig. 1). In contrast to the Netherlands, Great Britain or Germany, the Pleistocene ice advances never reached Belgium (e.g., Ehlers and Hughes, 2011) which has major implications for geomorphology and site preservation. During the maximum extent of the glaciations, Belgium was undergoing periglacial conditions; several permafrost episodes are known (Haesaerts, 1984a; Haesaerts and Van Vliet-Lanoë, 1981).

The Belgian territory is quite small, with only 30,528 km^2, but presents contrasting geomorphological and geological settings. In just a few dozens of kilometres, the landforms can drastically change from deep valleys in the Ardenne to cuestas in Lorraine, from modern coastal plains to a loess plateau (De Moor and Pissart, 1992; Pissart, 1976). Similarly, various lithologies can be found, covering a large part of the geological timescale, from Early Palaeozoic to Holocene (Boulvain and Pingot, 2015; Pirson et al., 2008; Fig. 2). These important changes impacted the availability of useful resources such as plants, fauna, but also lithic raw materials. Moreover, the presence of natural shelters as well as the existence of various sedimentary contexts directly impacted the preservation of the archaeological evidence (fluviatile, aeolian, slope, and karst sedimentation contexts). The presence of such contrasting natural areas within a small region makes Belgium a favourable place for studying human behaviour in connection with environmental conditions.

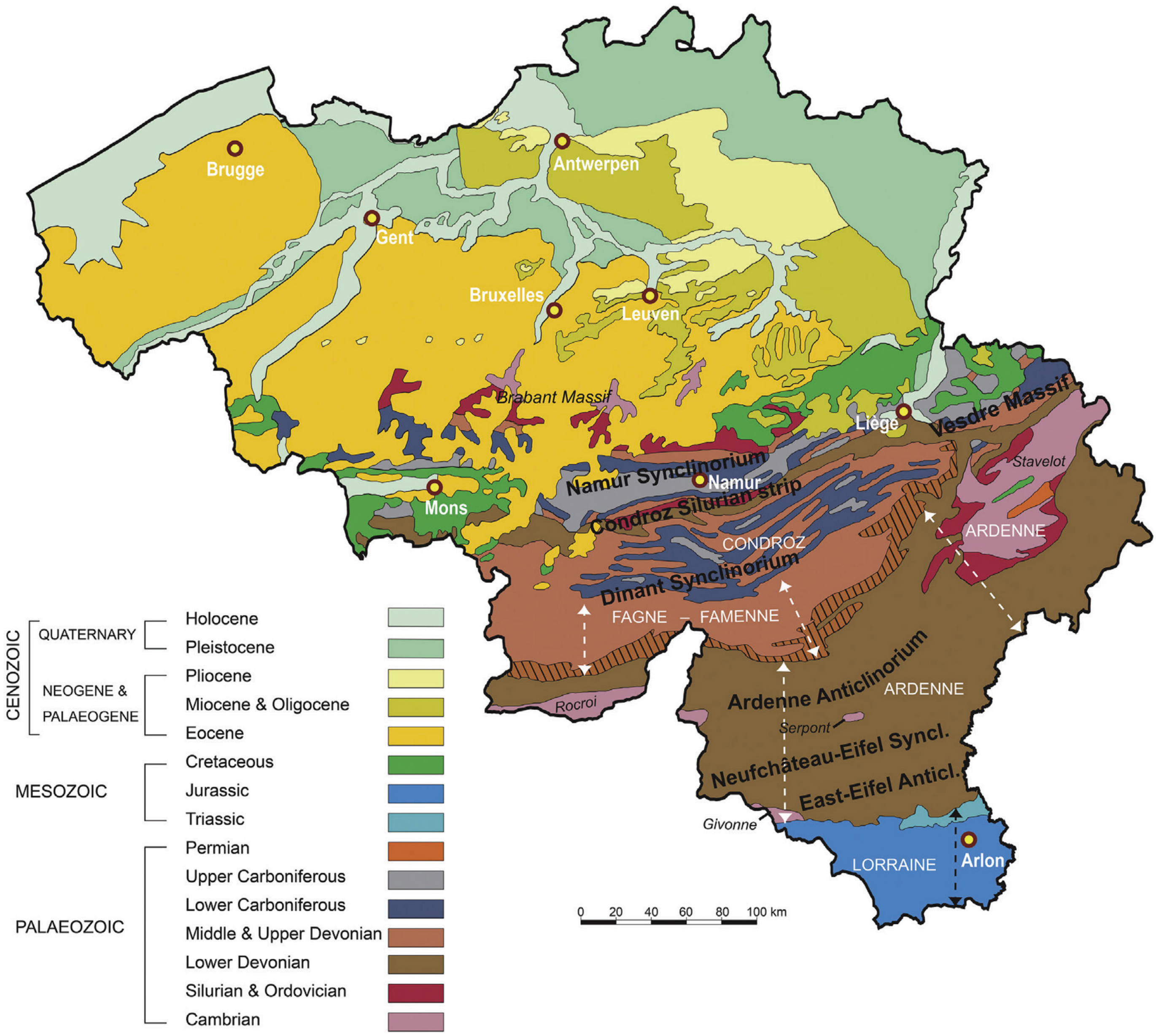

FIGURE 2. Geological map of Belgium (after Pirson et al., 2008b).

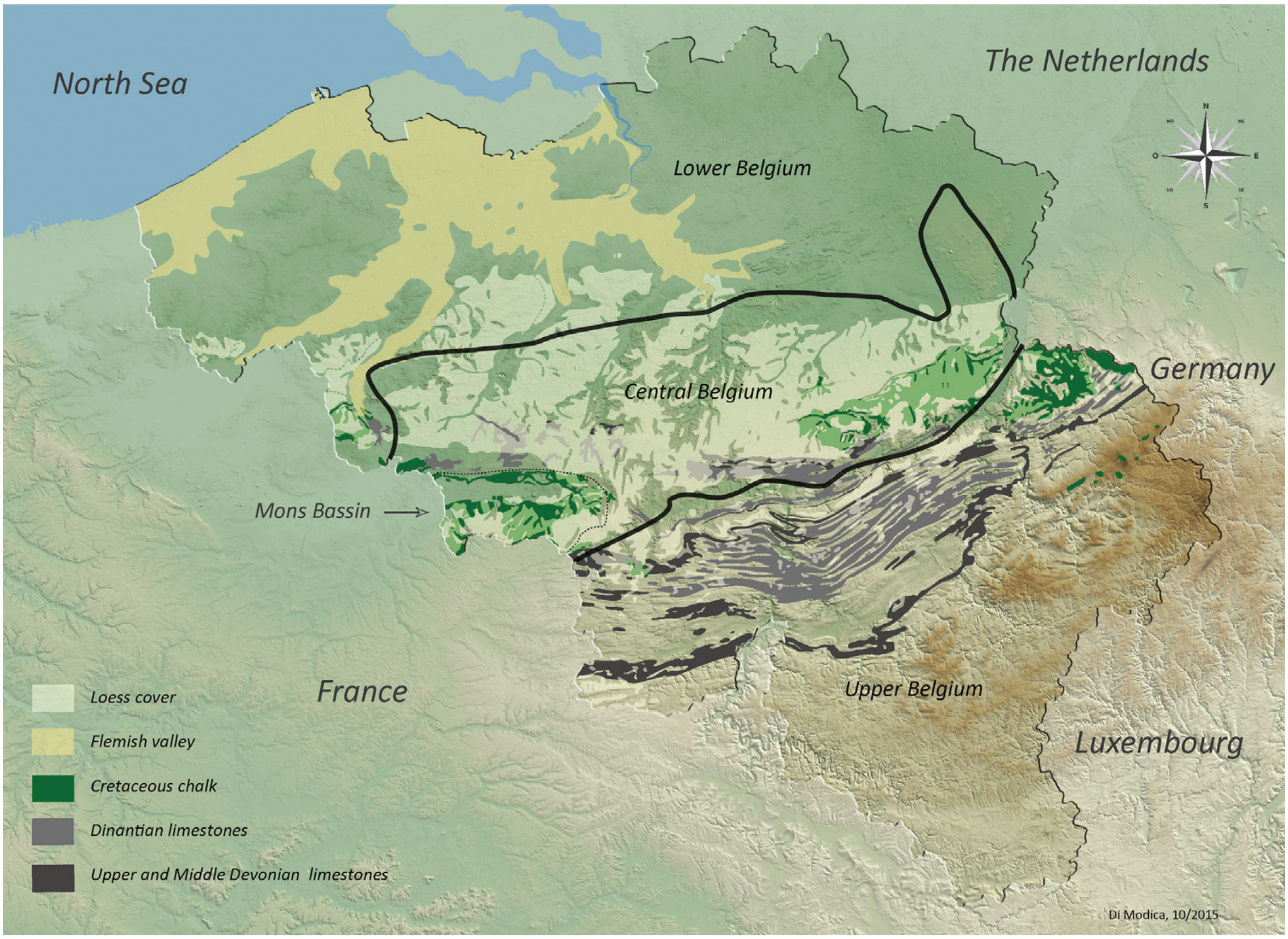

FIGURE 3. Geographical map of Belgium with localization of the Flemish valley (redraw from Gullentops and Wouters, 1996), the loess cover (after Marechal, 1992), the Cretaceous chalk outcrops and the Palaeozoic limestone outcrops (after de Bethune, 1954).

Belgium is usually divided into 3 main areas (Fig. 3) based on altitude (e.g., De Moor and Pissart, 1992): Lower (<100 m asl), Central (100e200 m) and Upper Belgium (200e694 m). The northern half of the country, encompassing Lower and Central.

Belgium is dominated by plains and plateaus belonging to the European Plain. In the southern half (Upper Belgium), the situation is completely different with deep valleys incised in a consolidated Palaeozoic rock substratum of the Ardenne-Rhenish Massif.

Lower Belgium is in the north of the country and is characterized by a flat relief. This area mainly exhibits marine and coastal unconsolidated sediments from the Paleogene and Neogene (e.g., Laga et al., 2001; Vandenberghe et al., 1998) as well as from the Quaternary (e.g., Baeteman, 1991; Haesaerts, 1984a; Paepe and Vanhoorne, 1976; Fig. 2). Continental Pleistocene sediments generally consist of cover deposits (aeolian sands and sandy silts), a fluviatile terrace system in the Scheldt Basin, and the infill of a vast depression formed by the Scheldt hydrographic network during the Saalian (Gullentops and Wouters, 1996; Tavernier and De Moor, 1974). This depression is called the "Flemish valley" (Fig. 3) and can reach 30 m deep. Lower Belgium is also characterized by a lack of raw material suitable for knapping activities. Flint pebbles are present in some of the Cenozoic marine formations but are mostly limited in size which prevent or considerably restrain the lithic tool production possibility.

Central Belgium is primarily formed by Paleogene marine un-consolidated sediments as well as by Mesozoic rocks (Cretaceous) occurring north of Liège and in the Mons Basin, a geologic structure filled with Cretaceous-Cenozoic sediments. Some rivers of the Scheldt and Meuse Basins have cut the unconsolidated cover and exposed the Palaeozoic basement (Fig. 2). Caves are present in the Devono-Carboniferous limestones of the Meuse Basin (Fig. 3).

Where Cretaceous chalk formations are exposed (Fig. 3), flint nodules suitable for knapping activities are present in great quantity. Such nodules can also be found in a secondary position, reworked as pebbles either in some marine formations or by the hydrographic networks. Pleistocene deposits are dominated by the presence of a thick loess cover (Haesaerts, 1984a). Fluvial terrace systems are known in the Meuse Basin (Juvigné and Renard, 1992; Meijs, 2002; Pissart, 1974) and in the Haine Basin (Haesaerts, 1984b; Pirson et al., 2009b).

Upper Belgium concerns the southern half of the country which is characterized by plateaus deeply incised by the hydrographic networks. Consolidated Palaeozoic rocks form the main part of the outcrops, mainly belonging to Devonian and Carboniferous (e.g., Bultynck and Dejonghe, 2001; Delmer et al., 2001; Poty et al., 2001; Fig. 2). Several caves are known in the Devono-Carboniferous limestones in the northern part of Upper Belgium. These Devono-Carboniferous rocks (Fig. 3) belong to the Rheno-hercynian fold-and-thrust belt and have been subjected to strong deformation at the end of Carboniferous, related to the Variscan orogeny (Oncken et al., 1999). In the eastern part of Upper Belgium, some Cretaceous deposits appear. Apart from a few notable exceptions (mainly the cave sequences), the Pleistocene deposits are generally badly preserved and difficult to interpret from a chronostratigraphic and paleoenvironmental perspective, especially in the Ardenne. In terms of Middle Palaeolithic research, the most important settings are the Flemish valley, the Haine Basin fluviatile terraces, the loess cover, and the caves (Fig. 3).

3. Historical research context

Most of the major discoveries related to the Middle Palaeolithic period in Belgium occurred during the 19th Century. At that time, an intense research activity took place both in caves and in open-air locations (Di Modica, 2010; Otte and Michel, 1984; Toussaint and Pirson, 2007).

In caves, the majority of 19th Century archaeological activity can be grouped into 3 main phases: the pioneer work of Schmerling (from 1829 to 1836), the prehistoric research program developed by Dupont (from 1864 to 1872) and the excavations led by De Puydt, Lohest and Fraipont (last quarter of the 19th Century). Schmerling and Dupont explored respectively 62 and 30 caves among which figure famous caves such as Engis, Fond-de-Forêt, La Naulette and Goyet. Their intense research activity allowed them to significantly contribute to issues such as the antiquity of the human species, the recognition of the Neandertal as a fossil human type, and the establishment of the chrono-cultural framework of the Palaeolithic period. Numerous other caves were also excavated by De Puydt, Lohest and/or Fraipont. These include Spy cave, where two fragmentary Neandertal skeletons were discovered (Spy 1 and Spy 2). The discovery of Spy 1 allowed the antiquity of the Neandertal type to be proposed as well as its association with both the Mousterian culture and a "Mammoth age" fauna (De Puydt and Lohest, 1887a).

Besides these major contributions, other research was undertaken in caves which notably led to the discovery of the Fonds-de-Forêt Neandertal remains (e.g., Tihon, 1898). Prehistoric research activity was so intense at that time that 75% of the major Middle Palaeolithic karst locations were already discovered and mostly emptied by the turn of the 20th Century (Di Modica, 2010). Nowadays, this situation seriously impacts our understanding of the Middle Palaeolithic settlements as early excavation methods were not as rigorous or precise as current methods.

The bulk of the 19th Century work in open air sites occurred in conjunction with industrial development around Mons. In particular, the building of a railroad line exposed an important Pleistocene stratigraphy overlying Cretaceous chalk where the entire sequence had been cut by Neolithic flint mines. A multidisciplinary team examined the archaeological, palaeontological, and strati-graphic evidence in the profiles and discovered the association of handaxes and "Mammoth age" fauna within a buried gravel (Arnould et al., 1868). The study of regional quarries contributed to the discovery of the earliest lithic industries which led to the first attempts at inter-site correlations based on a combination of stratigraphic, paleontological, and archaeological evidence (de Munck, 1891; Delvaux, 1885–1886).

During the first half of the 20th Century, Palaeolithic research activity focused on previously known caves (Toussaint and Pirson, 2007) and decreased in open-air locations (Di Modica, 2010). Only a few new sites were discovered at that time.

The second half of the 20th Century and the beginning of the 21st Century was marked by a progressive professionalization of Palaeolithic research. Several sites (both cave and open-air) were investigated. These were studied with a modern approach.

In caves, the main excavation programs concerning the Middle Palaeolithic were undertaken in Walou Cave from 1985 until 2004 (e.g., Draily, 2011c) and Scladina Cave from 1978 to the present (e.g., Bonjean et al., 2011). These two caves were/are subjected to interdisciplinary analyses providing accurate data on the paleoenvironmental and chronostratigraphic contexts of human occupations, as well as on the complexity of cave sedimentary infilling (Pirson, 2007, 2011; Pirson et al., 2014b). The detailed study of the stratigraphic framework and sedimentary dynamics (Pirson, 2007, 2014; Pirson and Draily, 2011) helped to better understand the impact of natural processes on the paleoethnographic signals, leading to a better interpretation of human occupation in these caves. These analyses also elucidated issues related to the re-examination of old collections from caves, such as the recent re-evaluation of those from Spy (Pirson et al., 2013).

Since the late 1940's in open-air sites, numerous multidisciplinary projects were undertaken by the Royal Belgian Institute of Natural Sciences, for instance in Otrange (de Heinzelin, 1950) and Saint-Symphorien/Hélin Pit (de Heinzelin, 1959). During the late 1970's and the 1980's, an intense scientific activity was developed in the Haine Basin, which led to a better understanding of the fluviatile terrace system in this area (Haesaerts, 1984b) as well as the identification of some of the oldest archaeological evidence in Belgium (Cahen and Haesaerts, 1983; Cahen et al., 1984). In the loess domain, archaeological sites were investigated by the Royal Belgian Institute of Natural Sciences, the Public Service of Wallonia, and the Katholieke Universiteit Leuven (Bosquet et al., 1998; Bringmans, 2006b; de Heinzelin, 1950, 1959; Haesaerts, 1978; Van Baelen et al., 2008; Van Der Sloot et al., 2011). From the 1970's onward, the stratigraphic sequences from most of these locations were combined with loess sections from quarries to establish and progressively refine a reference pedo-sedimentary loess sequence which provides a precise chronostratigraphic position for the human settlements (Haesaerts, 1978; Haesaerts et al., 2011b; Meijs et al., 2012; Pirson et al., 2009b).

4. Archaeological and anthropological dataset

A recent inventory listed 442 locations spread across Belgium with material and/or anthropological remains attributed in the literature to the Lower and Middle Palaeolithic periods (Fig. 4). At this stage of the present paper, the distinction between Lower and Middle Palaeolithic find-sites cannot be accomplished as most of them lack any chronostratigraphic data, and because an assignment based on techno-typological attributes is impossible in most of the cases. A list of these find-sites is given in (Di Modica, 2011a). These 442 find-sites do, of course, represent a minimal number as some unpublished discoveries have recently surfaced.

The find-sites presented in this database vary greatly in quality. Therefore, the elements of this database have a very uneven value. Beside few recently excavated sites, a significant portion of the dataset lacks reliable contextual information because the collections were recovered during ancient excavations or discovered as surface collections. However, a rigorous, critical review of the documentation helps understanding the uneven quality of this information and to which extent each site can contribute to our comprehension of Middle Palaeolithic in Belgium. On the one hand, well-documented sites excavated with a multidisciplinary strategy are ne-

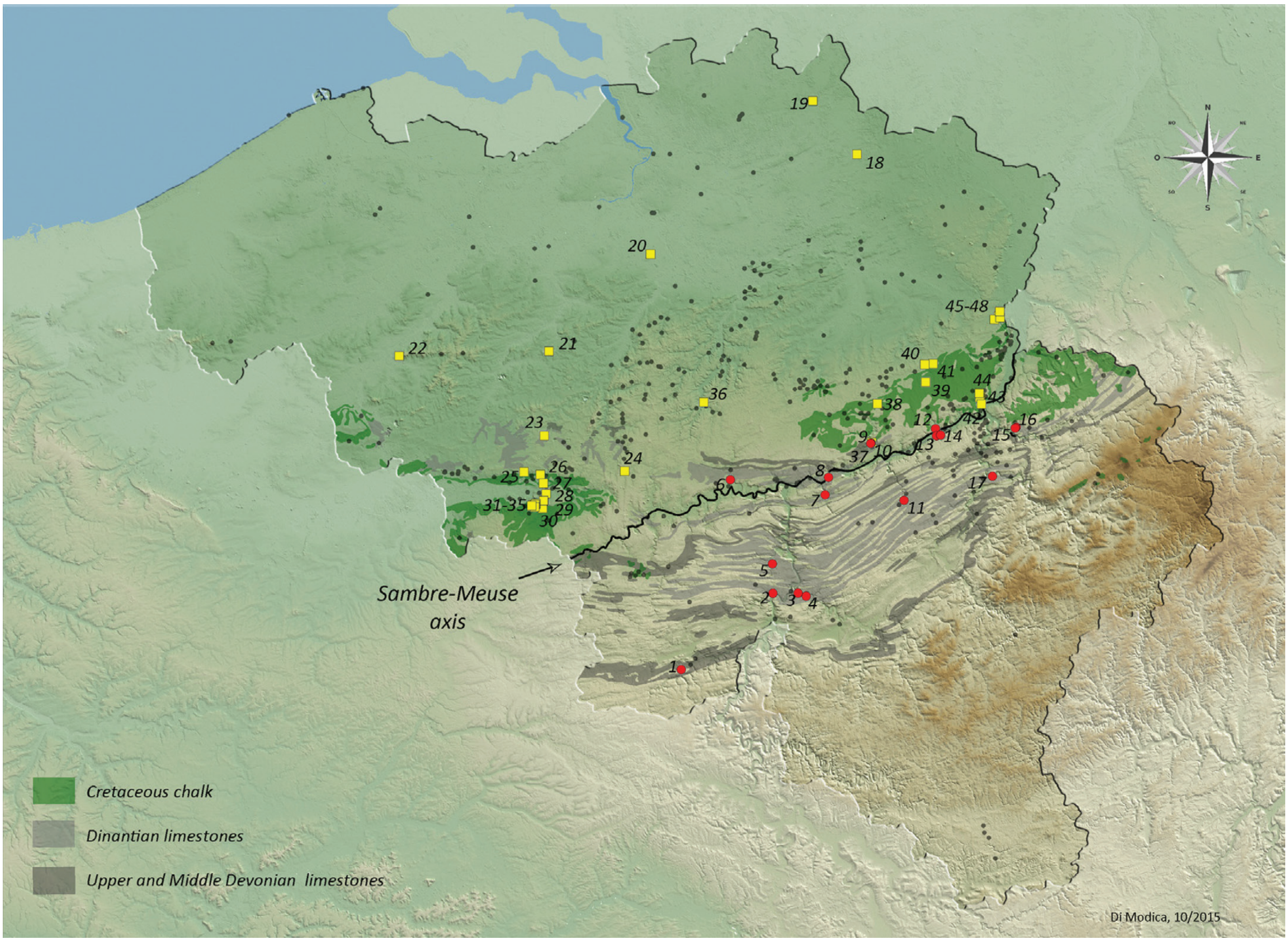

FIGURE 4. Distribution map of the Lower and Middle Palaeolithic find-sites in Belgium. Red circles: major cave sites; yellow squares: major open-air sites. Cretaceous chalk outcrops and Palaeozoic limestones outcrops redrawn after de Bethune (1954). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

cessary for deciphering problems related to the chronostratigraphic distribution of sites and site function(s). On the other hand, even lithic assemblages deprived of any contextual data can contribute, to some extent, to issues such as human mobility, land-use strategies, and cultural aspects of the settlements.

A find-site can correspond to the following situations:

- Single artefact/small group of artefacts gathered on the ground surface (e.g., multiple strays find in the Lower Meuse valley: Cahen and Peuskens, 1977–1979;
- Single artefact/small group of artefacts found buried in the ground, but without any indication of the stratigraphic position (e.g., Argenteau: De Puydt, 1907);
- Single artefact/small group of artefacts found in a recorded stratigraphic sequence (e.g., Harmignies: de Heinzelin, 1977; de Heinzelin et al., 1975);
- Large artefact assemblage found on the surface during surveys (e.g., Otrange; Thisse-Derouette and Destexhe-Jamotte, 1947); large artefact assemblage with or without human remains found in unreliable stratigraphic position given the age of excavation (e.g. Engis cave: Schmerling, 1833); large artefact assemblage with or without human remains found in a stratigraphic position indicating a single Middle Palaeolithic setting (e.g.: Rocourt: Haesaerts et al., 2011a); large artefact assemblage with or without human remains found in distinct units of a recorded stratigraphic sequence and indicating multiple Middle Palaeolithic settings (e.g., Scladina cave: (Bonjean et al., 2014b);
- Discovery of human remains without any artefacts (e.g., La Naulette cave: Dupont, 1866).

Among these 442 find-sites 47 are karst find-sites (10.63%) and 395 are open-air find-sites (89.37%). 17 caves out of 47 (36.17%) and 31 open-air find-sites out of 395 (7.85%) can be considered as 'of major importance' (Fig. 4; Tables 1 and 2) according to one or several of the following criteria:

- Discovery of human remains;
- Discovery of a large quantity of artefacts;
- Important historic contribution;
- Presence of contextual data (chronological and/or paleoenvironmental).

Lithic artefacts are represented in all but one cave as well as in all the open-air find-sites. In open-air settings, the faunal remains are often poorly preserved due to taphonomic processes. Thus, most of the available data concerning the land-use organization, the settlement intensity, and the mobility of Neandertal populations consist of lithic assemblages spread across the whole territory.

Faunal remains (modified or not) were preserved in all caves but are documented for only 15 open-air find-sites. Human bones were exclusively recovered from caves. This bone material provides complementary information to the lithic series. However, the scarcity of the faunal data in open-air sites prevents the appreciation of the full range of activities performed in these locations.

Major cave sites				
Label	Province	Municipality	Locality	Name
1	Namur	Couvin	Couvin	Trou de l'Abîme
2	Namur	Hastière	Hastière-Lavaux	Trou du Diable
3	Namur	Anhée	Walzin	Trou Magrite
4	Namur	Dinant	Hulsonniaux	La Naulette cave
5	Namur	Onhaye	Montaigle	Trou du Sureau
6	Namur	Jemeppe-sur-Sambre	Spy	Spy cave ("Bètche-aux-Rotches" cave)
7	Namur	Gesves	Goyet	Goyet caves
8	Namur	Andenne	Sclayn	Scladina cave
9	Liège	Wanze	Huccorgne	Doctor's cave
10	Liège	Wanze	Moha	Hermitage cave
11	Liège	Modave	Petit-Modave	Trou Al'Wesse
12	Liège	Flémalle	Les Awirs	Engis cave ("Schmerling cave")
13	Liège	Nandrin	Engihoul	Palaeolithic site
14	Liège	Flémalle	Ramioul	Ramioul cave
15	Liège	Trooz	Forêt	Fond-de-Forêt cave ("Bay Bonnet cave")
16	Liège	Trooz	Forêt	Walou cave
17	Liège	Sprimont	Sprimont	La Belle Roche

TABLE 1. Major cave sites from Belgium.

Major open-air sites				
Label	Province	Municipality	Locality	Name
18	Anvers	Mol	Mol	New sandpits
19	Anvers	Oud-Turnhout	Oosthoven	Heieinde
20	Flemish Brabant	Zemst	Zemst	Bos van Aa
21	Flemish Brabant	Galmaarden	Vollezele	Congoberg
22	Hainaut	Mont de l'Enclus	Amougies	Mont de l'Enclus
23	Hainaut	Soignies	Neufvilles	Le Clypot
24	Hainaut	Chapelle-lez-Herlaimont	Godarville	Canal
25	Hainaut	Jurbise	Masnuy-Saint-Jean	Le Rissori
26	Hainaut	Mons	Obourg	Bois du Gard
27	Hainaut	Mons	Obourg	Canal
28	Hainaut	Mons	Saint-Symphorien	Hardenpont pit
29	Hainaut	Mons	Saint-Symphorien	Hélin pit
30	Hainaut	Mons	Harmignies	Harmignies cuesta
31	Hainaut	Mons	Spiennes	Pa d'la l'iau terrace
32	Hainaut	Mons	Mesvin	Petit-Spiennes terrace
33	Hainaut	Mons	Mesvin	Mesvin terrace
34	Hainaut	Mons	Mesvin	Mesvin IV
35	Hainaut	Mons	Spiennes	Petit-Spiennes III
36	Walloon Brabant	Ottignies	Franquenies	Palaeolithic station
37	Liège	Wanze	Huccorgne	Hermitage station
38	Liège	Geer	Omal	Kinart sandpit
39	Liège	Remicourt	Remicourt	En Bia Flo I
40	Liège	Oreye	Otrange	Palaeolithic site
41	Limbourg	Tongres	Lauw	Boven Butters Berg
42	Liège	Liège	Liège	Mont Saint-Martin
43	Liège	Liège	Liège	Sainte-Walburge
44	Liège	Liège	Rocourt	Gritten sandpit
45	Limbourg	Lanaken	Kesselt	Op de Schans pit
46	Limbourg	Lanaken	Kesselt	Nelissen pit
47	Limbourg	Lanaken	Kesselt	Albert canal
48	Limbourg	Lanaken	Veldwezelt	Hezerwater pit

TABLE 2. Major open-air sites from Belgium.

5. Geographical distribution of the dataset

The geographical distribution of Lower and Middle Palaeolithic find-sites (Fig. 4) indicates that the 442 find-sites are unevenly distributed across the Belgian landscape. Two areas are particularly rich in sites: Middle Belgium open-air find-sites on the one hand, the Meuse Basin caves and rock shelters on the other hand. This situation is primarily due to the following four factors.

Site preservation: in some areas affected by strong erosional processes, almost no Pleistocene sedimentation is preserved (e.g., on the Ardenne plateaus). This implies open-air Palaeolithic sites in this area were more subject to natural destruction. On the contrary, some other regions were subject to an intense sedimentation during the Pleistocene. In the "Flemish Valley" or in Limburg for instance, the Quaternary deposits have an important thickness which complicates access to the archaeological documentation as the sites are too deeply buried. Favourable places for preservation in open-air sites are the Mons Basin and the Lower Meuse Basin where the presence of a thick loess cover and a fluvial terrace system co-exist. Caves provide a unique situation as they are sedimentary traps, and, therefore, are particularly favourable for the preservation of archaeological, anthropological, and palaeontological material.

Appeal of caves in the Meuse Basin for Palaeolithic populations: this could partially explain the quantity of cave sites documented in Belgium.

Availability of lithic resources suitable for knapping activities: Cretaceous deposits are exposed in some areas and flint nodules are available in an autochthonous context (primary or secondary position; sensu Turq, 2005).

History of research: in the 19th Century, some areas of the country were investigated more than others in relation to agricultural and industrial developments and the particular focus of the researchers (e.g., caves, phosphatic chalk quarries).

6. Archaeological sites and anthropological remains: a chronological and paleoenvironmental perspective

Out of the 442 identified find-sites, only 28 (ca. 6%) yielded reliable information with a reasonable degree of accuracy concerning their chronostratigraphic position. Among these 28 find-sites, 9 are from caves and 19 from open-air sites, the latest mainly from loess and fluviatile contexts. Some of these find-sites incorporate several cultural assemblages (e.g., a cave with several layers yielding artefacts). All in all, the 28 selected find-sites encompass 63 sites (sensu Depaepe, 2010) ranging from the Lower Palaeolithic to the end of the Middle Palaeolithic (Figs. 5 and 6). This paper presents the locations from MIS 8 onwards. Accurate correlations between continental sequences and marine isotopic stages (MIS) are problematic (e.g., Gibbard and Van Kolfschoten, 2004; Sanchez Goñi et al., 2000; Sier et al., 2011). The reference to MIS used in this paper is for convenience.

6.1. The early Middle Palaeolithic (MIS 8-6)

Archaeological assemblages attributed to this period originate from various sedimentary contexts: alluvial terraces, loess sequences, and a cave (Figs. 5 and 6).

6.1.1. The fluvial terraces in the Mons Basin

In the Mons area, a fluvial terrace staircase of four levels has been recognized in the Haine Basin. The chronostratigraphic interpretation of this terrace system suggests they range from MIS 12 to MIS 6 (Haesaerts, 1984b; Pirson et al., 2009b; Fig. 7). This assessment is based on the recognition of a cyclic glacial-interglacial pattern within the sequence and the overlying loess cover, like that from the Somme Basin (e.g., Antoine et al., 2003; Antoine et al., 2006) and is corroborated by bio-stratigraphic, geochronological and paleoenvironmental datasets. The two most recent terraces are the Mesvin terrace and the gravel C of the Saint-Symphorien/Hélin Pit. In this model, they are respectively attributed to MIS 8 and MIS 6.

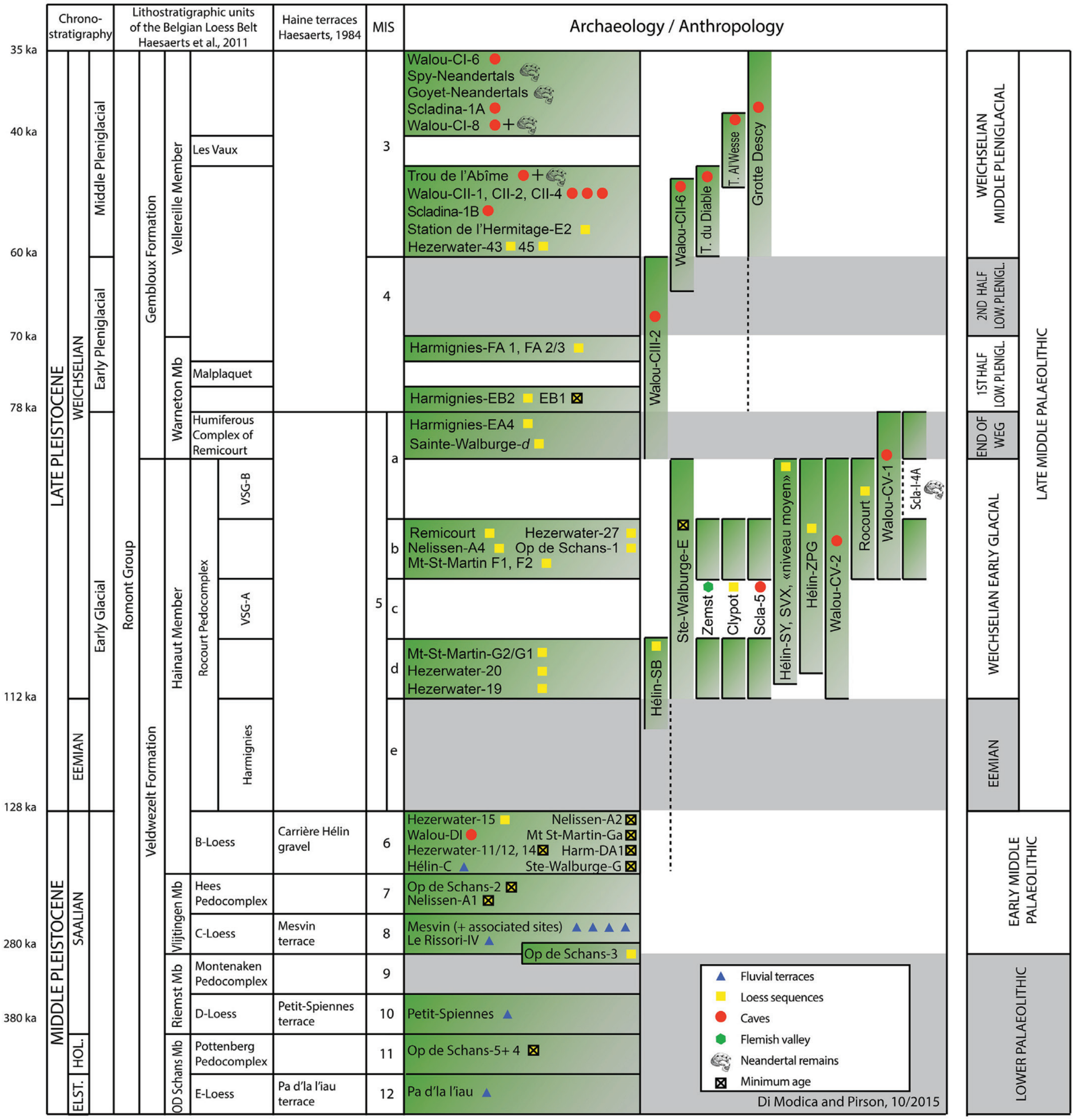

FIGURE 5. Chronostratigraphic distribution of the Middle Palaeolithic sites from Belgium.

The Mesvin terrace archaeological content has been recognized since the end of the 19th Century because of surface prospection and the digging of the trench for the Mons-Beaumont railway (Arnould et al., 1868; Michel, 1981; Pirson et al., 2009b). In the 1970s and 1980s, two archaeological sites in relation with the Mesvin terrace were excavated: Petit-Spiennes III (Cahen and Haesaerts, 1982) and Mesvin IV (Cahen et al., 1984). A third site was excavated in 2014, thanks to the excavation of a Neolithic flint mine (ST 06) in Petit-Spiennes (Di Modica et al., 2014). The Neolithic access shaft cut the terrace and its Pleistocene slope cover, leading to a small archaeological campaign; analyses are still in progress. In all these sites, artefacts in relation with the Mesvin terrace present various preservation states (edge damage, patina). Mesvin IV is of particular importance as it provided data on the chronological and paleoenvironmental context of the human occupation (Cahen et al., 1984).

The gravel C of the Saint-Symphorien/Hélin Pit has yielded 14,540 artefacts since the end of the 19th Century

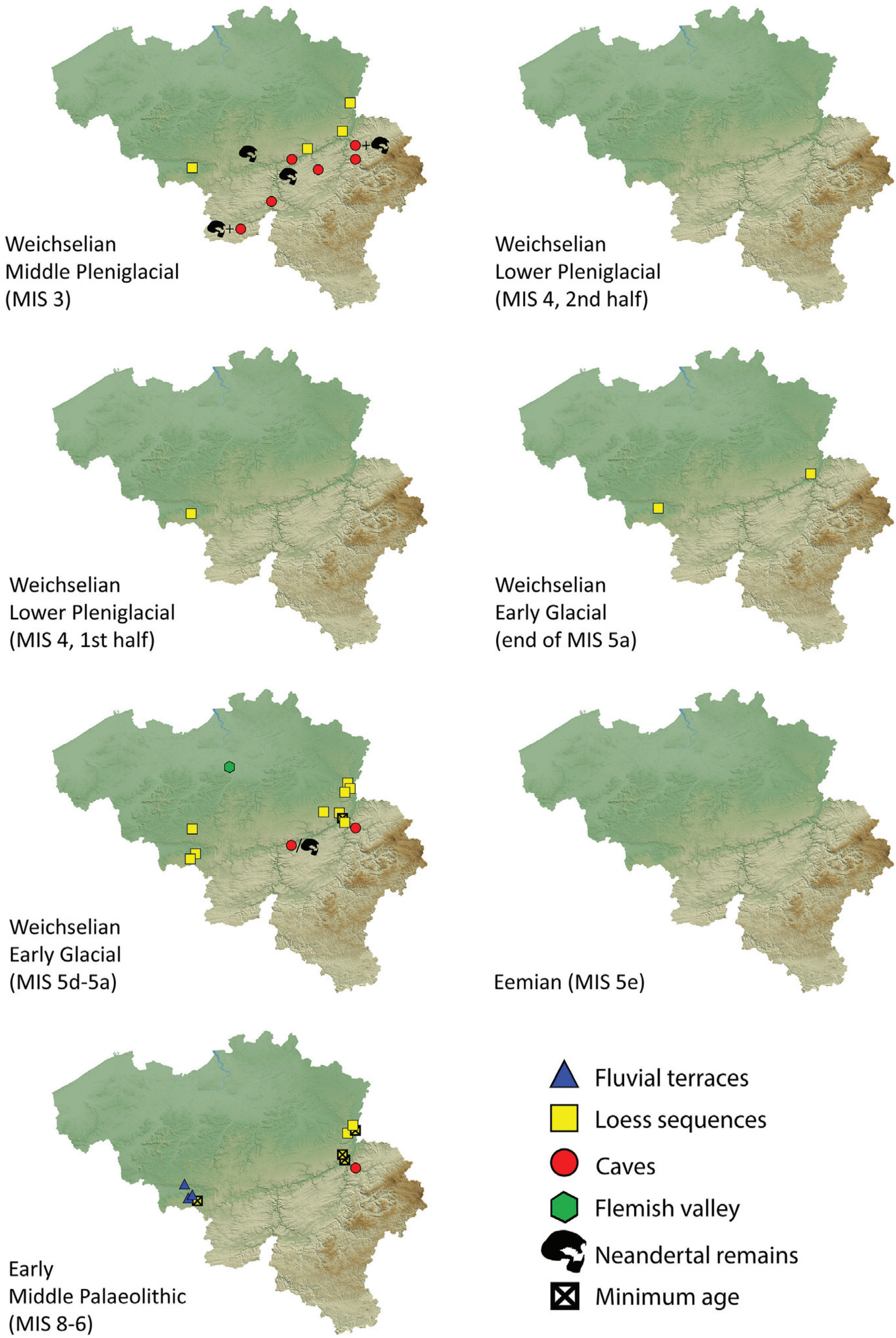

FIGURE 6. Distribution maps of the dated Middle Palaeolithic find-sites in Belgium.

tury. The assemblage is characterized by various preservation states, with some very fresh artefacts adjacent to rolled artefacts (Michel, 1978).

Masnuy-Saint-Jean/Le Rissori comprises multiple gravel layers containing archaeological assemblages ("series IV, IIIB, IIIA"). Based on the altitude, the lowest gravel layer was correlated with the same incision stage as the Mesvin terrace (Adam, 2002). This lower gravel and the artefacts from "series IV" were therefore positioned in MIS 8. The age of the series IIIA and IIIB is more controversial. They derive from gravels that are separated from each other and from the lower gravel by 2 palaeosoils attributed to MIS 7c and 7a, while the gravel including "serie IIIA" is affected by another pedogenesis attributed to MIS 5. According to this scheme, the gravel containing the "series IIIB" is related to MIS 7b while the gravel containing the "series IIIA" is attributed to MIS 6 (Adam, 2002). However, given their depositional context (slope deposits), the gravels containing "series IIIA and IIIB" could be reworked from the lowest level. In this hypothesis, they would have been the same MIS 8 age as "series IV" (Pirson and Di Modica, 2011).

6.1.2. The middle Belgium loess sequence

In the Mons Basin, one find-site yielded a single artefact from MIS 8-6: a scraper recovered in Harmignies discovered within unit DA1 which records the Bt horizon of the Harmignies luvisol (de Heinzelin et al., 1975). This pedological horizon attributed to the Eemian (Haesaerts, 1974; Haesaerts et al., 2011a) affected MIS 6 loess, which is therefore the minimum age for the artefact (Pirson and Di Modica, 2011).

From Liège to the Dutch border near Maastricht, the chronostratigraphic framework for human occupations has been built thanks to the presence of a thick loess cover with multiple palaeosoils overlying the Meuse terrace system (Meijs, 2002; Meijs et al., 2012; Fig. 8).

At Kesselt/Op de Schans Pit, four artefact concentrations in a primary archaeological context have been excavated inside archaeological level 3 (Van Baelen, 2014; Van Baelen et al., 2007; Van Baelen et al., 2008). Their stratigraphic position between the Montenaken discordance and the Montenaken chernosem associates them with the transition of MIS 9 and MIS 8 (Meijs et al., 2012).

At Kesselt/Nelissen Pit, two artefact concentrations have been found in a Middle Pleistocene context (Groenendijk et al., 2001). On the lowest level (A1), 4 flake fragments have been discovered on the upper part of the Hees luvisol (Fig. 8); they were in a position like the scrapper fragment at Op de Schans, i.e., MIS 7 (Meijs, cited in Van Baelen and Ryssaert, 2011). The second le-

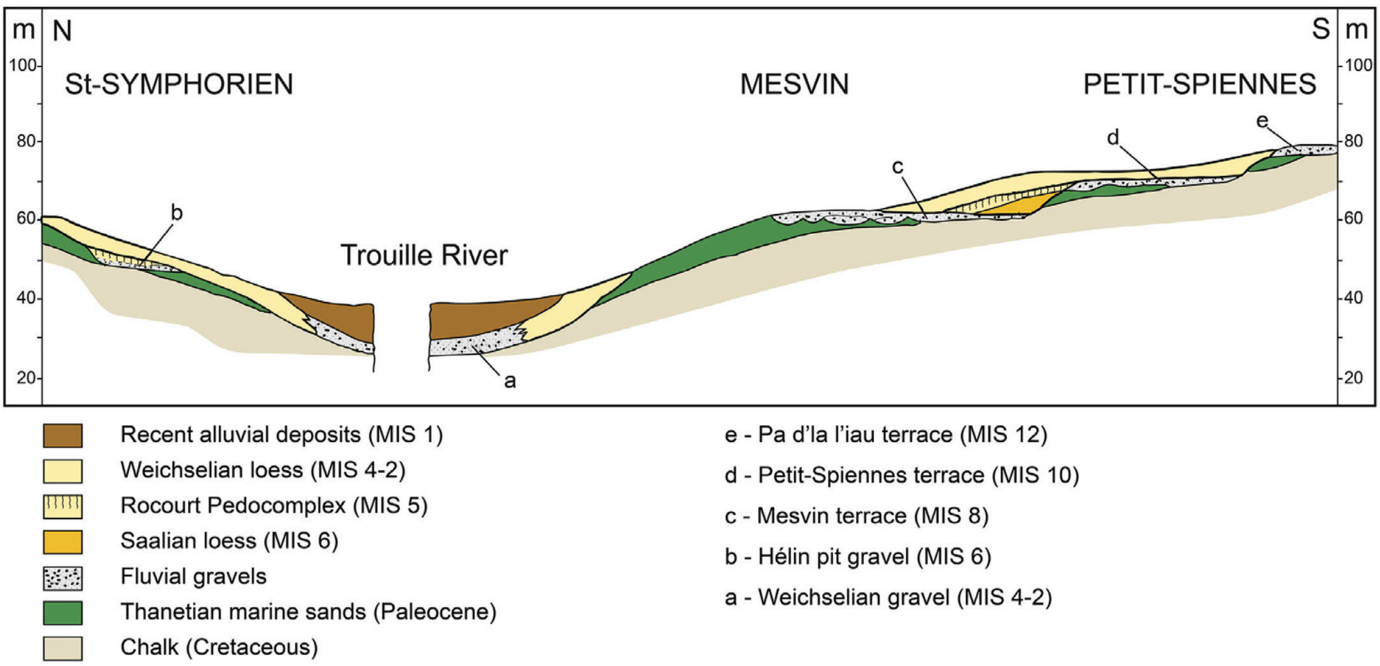

FIGURE 7. Schematic profile of the terrace system in the Haine Basin (modified after Haesaerts, 1984b).

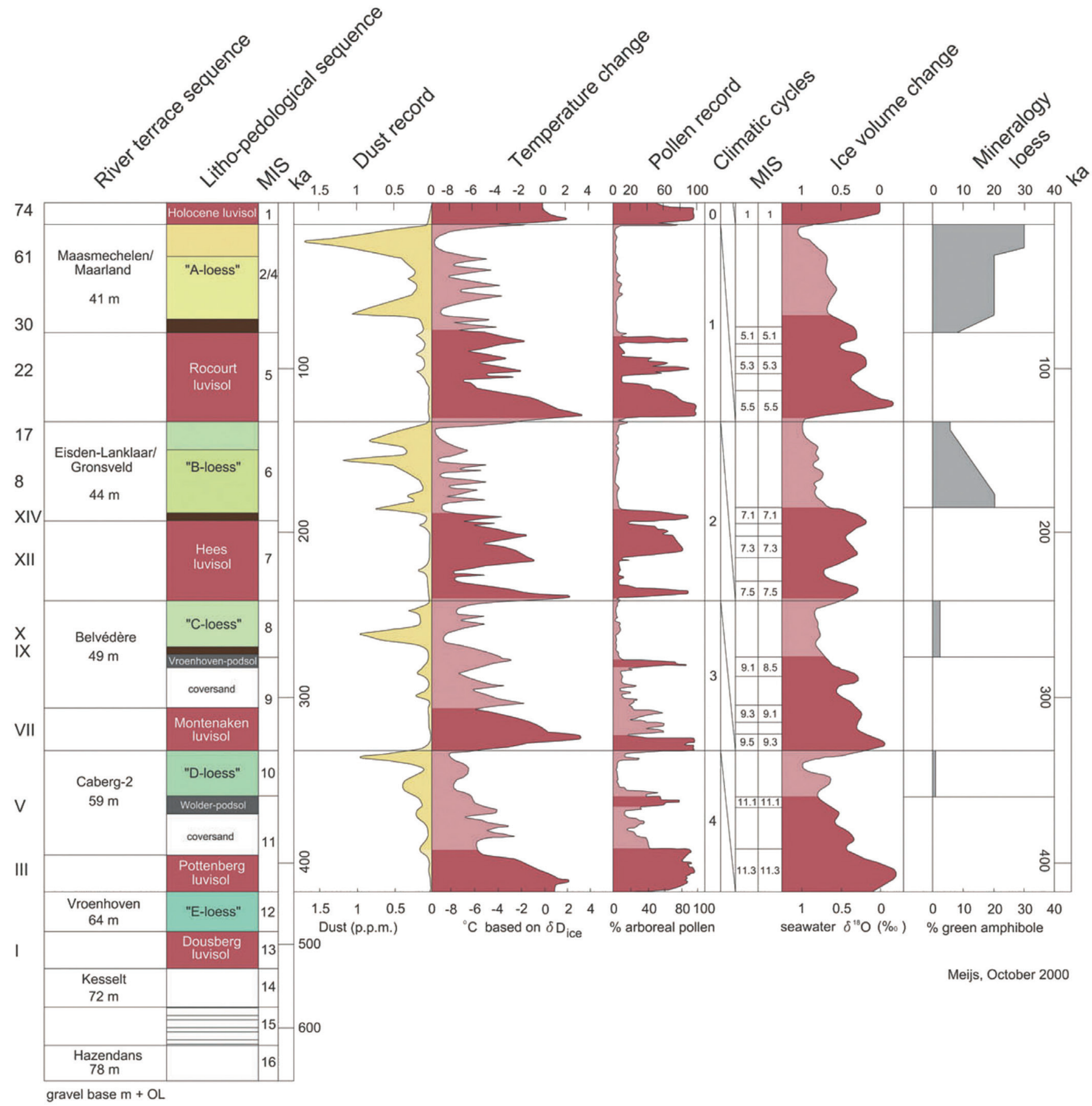

FIGURE 8. Reference sequence for the Middle and Upper Pleistocene in the Lower Meuse area (Meijs et al., 2012).

vel ("A2") yielded 27 artefacts on an erosion surface separating the MIS 6 loess cover (B-Loess) and the Hees soil, suggesting a MIS 6 age (Fig. 8). This should be considered as a minimal age given the position of the artefacts on an erosion surface and their preservation state (Groenendijk et al., 2001; Meijs, s.d.).

At Veldwezelt/Hezerwater Pit, 68 artefacts coming from various loci can be attributed to the Early Middle Palaeolithic. The artefacts were recovered from units 11/12, 14 and 15 (Bringmans, 2006a; Meijs, 2011; Meijs, s.d.) and were generally in secondary position. Only 4 artefacts coming from unit 15 (locus ZNB) were considered as "almost in situ" (Bringmans, 2006a). Given the green amphibole content and the general stratigraphic context of the site, units 8 to 17 can be correlated to the end of MIS 6 (Meijs, 2011; Fig. 9). Previous arguments suggested that units 19 (VLL) and 20 (VLB) might belong to the very end of MIS 6 (e.g., Bringmans, 2007; Bringmans et al., 2004). However, this hypothesis has been discarded, these units have been positioned in Weichselian Early Glacial (cf. 7.1.3.1) because of the discovery of the Unit 18 luvisol, correlated with the Harmignies luvisol and attributed to the Eemian (Meijs, 2011; Pirson and Di Modica, 2011; Fig. 9).

At Liège/Sainte Walburge, an important archaeological assemblage was recovered in 1911 in a sand quarry (De Puydt et al., 1912). Most of the discoveries, among which figure ten handaxes, come from a gravel layer ("unit G") separating the Oligocene sands from loess deposits. The stratigraphic description of the excavators suggests that a luvisol was recorded in unit E above the gravel. The correlation of this possible luvisol with the "Rocourt soil" (MIS 5 soil complex) has been suggested (Roebroeks, 1981). This would confer the archaeological assemblage at least a MIS 6 age.

At Liège/Mont Saint-Martin, several artefact concentrations have been found in a rich Upper Pleistocene loess sequence during preventive archaeology operations (Haesaerts et al., 2008; Van Der Sloot et al., 2011; van der Sloot et al., 2009). At the bottom of the sequence, artefacts have been found in unit G-a, which record the Bt horizon of a luvisol correlated with the Eemian Harmignies luvisol. In this context, the artefact scatters would predate the soil formation and would at least date from MIS 6.

6.1.3. Cave from the Meuse Basin

In Walou Cave, several chronostratigraphic criteria associated the two lowermost cycles (DII and DI) to before the Upper Pleistocene (Pirson, 2011; Pirson et al., 2006a). Altogether, these two cycles yielded 189 artefacts (Draily, 2011a). Cycle DI is attributed to the end of MIS 6, notably based on green amphibole data combined with evidence of interglacial conditions on top of cycle DI, while the age of the underlying cycle DII is undetermined. A stratigraphic attribution of the lithic material to DI or to DII was not always possible, but when observed, all but one artefact came from DI (Draily, 2011a).

6.2. The late Middle Palaeolithic (MIS 5-3)

6.2.1. The middle Belgium loess sequence

In Middle Belgium, the study of several thick loess profiles in archaeological sites since the 1970's led to development of a regional loess reference sequence for the Upper Pleistocene (Haesaerts, 1974, 1978; Haesaerts et al., 1999; Pirson et al., 2009b; Fig. 10). This reference sequence often allows a rather precise chronostratigraphic position for the archaeological assemblages.

6.2.1.1. Eemian interglacial

Based on the current state of research, no site can be attributed to the Eemian. Potentially some of the artefacts recovered in Belgium from Weichselian Early Glacial contexts contain some reworked Eemian material, but this attribution is impossible to demonstrate as these artefacts could also date from the Early Glacial, or even result from reworking processes from Saalian deposits (Figs. 5 and 6).

6.2.1.2. Weichselian Early Glacial

Nine find-sites have yielded material attributed to the Weichselian Early Glacial: two from the Mons Basin and seven from the lower Meuse Basin (Figs. 5 and 6). In Saint-Symphorien/Hélin Pit, archaeological material comes from several deposits identified in 1958 which superimpose the lower gravel (de Heinzelin, 1959). A few dozen artefacts were found in unit SB. This unit is interpreted as the result of the reworking of the A2 horizon of the Eemian soil, i.e., Harmignies luvisol (Haesaerts, pers. com.). The artefacts are therefore either contemporaneous with the first stadial of the Weichselian Early Glacial or reworked from the Eemian. Higher in the sequence, units SVX, SY and ZPG yielded artefacts. These units are positioned in the Weichselian Early Glacial as they occupy an intermediate position between the Harmignies luvisol (unit SJ; MIS 5e) and the Humic Complex of Remicourt (unit ZPA; end of MIS 5a). The 19th Century "niveau moyen" (Michel, 1978) seems to be positioned between SVX and SY and would, therefore, also be Weichselian Early Glacial in age. In total, more than 3000 artefacts have been recovered from these deposits (Michel, 1978).

In Soignies/Le Clypot, more than a thousand artefacts have been collected in unit B1 (Haesaerts, 1978). On another part of the quarry, this unit is situated above the Harmignies luvisol (MIS 5e). Strati-graphic correlations with the nearby Harmignies sequence suggested the position of the Soignies/Le Clypot archaeological assemblage in the first cold episodes of the Weichselian Early Glacial (Haesaerts, 1978).

In Veldwezelt/Hezerwater Pit, units 19 (VLL; Fig. 9) and 20 (VLB; Fig. 9) yielded respectively 901 and 689 artefacts. These two archaeological assemblages were considered as "in situ like" (Bringmans, 2006a). Unit 19 is composed of slope-derived deposits at the bottom of a gully eroding the Eemian luvisol of unit 18 (SVLB; Fig. 9; Meijs, 2011). The deposition of the artefacts from VLL therefore relates to MIS 5d. Unit 20 records a small humic horizon (Meijs, 2011). Given the pedostratigraphic sequence, especially the presence of an Early Glacial luvisol (unit 22; Fig. 9) and a Greyzem (unit 27; Fig. 9) above unit 20, the artefacts are attributed to MIS 5d (Meijs, 2011). The greyzem of unit 27 (VBLB), correlated with Villers-Saint-Ghislain B (VSG-B) soil

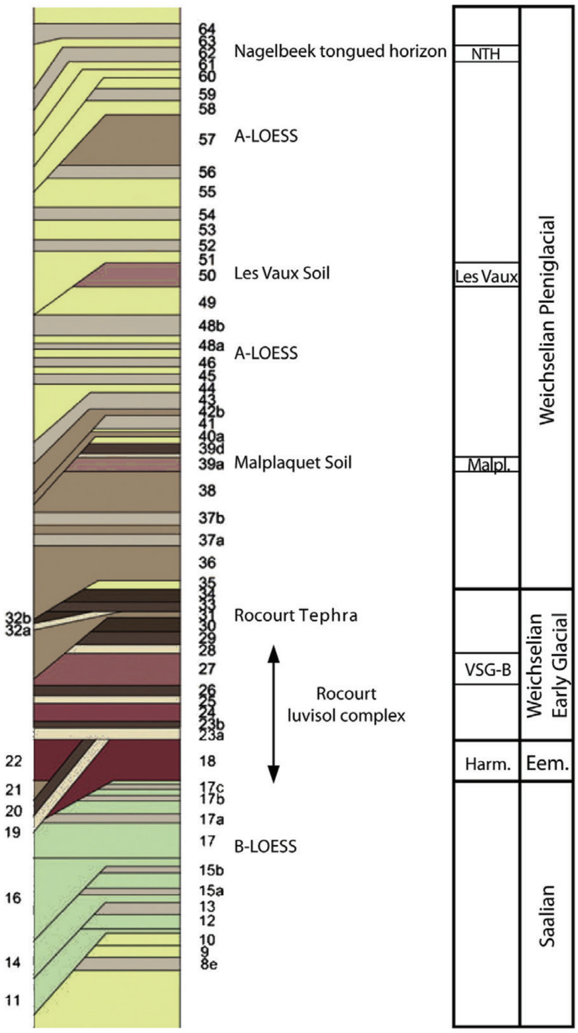

FIGURE 9. Composite profile of the Veldwezelt area (redrawn from Meijs et al., 2012) showing the major stratigraphic units for the Veldwezelt/Hezerwater Pit.

(sensu Haesaerts et al., 2011a; cf. Pirson and Di Modica, 2011; Fig. 10), yielded 354 artefacts considered as in situ (Bringmans, 2006a). These artefacts can be related to the sedimentation episode preceding the Greyzem and are therefore attributed to MIS 5b (Pirson and Di Modica, 2011; Pirson and Di Modica, 2011).

In Kesselt/Op de Schans Pit (archaeological level 1; Meijs et al., 2012) as well as in Kesselt/Nelissen Pit (archaeological level A4; Groenendijk et al., 2001), artefacts have been recorded in a similar stratigraphic position as Veldwezelt/Hezerwater Pit unit 27 and would therefore date from MIS 5b (Pirson and Di Modica, 2011).

In Kesselt/Nelissen Pit (archaeological level A3; (Groenendijk et al., 2001)), a single flake has been discovered in vertical position within sediments affected by a pedogenesis, probably VSG-A (MIS 5c; Fig. 10). This evidence suggests the artefact relates to the sedimentation phase of MIS 5d. However, the vertical position could also suggest the artefact was deposited within an ice wedge opening from an overlying surface as has been observed at Liège/Mont Saint-Martin (van der Sloot et al., 2009).

In Rocourt, the lithic assemblage comes from unit DC, corresponding to the Whitish Horizon of Momalle (WHM) overlying the VSG-B soil (Haesaerts et al., 2011a; Fig. 10). Given the strong cryogenic deformation of the sequence, two hypotheses exist concerning the age of the material: it can be attributed to either MIS 5a or MIS 5b (Haesaerts et al., 2011a; Pirson and Di Modica, 2011).

In Remicourt/En Bia Flo I, around 400 artefacts originate mainly from unit 26, which corresponds to the WHM (Fig. 10), like in Rocourt. Some artefacts come from unit 27a which records the VSG-B greyzem (Bosquet et al., 2011; Fig. 10). Several arguments, notably refitting between the artefacts from the two units as well as the presence of humic clay coatings typical of VSG-B pedogenesis on the surface of the artefacts from unit 27a, suggest a single occupation phase. The artefacts from unit 26 are therefore in a secondary po-

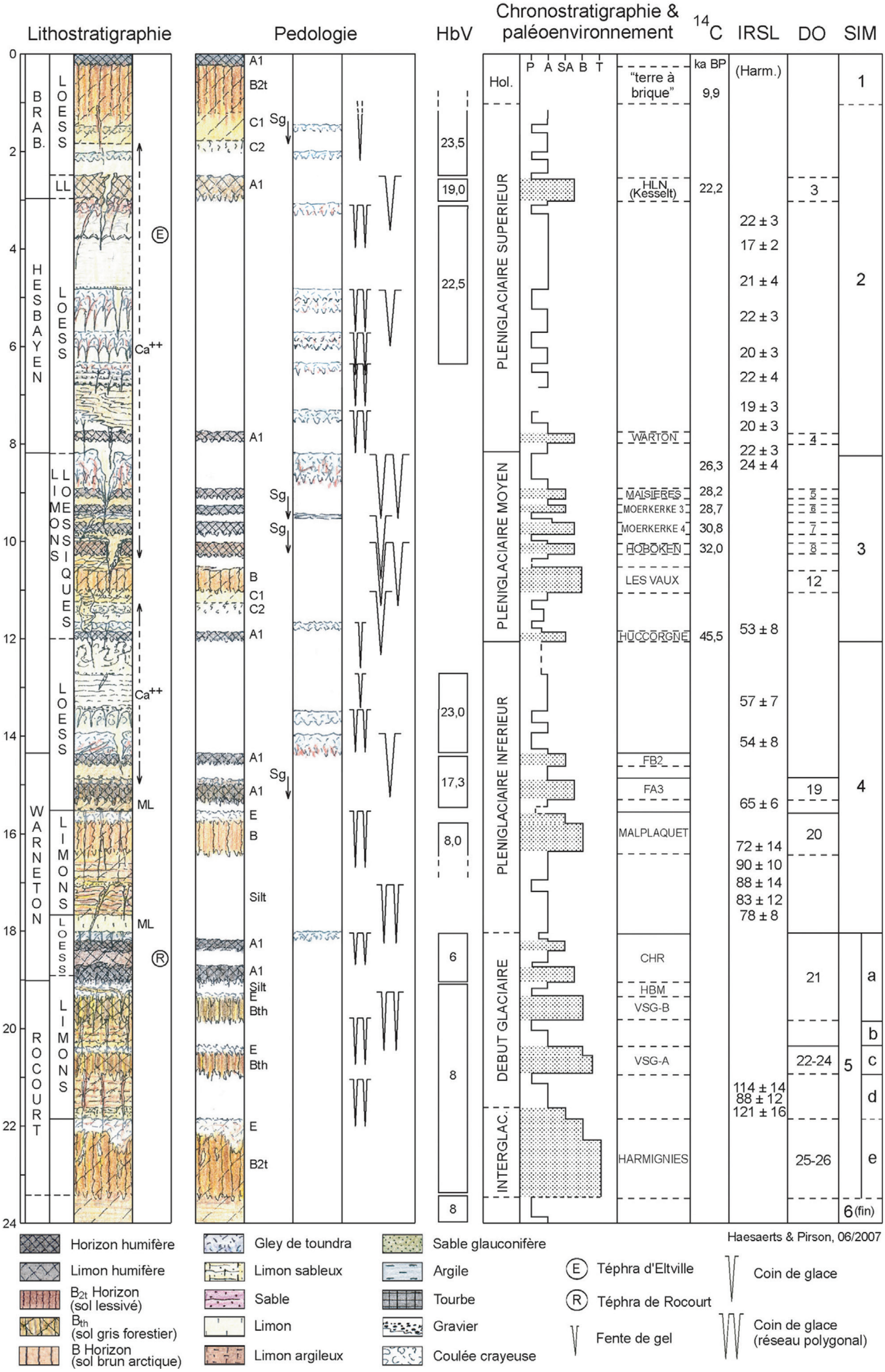

FIGURE 10. Reference loess sequence for the Upper Pleistocene (Pirson et al., 2009b).

sition. As the human settlement in Remicourt/En Bia Flo I predates the VSG-B pedogenesis, occupation is attributed to MIS 5b (Bosquet et al., 2011; Pirson and Di Modica, 2011).

In Liège/Mont Saint-Martin, artefacts were recovered at the boundary between units G-1 and G-2, recording respectively the Harmignies luvisol (Eemian; Fig. 10) and the Villers-Saint-Ghislain A (VSGeA) luvisol (Saint-Germain I; Fig. 10; Van Der Sloot et al., 2011). This evidence suggests positioning the artefacts in MIS 5d. Higher up in the sequence, units F-1 and F-2 also yielded artefacts. As these units record respectively slope deposits and the VSG-B greyzem, the human occupation can be related to MIS 5b. Artefacts have also been recovered from unit E, but these are in a secondary position as attested by interstratigraphic refitting (Van Der Sloot et al., 2011).

In Liège/Sainte-Walburge, the early 20th Century fieldwork led to the discovery of artefacts in unit E (De Puydt et al., 1912). Based on the descriptions made at the time of the excavation, correlation of this unit with the Rocourt pedocomplex has been proposed (Pirson and Di Modica, 2011; Roebroeks, 1981). The position of the material below a probable equivalent of HCR (unit d; see below) and the results obtained on the nearby site of Liège/Mont Saint-Martin suggest that artefacts from unit E might belong to the Weichselian Early Glacial. However, we cannot formally exclude the artefacts dating from a period prior to the Rocourt pedocomplex.

6.2.1.3. The end of the Weichselian Early Glacial: the Humiferous Complex of Remicourt

In Harmignies, a single blade fragment was found in unit EA4 (de Heinzelin et al., 1975), which corresponds to the Humiferous Complex of Remicourt (HCR). This pedocomplex overlying the WHM (Fig. 10) contains the Rocourt Tephra (Pouclet et al., 2008) and is attributed to the end of MIS 5a (Haesaerts et al., 2011a; Haesaerts et al., 2011b; Pirson et al., 2009b; Figs. 5 and 6).

In Liège/Sainte-Walburge, artefacts were also found in unit D, a gravel eroding unit E (De Puydt et al., 1912). A profile description by V. Commont indicates this gravel (named unit c) lies above a layer (named unit d) that also contains artefacts. Given V. Commont's description (in Lohest and Fraipont, 1911–1912), unit d could correspond to the Humiferous Complex of Remicourt (Pirson and Di Modica, 2011); Fig. 10). Therefore, the artefacts from Commont's unit d might relate to the end of MIS 5a (Figs. 5 and 6). The exact chronostratigraphic attribution of the stone tools within the overlying gravel (Commont's unit c De Puydt's unit D) is unknown. However, the comparison with the nearby site of Liège/Mont Saint-Martin suggests the artefacts are probably reworked from Commont's unit d and/or De Puydt's unit E.

6.2.1.4. First half of Weichselian Lower Pleniglacial

In Harmignies, some artefacts were found in the laminated silty deposits of unit EB1 overlying the HCR (Fig. 10), as well as in the Malplaquet soil (unit EB2; Fig. 10). This part of the sequence is positioned in the first half of the Weichselian Lower Pleniglacial (Haesaerts et al., 2011a; Haesaerts et al., 2011b; Pirson et al., 2009b). While artefacts from EB2 are probably related to the Lower Pleniglacial (Figs. 5 and 6), the material from EB1 could be reworked from underlying deposits. Higher up in the sequence, units FA 1-3 also yielded a few artefacts in between the Malplaquet soil (EB2) and the Kincamp soil (FA3; Fig. 10). These soils are indicative of two interstadials ending the first half of the Lower Pleniglacial.

6.2.1.5. Second half of Weichselian Lower Pleniglacial

This period is characterised by the first major allochthonous loess input in Belgium, and records rigorous climatic conditions. This period has been documented only in three sites: Harmignies, Remicourt/En Bia Flo I, and Veldwezelt/Hezerwater Pit (Haesaerts et al., 1999; Meijs, 2011). In the current state of research, no artefact has been found in such context (Figs. 5 and 6).

6.2.1.6. Weichselian Middle Pleniglacial

In Veldwezelt/Hezerwater Pit, Middle Palaeolithic artefacts have been recovered from multiple loci within units 43 (TLB, TL-R, TL-GF, TL-W) and 45 (WFL; (Bringmans, 2006a)). These are considered 'in situ' artefacts. Units 43 and 45 are positioned above the Lower Pleniglacial loess cover (from unit 40 onwards; Fig. 9) and below Les Vaux soil (unit 50; Fig. 9). The artefacts are therefore related to the beginning of the Middle Pleniglacial (Bringmans, 2006a; Meijs, 2011; Figs. 5 and 6). This interpretation is strengthened by a radiocarbon date obtained from a group of bone fragments found in WFL (45.440±4450/2850 uncal BP).

In Huccorgne/Hermitage station, Middle Palaeolithic artefacts have been found in association with faunal remains during the 19th century as well as during late 20th century through stratigraphic surveys and excavations (Straus et al., 2000). However, very few artefacts can be positioned in the sequence. Four flakes interpreted as "apparently in situ" have been recovered from unit E2 which overlies the Huccorgne soil. This interstadial is positioned in the beginning of Weichselian Middle Pleniglacial (Haesaerts, 2004; Pirson et al., 2009b; Figs. 5 and 6).

6.2.2. Caves from the Meuse Basin

6.2.2.1. Eemian deposits

While a few Eemian speleothems are documented through U/Th and palynological data in endokarst sequences (e.g., (Quinif, 2006)), the presence of the Eemian in a cave entrance sequence is only documented in Walou Cave, where a pedogenesis corresponding to the Harmignies luvisol has been documented (Pirson, 2011). However, as for the open-air sites, the top of this palaeosoil has been eroded and no archaeological evidence can be linked with that period (Figs. 5 and 6).

6.2.2.2. Weichselian Early Glacial deposits

In Walou Cave, the stratigraphic sequence covers large parts of the Upper Pleistocene and contains multiple archaeological assemblages. Dates, climatostratigraphic markers, tephrostratigraphy, as well as correlations with the regional reference loess sequence give the archaeological material a strong chronostratigraphic framework (Pirson, 2011; Pirson et al., 2006b). About thirty artefacts come from units CV-I (10 artefacts) and CV-2 (21 artefacts; Draily, 2011a). Layer CV-2 records the reworking of an interstadial ("Walou 3") correlated with either VSG-A or VSG-B soils from the loess sequence. The ar-tefacts are therefore probably related to Weichselian Early Glacial, somewhere between MIS 5d and the first half of MIS 5a (Figs. 5 and 6). Unit CV-1 records an in situ humic soil corresponding to the HCR, as demonstrated by the presence of the Rocourt Tephra (Pirson, 2011; Pirson and Juvigné, 2011). If the artefacts from CV-1 are in situ, they would date from the end of the Early Glacial (MIS 5b-5a).

In Scladina Cave, most of the stratigraphic sequence deals with the Upper Pleistocene. Several archaeological assemblages dating from the Weichselian are recorded. On the lower part of the sequence, the quantitatively most important archaeological assemblage is in secondary position within sedimentary unit 5 (Bonjean et al., 2014b; Pirson, 2007). Multiple arguments including dates and climatostratigraphic markers and correlation with the loess reference sequence (notably through mineralogical data) led to a general chronostratigraphic interpretation of the sequence (Pirson, 2007; Pirson et al., 2014b; Pirson et al., 2008). This scheme suggests that unit 5 has been deposited during one of the two stadials of the Weichselian Early Glacial, i.e., MIS 5d or 5b (Pirson, 2007; Pirson et al., 2014b; Figs. 5 and 6). Above unit 5 lies sedimentary complex 4. Remains of a juvenile Neandertal were recovered from the unit 4A-CHE and 4A-POC. Taphonomic observations made on the fossil (Bonjean et al., 2014a) as well as the study of the sedimentary dynamics (Pirson et al., 2014a) point to a rapid burial of the remains after the death of the Neandertal child, followed by multiple redistribution phases within units 4A-CHE and 4A-POC. According to these new results, the fossils are interpreted as approximately contemporaneous with the formation of unit 4A-CHE. Two hypotheses are proposed concerning the age of the fossils: either MIS 5b or the second part of MIS 5a

(Pirson et al., 2014a; Figs. 5 and 6).

6.2.2.3. Weichselian Lower Pleniglacial

In Walou Cave (layer CIII-3; (Draily, 2011a)) as well as in Scladina Cave (unit 2A; (Bonjean et al., 2014b)), artefacts have been retrieved from deposits that could be attributed to the Weichselian Lower Pleniglacial (Pirson, 2007). However, in both cases these artefacts lie in secondary position and are not contemporaneous with the deposits. In the current state of research, a few artefacts from Walou cave (layer CIII-2) have been published as contemporaneous with deposits that could be assigned to MIS 4 (Draily, 2011a; Fig. 5).

6.2.2.4. Weichselian Middle Pleniglacial

In Walou Cave, multiple layers from cycles CII and CI yielded archaeological material ranging from the Middle Palaeolithic to the Aurignacian (Draily, 2011a). Given the good control on the chronostratigraphy of the sequence, Middle Palaeolithic assemblages coming from units CII-4, CII-2, CII-1 and CI-8 can be positioned in the Weichselian Middle Pleniglacial (Figs. 5 and 6). Most of these assemblages are limited in size (8 to 102 artefacts; (Draily, 2011a)). The assemblage from layer CII-6 (22 artefacts) might belong to an early phase of the Weichselian Middle Pleniglacial but an attribution to the Early Pleniglacial cannot be totally excluded. Layer CI-8 yielded the main archaeological assemblage (1280 artefacts) as well as a Neandertal left lower first premolar (Draily et al., 1999; Toussaint, 2011). Radio-carbon dates combined with other chronostratigraphic arguments led researchers to suggest CI-8 was formed between 40 ka uncal BP and 38 ka uncal BP (Pirson et al., 2012), and probably closer to 40 ka uncal BP (Figs. 5 and 6). The hypothesis of the sedimentary deposit and the archaeological assemblage being contemporaneous has been favored (Draily, 2011a). However, stratigraphic evidence shows that layer CI-8 is erosive on the underlying deposits and partly rework unit CII-1 (Pirson, 2007; Pirson and Draily, 2011). Therefore, the hypothesis of the assemblage being slightly older than the layer formation remains open (Pirson and Di Modica, 2011). This evidence could explain the edge damages on flakes coming from CI-8 (Draily, 2011a).

In Scladina Cave, several layers are attributed to the Middle Pleniglacial and yielded Middle Palaeolithic artefacts (Bonjean et al., 2014b). Stratigraphic observations as well as interstratigraphic refitting allow the identification of two archaeological assemblages for that period. The oldest (1B) is spread in multiple layers from units 1B-GRI, 1B-JAU and 1B-TAB. The youngest (1A) is represented in multiple layers, from layer 1A-GL up to the top of unit T, as well as in unit Z-INF. Based on a cross-examination of radiocarbon dates (Bonjean et al., 2013), taphonomic processes on bone material and sedimentary processes, the archaeological assemblage 1A can be dated from a period ranging from 40.2 ka uncal BP to 38.5 ka uncal BP (Figs. 5 and 6). Regarding the archaeological assemblage 1B, the age of the human settlement can be approached based on pedosedimentary observations as well as on radiocarbon dates. This allows for the proposal of an age slightly older than 40.2 ka uncal BP, probably around 43–45 ka uncal BP (Figs. 5 and 6).

In Trou de l'Abîme, an isolated mandibular deciduous right second molar has been recovered in layer II, associated with a Middle Palaeolithic assemblage (Cattelain et al., 2011; Cattelain et al., 1986; Toussaint et al., 2010). Some arguments suggest the archaeological assemblage could predate Les Vaux soil, implying an age older than 40–42 ka uncal BP (Pirson et al., 2009a; Figs. 5 and 6). This is supported by two radiocarbon dates obtained on faunal remains from the same layer: 46.8 ka uncal BP and 44.5 ka uncal BP (Pirson et al., 2009a; Toussaint et al., 2010).

In Trou Al'Wesse, the three layers within unit 17 have yielded 730 artefacts from a 2 m2 test pit (Collin et al., 1996; Di Modica et al., 2005). The artefacts present two very distinct states of preservation, some of them being very fresh and allowing short-distance technical refitting, while others are extremely damaged (Di Modica et al., 2005). At least the freshest artefacts might be contemporaneous with the deposition of unit 17. A radiocarbon date obtained on a bone coming from this unit is for now the only chronological argument, with a result of 41 ka uncal BP (Otte et al., 1998a).

In Trou du Diable, most of the archaeological material comes from 19th century excavations and is therefore deprived of any reliable contextual information (Di Modica, 2005). However, limited fieldwork between 1978 and 1981 allowed the identification of artefacts in stratigraphic position (Toussaint, 1988). Palaeontological data suggest a cold and steppic climate, while a radiocarbon date performed on a set of bear bone fragments yielded a result of 46 ka uncal BP. Together, these two sources concur with a plausible MIS 3 age (Figs. 5 and 6), but this age should be confirmed by other arguments.

In Descy Cave, five flakes were recovered from layers 10 and 9, interpreted as a reworked palaeosoil (Mathys et al., 1986). The identification of the Rocourt Tephra within layers 10 to 3 (Mathys et al., 1986) indicates these deposits post-date 78–80 ka (Juvigné et al., 2013). A radiocarbon date performed on bone fragments yielded an age older than 35 ka uncal BP, with a result most probably between 37 ka uncal BP and 46 ka uncal BP (Mathys et al., 1986). If this date is correct and reflects the archaeological occupation, the material would date from the Weichselian Middle Pleniglacial (Figs. 5 and 6).

Finally, human remains recovered during 19th century excavations have been directly radiocarbon dated in three caves: Engis (Toussaint and Pirson, 2006, Goyet (Wißing et al, 2016) and Spy (Semal et al., 2013b; Semal et al., 2009). Results obtained in Spy indicate an age around 36.5 ka uncal BP, and dates on the Goyet individuals range from 36.6 to 41.2 ka uncal BP. The two radiocarbon dates obtained in Engis directly from the Neandertal parietal bone are obviously too young (ca. 26.8 and 30.5 ka uncal BP; Toussaint and Pirson, 2006).

6.2.3. The Flemish valley

Some artefacts have been discovered in two sand quarries in Zemst/Bos van Aa in the Senne valley (Bogemans and Caspar, 1984; Van Peer and Smith, 1990). Fluviatile deposits containing the artefacts are related to the eastern branch of the Flemish valley. The deposits belong to the Eecklo Formation attributed to the first part of the Upper Pleistocene (Gullentops et al., 2001). Only 4 artefacts have been found in the stratigraphy (Bogemans and Caspar, 1984) while the rest of the collection has been found during mechanical sieving in the quarry (Van Peer and Smith, 1990). Also, bone material belonging to cold fauna species has been retrieved from the same layer. One of the remains - a reindeer horn - bears cutmarks, suggesting a link between the artefacts and at least part of the faunal assemblage. All the arguments point to a stadial of the Weichselian Early Glacial (Figs. 5 and 6). This interpretation is in harmony with two ESR dates obtained on a Mammoth tooth: 17 ±20 ka and 122 ±20 ka (Germonpré, 1989).

7. Anthropological remains

Anthropological remains have been recovered from at least 8 caves in Belgium (Toussaint, 1996; Toussaint and Pirson, 2006; Toussaint et al., 2001; Toussaint et al., 2011). No human bones dating from the Middle Palaeolithic have so far been recovered from alluvial, estuarine/coastal or loess context.

The earliest Neandertal fossil ever discovered was in Engis during the winter 1829–1830 (Schmerling, 1833), but it was recognized as Neandertal only a century later (Fraipont, 1936). Stratigraphic information on the fossil position within the sequence is not available. Based on lithic artefact typology, the cave contained at least Middle Palaeolithic and Gravettian assemblages (Otte, 1979; Toussaint and Pirson, 2006; Ulrix-Closset, 1975). The Middle Palaeolithic comprises numerous Mousterian points made on flint. This material has been possibly related to the end of the Middle Palaeolithic based on both techno-typological characteristics and an assumed stratigraphic proximity with the Aurignacian (Ulrix-Closset, 1990). However, these arguments must be rejected based on modern standards of research (Pirson and Di Modica, 2011). The Middle Palaeolithic material has always been deemed to belong to a unique archaeological assemblage e and presumably a single occupation e but no stratigraphic data or refitting program can support this hypothesis. Radiocarbon dates have been per-formed, but the results are too young, probably due to contamination related to the varnish applied to the bones during the 19th century (Toussaint et al., 2011).

In 1866, E. Dupont discovered 4 human fossils in La Naulette cave: a mandible, a lower canine (now lost), an ulna and a metacarpal (Dupont, 1866, 1867b). Stratigraphic information can be considered as accurate for that time and indicates the fossils were deeply buried within the sedimentary sequence and under several generations of stalagmitic floors (Toussaint and Pirson, 2006). These fossils were associated with faunal remains. The anthropological study indicates the mandible presents plesiomorphic characters while the ulna and the metacarpal have more modern characteristics (Leguebe and Toussaint, 1988). Such differences can be normal for a single individual and could suggest an age older than the classic Neandertals (Toussaint et al., 2011). However, given the age of the excavation and despite the good quality of Dupont's work in this cave, one cannot exclude the possibility the fossils belong to different individuals.

In 1869, E. Dupont relates the discovery of the Goyet caves (Dupont, 1869). Most of the archaeological material he collected came from 3 of the 5 "fauna-bearing levels" of the Troisième Caverne. The archaeological material was believed to belong to a single cultural group ("Goyet type"; Dupont, 1874) despite the fact the artefacts came from multiple layers and despite the acknowledged techno-typological changes from one "fauna-bearing level" to another (Dupont, 1872a). The presence of human remains was already published by E. Dupont (1872), but the Neandertal bones were not identified within the bone collection until 2004 (Rougier et al., 2009; Wißing et al., 2016). The cave's cultural sequence includes Middle Palaeolithic, Lincombian-Ranisian-Jerzmanowician (LRJ), Aurignacian, Gravettian, and Magdalenian material, each possibly representing multiple archaeological assemblages. Given the age of the excavation and the poor quality of Dupont's stratigraphic record for this cave, no evidence exists regarding the association of the Neandertal remains to one or several Middle Palaeolithic and/or LRJ settlements.

In the summer of 1886, M. Lohest and M. De Puydt discovered Neandertal remains belonging to two adult individuals on the terrace of Spy Cave. The sedimentary sequence was divided in a few layers grouped within 3 "fauna-bearing levels", while the whole cultural sequence was assigned to Mousterian. The Spy discovery can be considered the first evidence favouring the association of the Neandertal type and the Mousterian culture. Progressively, multiple cultural levels have been identified within the lithic material, ranging from the Middle Palaeolithic to the historic periods (see Pirson et al., 2013). The critical review of the Middle Palaeolithic material showed it contained multiple assemblages (Di Modica et al., 2013; Otte, 1979; Ulrix-Closset, 1975). The cultural association of the human fossils with one of the Middle Palaeolithic assemblages or with the so-called "transitional" LRJ culture remains open due to the lack of reliable stratigraphic evidence.

In 1897, F. Tihon discovered a Neandertal femur and a molar (now lost) during his excavation in the first cave of Fond-de-Forêt (Tihon, 1898). The human fossils came from Tihon's "layer c", which also yielded Middle Palaeolithic artefacts and fauna. However, "layer c" probably included several layers, as Tihon noticed it presented important variations in colour (black, grey, and yellow) depending on the area within the cave. Therefore, no guarantee exists concerning the attribution of all the artefacts to a single archaeological assemblage. The association between the Neandertal remains and the artefacts as well as the age of the human settlement(s) and the Neandertal remains are also questionable.

In 1984, an isolated mandibular deciduous right second molar was discovered during an excavation undertaken on the terrace of the Trou de l'Abîme in Couvin (Cattelain and Otte, 1985). The anthropological study indicates this tooth is Neandertal (Toussaint et al., 2010). The tooth was discovered in the same layer as Middle Palaeolithic artefacts (Pirson et al., 2009a; Toussaint et al., 2010) and bone retouchers (Abrams and Cattelain, 2014).

From 1993 on, Neandertal cranial remains belonging to a juvenile individual have been identified in Scladina Cave (Bonjean et al., 2014b; Otte et al., 1993). These fossils lie in secondary position within several layers from units 4A-CHE and 4A-POC and are spread on some 20 m inside the cave (Pirson et al., 2014a). They bear no marks of post-mortem anthropogenic or animal activity. Based on the evidence to date, no artefacts appear to be associated with the remains.

In 1997, an isolated mandibular left first premolar was recovered in Walou cave from layer CI-8. A first anthropological study of this fossil has been published recently, indicating its attribution to Neandertal (Toussaint, 2011). The fossil was found in the same layer as the main Middle Palaeolithic assemblage of the cave (Draily, 2011a).

8. Land-use strategies and mobility patterns: some aspects

8.1. Human settlements in the landscape

The 442 Lower and Middle Palaeolithic find-sites indicate multiple geographic contexts have been used for human settlements: floodplains, caves, valley shoulders, and plateaus.

Few sites are currently related to the floodplains. The Mons Basin is the only locale where the archaeological material is clearly associated with alluvial terraces notably in sites such as Mesvin IV. In the Scheldt Basin, the sites of Zemst/Bos van Aa as well as Schulen and Rotselaar (Van Peer, 1982, 1989) illustrate human settlements in alluvial contexts, probably during the Weichselian Early Glacial. They show the potential of these deeply buried fluvial contexts.

The 47 caves that yielded Lower and Middle Palaeolithic settlements present common topographic features and do not seem to be randomly positioned in the landscape. They are primarily located near the confluence of two river streams. None of the caves open directly on the Meuse valley. They all stand high in the valley slope, or just under the overhanging plateau. This evidence seems to indicate a preference for caves offering a view over the valley as well as an easy access to the overhanging plateau.

This preference for a position high in the valley is also valid for numerous open-air sites. In the Geer valley, the sites of Otrange (Di Modica and Jungels, 2009) and Lauw (Gijselings and Doperé, 1983), for example, occupy a south facing position on the top of the valley slope and on the valley shoulder. In the Meuse valley, surface prospection led to the discovery of numerous archaeological assemblages and scattered artefacts on the top of interfluve plateaus overhanging the Meuse valley and small tributary valleys (Di Modica, 2010, 2011a).

Finally, sites such as Soignies/Le Clypot, Remicourt/En Bia Flo I, Rocourt or Omal are in a plateau position (Di Modica, 2010, 2011a) and apparently do not relate to the current hydrographic network.

8.2. Territorial exploitation and mobility patterns

Cretaceous flint has been the most exploited raw material for the whole Lower and Middle Palaeolithic in Belgium. Each of the 442 find-sites yielded flint artefacts. On the contrary, most of the other raw materials have been used only locally when flint sources are lacking in the area surrounding the site. Therefore, the lithic raw materials represented on a Palaeolithic site constitute valuable sources of information relative to population mobility and land-use strategies. Archaeozoological evidence and a mineral pigment from Scladina Cave complement the information.

8.2.1. Lithic raw materials

Lithic assemblages are found spread throughout the whole territory in various geographic and geological settings. Some settings are characterized by easy access to autochthonous flint sources while others are totally deprived of flint sources, and still others contain allochthonous flint sources only. From one region to another, these assemblages present contrasted characteristics in terms of raw material acquisition, technological characteristics, and reduction degree (Di Modica, 2010). Major sites from will be shortly presented below in 4 categories: 1. caves distant from autochthonous flint sources, 2. open-air sites distant from autochthonous flint sources, 3. caves close to autochthonous flint sources, and 4. open-air sites distant from autochthonous flint sources.

Most of the cave sites from Upper Belgium are distant from autochthonous flint sources. This is the case for major sites such as Trou Magrite, Trou du Diable, Trou du Sureau, Goyet Cave, Engihoul Cave, Trou Al'Wesse and Scladina Caves. All these sites have as a common point the use of locally available raw material such as river pebbles (quartz, quartzite, sandstone, and occasionally flint) or outcropping rocks (chert, limestone) beside flint nodules trans-ported from autochthonous flint sources from sometimes up to 30 km. These sites are also characterized by an optimization of the lithic tools production on transported flint thanks to both an important flexibility of the debitage concepts (i.e., adaptation of debitage concepts to the size and the morphology of the blanks) and a great degree of core reduction.

Some major Middle Palaeolithic sites are also away from any autochthonous flint sources in Lower and Central Belgium. This is the case for instance in Zemst/Bos van Aa, Schulen/Torren ter Heide, Amougies/Mont de l'Enclus and Soignies/Le Clypot. No major open-air site has been recovered so far from Upper Belgium. In terms of raw material acquisition, the situation in these open-air sites is, therefore, quite comparable with cave sites. The assemblages are made of locally available small flint pebbles and transported flint nodules, cores and flakes. As for cave sites, the debitage is characterized by a flexibility of the chain of operations and a great reduction degree of the cores, showing a will to limit the waste of raw material on transported flint. The only notable exception to this scheme is Franquenies. There, the lithic assemblage is mainly made of a variety of phtanite presenting a quality like flint for knapping activities; cores are reduced according to Levallois and Discoid concepts.

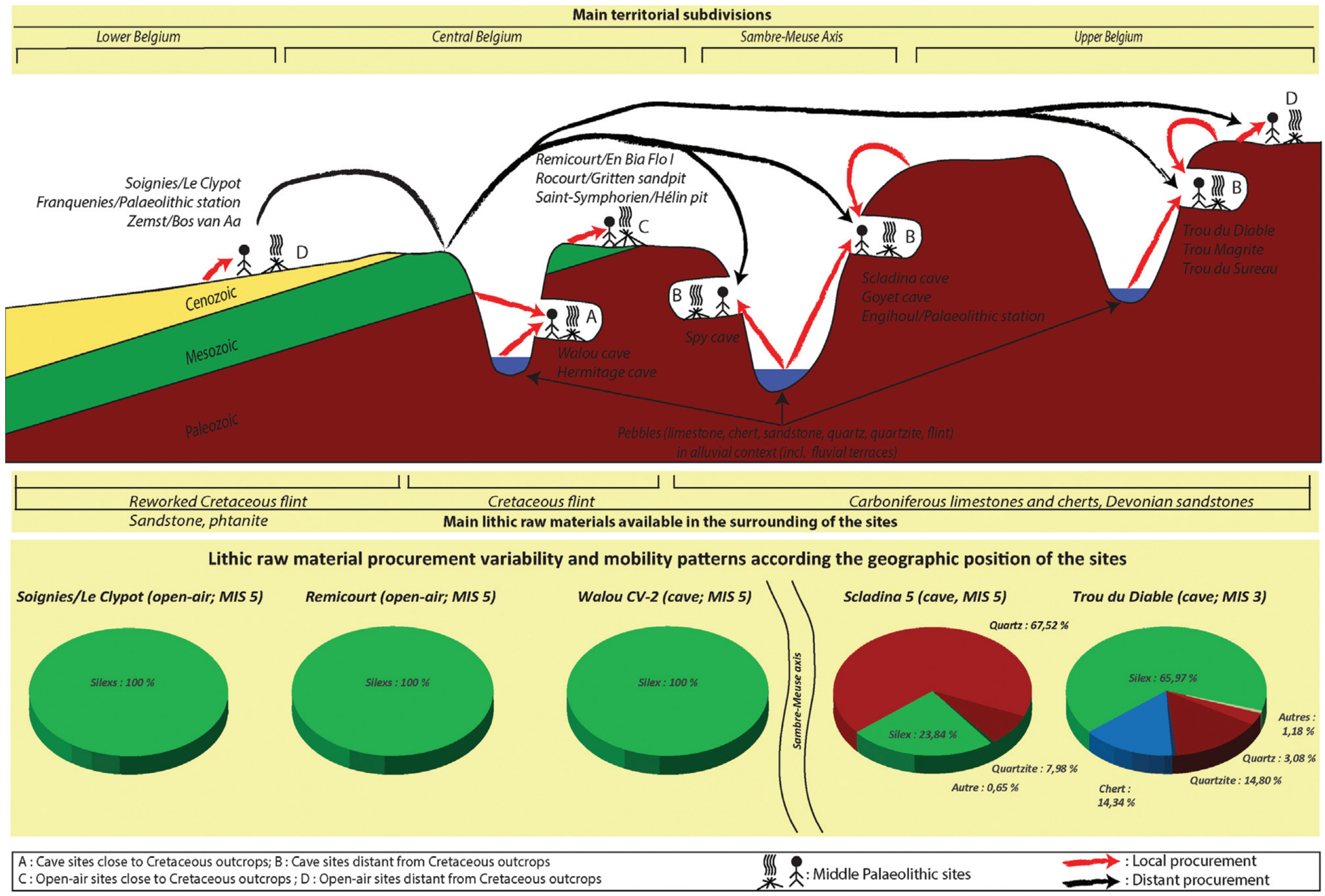

FIGURE 11. Lithic raw material acquisition and transportation pattern for the Middle Palaeolithic in Belgium.

In Middle Belgium, numerous major open-air sites are located close to the Cretaceous outcrops. Among these sites figure Saint-Symphorien/He,lin Pit, Remicourt/En Bia Flo I, Veldwezelt/Hezerwater Pit, Otrange Pit and Omal/Kinart Pit. The situation contrasts markedly with the previous examples. Locally available flint pebbles and nodules were acquired in a secondary autochthonous context and in an allochthonous context. In all cases, cores, flakes and refitting show the production of morphologically and technologically standardized products related to the Levallois concept. In Saint-Symphorien/Hélin Pit and Remicourt/En Bia Flo I, clear evidence of a laminar blade debitage also occur (Bosquet et al., 2011; de Munck, 1893).

Few caves of Middle and Upper Belgium are located close to the Cretaceous outcrops. This is particularly the case for the sites along the Mehaigne River (e.g., Hermitage Cave, Doctor's Cave) and in the Vesdre Basin (e.g., Fond-de-Forêt Cave, Walou Cave). Flint nodules are collected in a secondary autochthonous context and in an allochthonous context. The debitage activities occur primarily on site as attested by numerous cortical flakes and mainly follow a Levallois or a Discoid concept. In Fond-de-Forêt, Quina debitage also occurs. Due to a common ease of access to good quality raw material sources, these cave sites present many similarities with open-air sites close to the Cretaceous outcrops.

In terms of lithic reduction strategies, when the sites from these 4 categories are compared, differential access to raw materials tends to be the primary factor contributing to variability.

As highlighted by the examples presented above, open-air and cave sites distant from autochthonous flint sources present similarities in terms of lithic acquisition (locally available raw material transported flint) and reduction (minimal preparation and great reduction of the cores). Open-air and cave sites close to autochthonous flint sources also present similarities, with a preferential use of the locally available flint, a greater degree of preparation and an abandonment of the cores at an earlier stage of reduction compared to sites away from flint sources.

The Middle Palaeolithic sites of Belgium provide evidence for a lithic production variability pattern based on ease of access to good lithic flint sources. Flint was preferentially used for knapping activities and comes from around the site when present. The tool production was made preferentially following the Levallois concept. Other concepts such as Discoid, Laminar and Quina also occur in variable proportions. If flint was not locally available, it was collected elsewhere, and then transported to the site over distances of up to 30 km, sometimes by crossing topographic obstacles such as the Meuse River. In such cases, locally available raw materials were used as complements to flint (Fig. 11). On transported flint, the tool production is characterized by an adaptation of the main debitage concepts (Levallois, Quina and Discoid) to the shape and the size of the blanks to limit the core preparation/reju-venation and the waste of raw material associated with reduction strategies. On other raw materials, mainly Levallois, Quina and Discoid concepts were applied, sometimes successively on a single blank. Flint acquisition and its transportation to sites where flint is naturally missing can be considered informative regarding territorial exploitation and to population mobility from Middle Belgium outcrops to Upper Belgium sites situated to the south of the Meuse-Sambre axis.

A comparison of sites from these various environments in a diachronic perspective is also very informative and confirm the great impact of the raw material accessibility on lithic productions. Sites from the same environment but related to different periods present more similarities among each other than sites from the same period but coming from different environments. For instance, the comparison of the archaeological assemblages 5 (MIS 5d-b) and 1A (MIS 3) of Scladina Cave highlight similarities in the use of locally available raw materials together with transported flint despite their very different ages and paleoenvironmental contexts. Other examples are provided by comparisons between the MIS 5 sites of Scladina and Remicourt, or the MIS 3 sites of Hastière/Trou du Diable and Veldwezelt/Hezerwater: in both cases, important divergences in terms of raw material acquisition and lithic tool production appear in relation to the discrepancy in terms of raw material access.

8.2.2. Archaeozoological data

Very few open-air sites have yielded animal remains, because of taphonomic issues (Behrensmeyer, 1978). The very few sites including bones in a well-controlled stratigraphic context were mainly studied for environmental reconstructions and biostratigraphic purposes (e.g., Van Neer, 1986). Evidence of animal carcasses exploitation is therefore scarce (Fig. 12). Microscopic analyses made on the sediment samples collected during the excavations of Remicourt/En Bia Flo I highlighted the presence of burned bones, resulting from the use of bone fragments as fuel (Bosquet et al., 2009). The burned fragments have been found in a stratigraphic and spatial association with the lithic industry. In Zemst/Bos van Aa, a reindeer antler bearing cut marks has been found in the same sedimentary deposit as the artefacts (Van Peer and Smith, 1990).

In caves, animal remains are frequently found together with Middle Palaeolithic lithic assemblages. Faunal material has frequently been studied for the characterization of the environment (e.g., Cordy, 1984; Germonpré et al., 2013). However, detailed archaeozoological studies are scarce. This can partly be explained by the antiquity of many of the excavations, implying the strict association of the skeletal remains and the stone artefacts may be questionable (Daujeard et al., 2016). Interesting data have been provided by 5 archaeological assemblages (Fig. 12): units 1A and 5 of Scladina Cave (Abrams et al., 2014b; Abrams et al., 2010; Patou-Mathis, 1998), layers CV-2 and CI-8 of Walou Cave (Daujeard et al., 2016; Van Neer and Wouters, 2011), and the material from Trou de l'Abîme (Abrams and Cattelain, 2014).

Despite different environmental conditions, among these 5 assemblages, all but the layer CV-2 of Walou Cave have provided numerous burned bones. This highlights the use of bones as fuel (Abrams et al., 2010; Abrams and Cattelain, 2014; Daujeard et al., 2016). The small size of the fragments and the low representation of calcined bones could result from their reworking within the cavities (Abrams et al., 2010).

In caves, despite a much better preservation of bones than in open-air sites, the impact of different taphonomic agents can be significant. Distinct animal activities and other diagenetic processes can superimpose anthropogenic marks, partially or completely obliterating them. The interpretation of traces recorded on bones can be further complicated by the fact that different actions made by different agents can produce similar marks (e.g., fracturing operated by percussion or by the pressure applied by carnivore canines). Despite these limitations, a few clear anthropic traces have been deciphered.

Clear cut marks have been observed on herbivore remains from Trou de l'Abîme (Horse and Bos/Bison; (Abrams and Cattelain, 2014). Similar marks were also observed on Chamois recovered in the archaeological assemblage 5 of Scladina Cave, highlighting a specialized hunting strategy on this species (Patou-Mathis, 1998). Cut marks on a hare pelvic fragment are also documented on the same assemblage 5 (Bonjean et al., 2011). Also, in Scladina Cave, the archaeological assemblage 1A contains only a few ribs of a middle-sized herbivore recovered from unit Z-INF and bearing possible cut marks that might be linked with a butchery activity. In this assemblage, carnivore activities e mostly hyenas (Bourdillat, 2008) and climate-edaphic agents (Lamarque, 2003) are the two main factors that have affected the preservation of the faunal re-mains. In layer CI-8 of Walou Cave, the absence of anthropogenic modifications on mammal remains has been noticed. The presence of numerous fish remains and the ichthyologic spectrum suggest the consumption of fish by Neandertals (Van Neer and Wouters, 2011).

Bone retouchers have been identified within 3 distinct archaeological assemblages. In assemblage 5 from Scladina Cave, some retouchers have been produced from cave bear remains. Four of these retouchers refit together and have been produced from a single femur diaphysis (Abrams et al., 2014b). Long bones of other species have also been used such as red deer and horse. In Trou de l'Abîme, horse teeth have similar marks and are retouchers (Abrams and Cattelain, 2014). In layer CV-2 from Walou cave, a single bone retoucher was made from a shaft fragment; this is the only modified bone within the whole assemblage.

In other caves, burnt bones, cut-marked bones and retouchers are well represented. They were sometimes reported in ancient studies (e.g., Dupont, 1872a). However, their association with the Middle Palaeolithic is often difficult to prove.

Currently, no proof has been found to support the exploitation of faunal resources distant from the site. The data from the archaeological assemblage 5 of Scladina Cave even seems to support the hypothesis of the exploitation of locally available faunal resources, with the exploitation of a rupicolous species for butchery (Chamois) and cave bear for bone tool production.

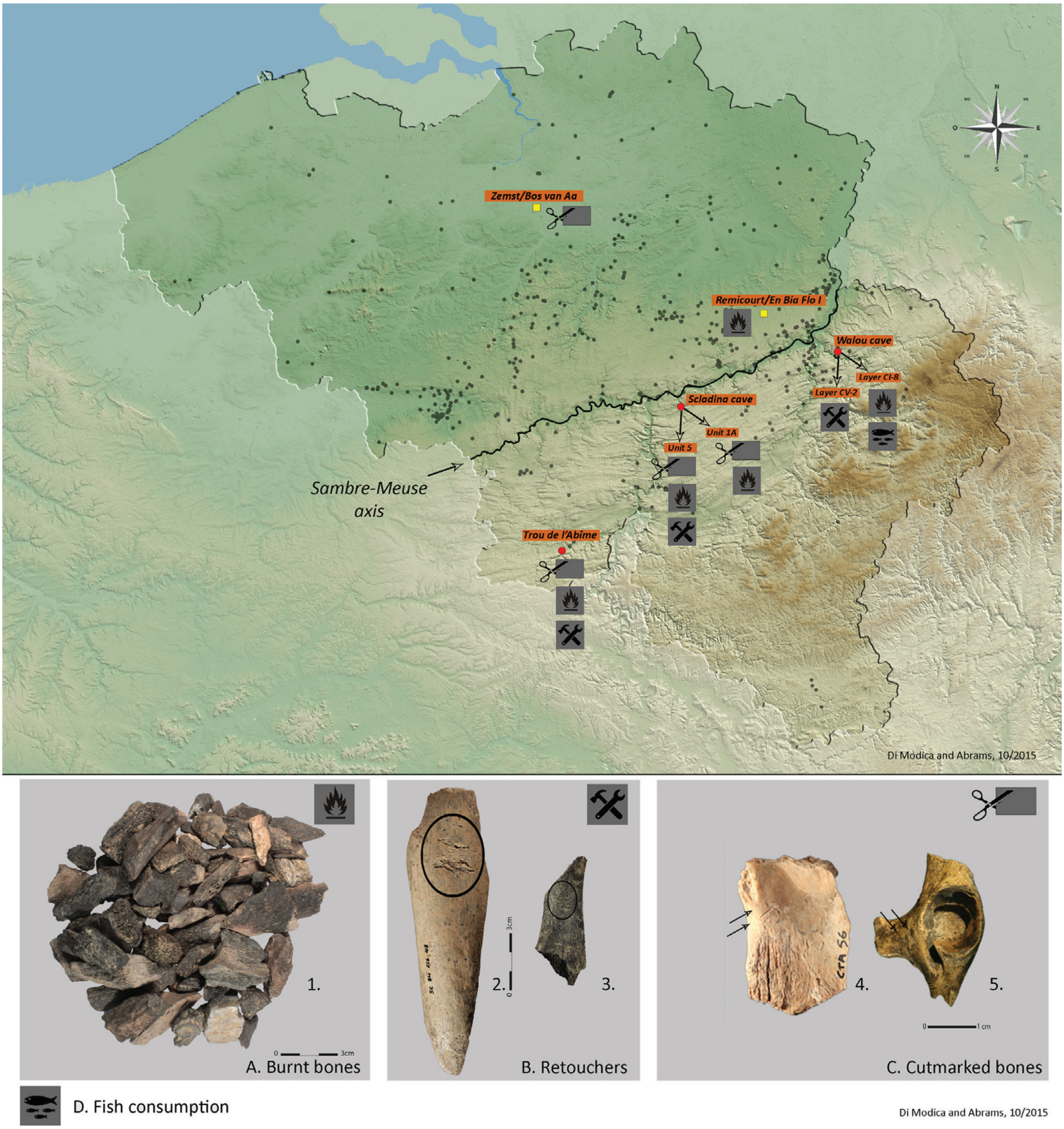

FIGURE 12. Distribution map of the sites with archaeozoological material and representative items: 1. Burned bones from Scladina Cave; 2. Bone retoucher from Scladina Cave unit 5; 3. Bone retoucher from Walou Cave unit CV-2; 4. Cut-marked bone from Trou de l'Abîme; 5. Cut-marked bone from Scladina Cave unit 5. Pictures: G. Abrams. © Scladina Cave Archaeological Center (1, 2, 5), Public Service of Wallonia (3), CEDARC (4).

8.2.3. Mineral pigment

Scladina cave yielded a black mineral pigment in the same sedimentary context and spatially associated with the archaeological assemblage 1A (Bonjean et al., 2015). The detailed analysis of this pigment allowed incontestable identification of its source and indicated transportation to Scladina Cave from some 35 km north-east of the site. This constitutes valuable information relative to territorial exploitation and indicates long-distance displacement like those shown by the flint transportation strategies.

9. Site functions

Given the antiquity of most of the excavations as well as the poorly preserved conservation of the anthropogenic spatial distribution in most of the sites, very little information is available regarding the spatial distribution of the lithic industry, or its as-sociation with the other classes of data. In such circumstances, combined with the very poor archaezoological data, site function(s) is difficult to decipher.

Even in more recent excavations, convincing data is very rare. For instance, in the archaeological assemblage 5 of Scladina Cave, some attempts were made to decipher the spatial distribution of the assemblage composed of stone tools and anthropogenic bone material (Bonjean, 1998; Bonjean and Otte, 2004; Mathis and Otte, 1987). However, none has convincingly demonstrated the anthropogenic origin of the distribution. On the contrary, the dispersal of the anthropogenic material is probably due to redistribution by sedimentary processes within the cavity (Pirson, 2007). As a result, no convincing, strictly in situ, spatial distribution of the archaeological material preserved in any site in Belgium can be discerned. A few sites yielded enough reliable data to allow for a discussion of the original anthropogenic spatial distribution of the material including Mesvin IV, Kesselt/Op de Schans Pit, Veldwezelt/Hezer-water Pit, Remicourt/En Bia Flo I, and Walou Cave (Bosquet et al., 2011; Bringmans, 2006a; Cahen and Michel, 1980; Draily, 2011a; Van Baelen and Ryssaert, 2011). Two examples will be presented below, to illustrate the limitations of site function analysis. Remicourt/En Bia Flo I can be considered as the best-preserved site concerning spatial distribution. Two loose concentrations have been identified: area 1 yielded lithic artefacts corresponding to a volumetric blade debitage while area 2 gave flakes, retouched tools, charcoal and burnt bones (Bosquet et al., 2011). In addition to spatial distribution, several arguments, including micro-wear analysis, refitting and techno-typological characteristics of the material, suggest these areas were subject to distinct functions. Area 2 has been interpreted as related to the processing of large herbivore carcasses next to a fire (Bosquet et al., 2009; Bosquet et al., 2011). While highly suspect, the strict contemporaneity of areas 1 and 2 cannot be proven.

The archaeological assemblage 1A of Scladina Cave is a complex case study where spatial and stratigraphic distributions are due to a combination of sedimentary processes and anthropogenic factors. Most of the archaeological assemblage has been reworked from the cave entrance through a wash processes and debris flow (Pirson, 2007; Pirson et al., 2012). However, another part of the assemblage has also been recovered deep within the cave, in a much better sedimentary context. There, the local collapse of the roof connected the cave to the overhanging plateau through an aven (Bonjean et al., 2002; Pirson, 2007). Slightly disturbed artefacts have been buried in the accumulation zone, right under the aven, on a surface which laterally corresponds to assemblage 1A. These two assemblages can be considered as distinct concentrations of archaeological material presenting common features and reflecting the occupation of two areas. A refitting confirms the two assemblages belong to a single human settlement (Di Modica, 2010).

Apart from Remicourt/En Bia Flo I and Zemst/Bos van Aa, no other open-air site shows the clear association of anthropogenically modified bones and lithic materials within the same context. In caves other than Scladina, the association of a lithic assemblage with bones bearing evidence of anthropogenic activities has been observed in Couvin (Abrams and Cattelain, 2014), Walou Cave and Trou Al'Wesse.

10. Techno and typo-complexes

Historically, multiple cultural facies have been identified in Belgium based on typological studies of lithic industries: Recent Acheulean, Mousterian of Acheulean tradition (MTA), Charentian (Quina and Ferrassie types), Mousterian with bifacial retouch and evolved Mousterian (Ulrix-Closset, 1975). This typological classifi-cation together with paleontological and stratigraphical arguments as well as inter-regional comparisons, led M. (Ulrix-Closset, 1975, 1990) to assign the Charentian and the evolved Mousterian to the Middle Pleniglacial while the MTA and the Recent Acheulean would range from the Penultimate Glacial to the Weichselian Early Glacial. However, this interpretation has been revised considerably.

First, the Charentian aspect of some industries has been linked with an adaptation of the lithic production to specific raw ma-terial procurement strategies (Di Modica, 2010; Otte, 1998a). Indeed, these "facies" occur exclusively in environments characterized by a lack of autochthonous flint resources and are not limited to the Weichselian Middle Pleniglacial (Di Modica, 2010; Pirson and Di Modica, 2011). Secondly, the concept of an evolved Mousterian has been abandoned (Di Modica et al., 2013). Thirdly, more recent research undertaken in Germany, northern France and Belgium have led to the recognition of a volumetric blade debitage among Middle Palaeolithic industries and the designation of these industries as a techno-complex mainly limited to the Weichselian Early Glacial (Depaepe, 2007; Locht and Depaepe, 2011; Locht et al., 2016; Révillion, 1995). In the current state of the research, blade production and bifacial tools appear as the most relevant for the discussion of cultural aspects of lithic production.

Volumetric blade debitage has been identified in several Middle Belgium open-air sites (Fig. 13): Rocourt (Haesaerts et al., 2011a), Remicourt/En Bia Flo I (Bosquet et al., 2011), Liège/Mont Saint-Martin (Van Der Sloot et al., 2011), Veldwezelt/Hezerwater Pit (Bringmans, 2006b), Soignies/Le Clypot (Di Modica, 2010), Saint-Symphorien/He,lin Pit (de Munck, 1893) and Masnuy-Saint-Jean/Le Rissori (Adam, 1991). Most of these sites are related to the Weichselian Early Glacial. Saint-Symphorien/He,lin Pit and Masnuy-Saint-Jean/Le Rissori are older (MIS 8-6). So far, no volumetric blade debitage has been identified in cave sites. However, a precise technological study of volumetric blade cores is required to verify if the material attributed to the Upper Palaeolithic does not include Middle Palaeolithic volumetric blade cores.

Various types of bifacial tools have been documented in 185 of the 442 find-sites (ca 42%) related to the Lower and Middle Palaeolithic in Belgium. Their spatial distribution is like the overall spatial distribution of the Middle Palaeolithic find-sites, and they are represented both in open-air and in cave sites.

The earliest evidence of Middle Palaeolithic bifacial tools has been recovered from Mesvin IV and Petit-Spiennes III, both sites chronologically attributed to MIS 8. The archaeological assemblages comprise a Levallois debitage as attested to by cores and flakes as well as a few bifacial tools identified as prodniks (Cahen and Haesaerts, 1982; Cahen and Michel, 1986; Soriano, 2001). The best comparisons for the Mesvin IV industry would then be with the Central and Eastern European Micoquian (Cahen and Michel, 1986). For the rest of the Early Middle Palaeolithic, no clear evidence of bifacial tools or handaxes has been found.

Triangular and cordiform handaxes have been recovered from a Weichselian Early Glacial context in Saint-Symphorien/Hélin Pit, Liège/Sainte-Walburge and Godarville-Canal (Ruebens and Di Modica, 2011; Fig. 14). Typological affinities exist between these handaxes and others with no reliable context, notably in Spy Cave, Trou Magrite, Hermitage Cave or Hardenpont Quarry. This resemblance could suggest a similar age for these sites. However, the presence of cordiform handaxes in the archaeological assemblage 1A from Scladina Cave (Ruebens and Di Modica, 2011), dated to ca. 40,000–38,000 uncal BP, clearly indicates that such handaxes were present both during MIS 5 and MIS 3.

Small foliate pieces/points have been recovered from a context corresponding to the Weichselian Early Glacial

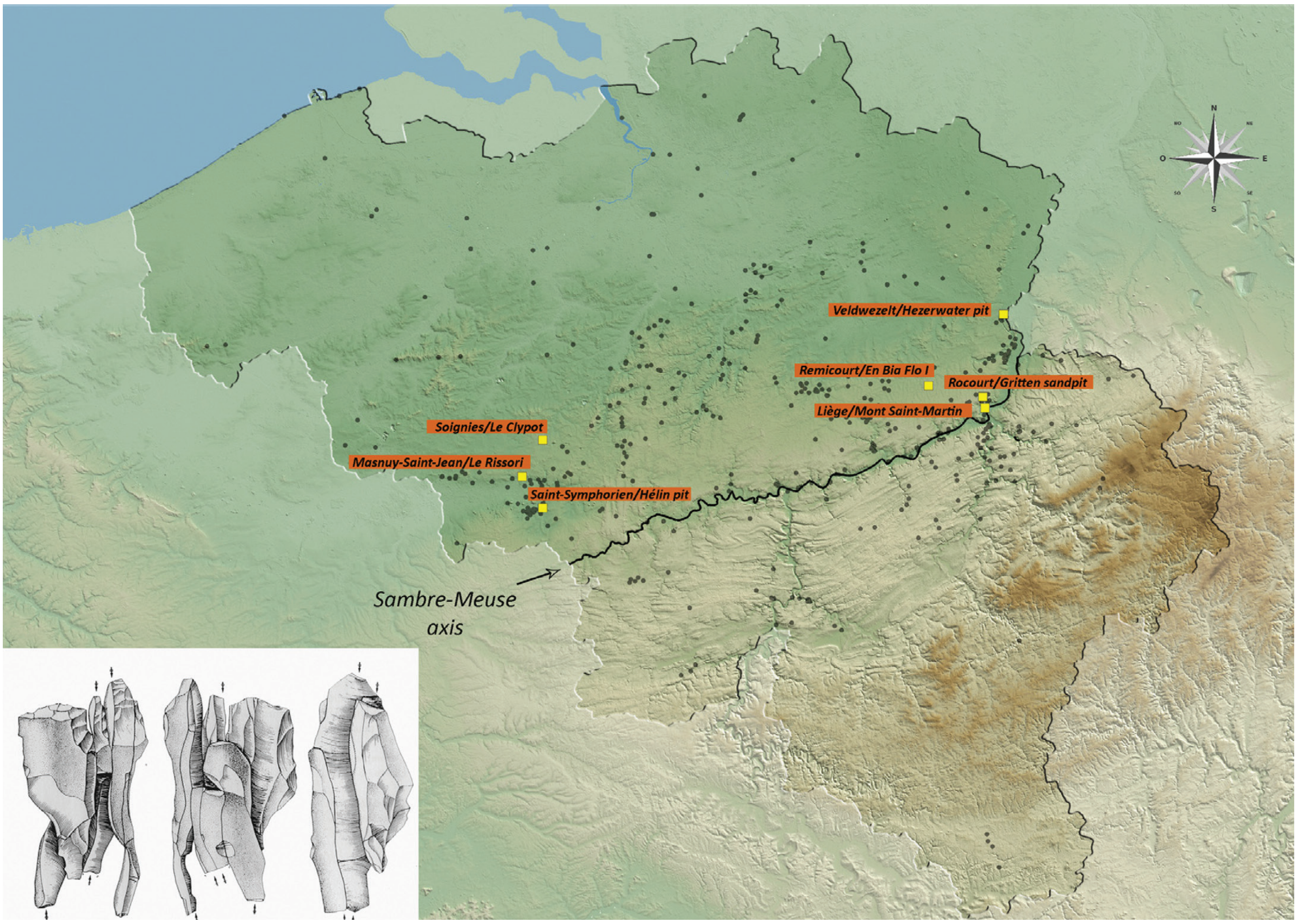

FIGURE 13.. Distribution map of the sites with volumetric blade debitage and refitting from Rocourt (after Haesaerts et al., 2011a).

or to an erosive phase at the beginning of the Lower Pleniglacial (Fig. 14). This is the case in Remicourt/ En Bia Flo I, Veldwezelt/Hezerwater Pit, Liège/ Mont Saint-Martin and Liège/Sainte-Walburge. An artefact of the same dimensions and similar from a techno-typological point of view has been retrieved from Doctor's Cave, but without any reliable context (Ruebens and Di Modica, 2011).

Foliate points with morphological and techno-typological characteristics different from the above-mentioned small foliate pieces have been retrieved from Spy Cave, Doctor's Cave, Engihoul, and Couvin (Ruebens and Di Modica, 2011; Fig. 14). Unfortunately, chronological data are scarce: in Couvin they relate to ca 45 ka uncal BP, while in Spy the conjunction of their geographical position on the cave terrace and radiocarbon dating on faunal remains from the same area (Semal et al., 2013a) suggest they belong to the end of the Middle Palaeolithic and fall in the range of the ^{14}C method.

Keilmesser is documented in Ramioul Cave, Doctor's Cave, Spy Cave and Trou du Sureau (Ruebens and Di Modica, 2011; Fig. 14). Unfortunately, all these caves lack reliable evidence that permits a chronological attribution. Based on typological grounds and comparisons with the German sites of Balve and Buhlen, Ramioul Cave has been proposed to date from the beginning of the Lower Pleniglacial (Jöris, 2002). In Spy Cave, same arguments as those used for the foliate points suggest they relate to the end of the Middle Palaeolithic.

Fäustel have been discovered in several sites, often on sites yielding other bifacial tool types such as in Trou Magrite, Spy Cave, Doctor's Cave and Goyet Cave (Ruebens and Di Modica, 2011; Fig. 14). As these sites represent old excavations, no reliable data concerning the chronological distribution of this tool type exists.

11. Discussion

The quality of the numerous archaeological data related to the Middle Palaeolithic in Belgium is highly variable.

However, the quantity of exploitable data is sufficient to propose a regional synthesis and to contribute to major issues such as: the emergence of the Middle Palaeolithic period, Neandertals ability to adapt to contrasting environmental conditions, aspects of Middle Palaeolithic cultural variability, and the so-called transition with the Upper Palaeolithic.

11.1. The onset of the Middle Palaeolithic: MIS 8 sites

The first evidence of Middle Palaeolithic industries dates from MIS 8, with Mesvin IV and Kesselt/Op de Schans Pit as the two main sites (see x7; Figs. 5 and 6). In Mesvin IV, the lithic industry is characterized by sophisticated prepared-core strategies including the Levallois concept, as well as by a few handaxes. In Kesselt/Op de Schans Pit, the Levallois concept occurs together with simple prepared core strategies and Discoid reduction. None of the 2 sites contain Acheulean type handaxes. These 2 sites indicate that fully Middle Palaeolithic lithic reduction concepts were already mastered at the

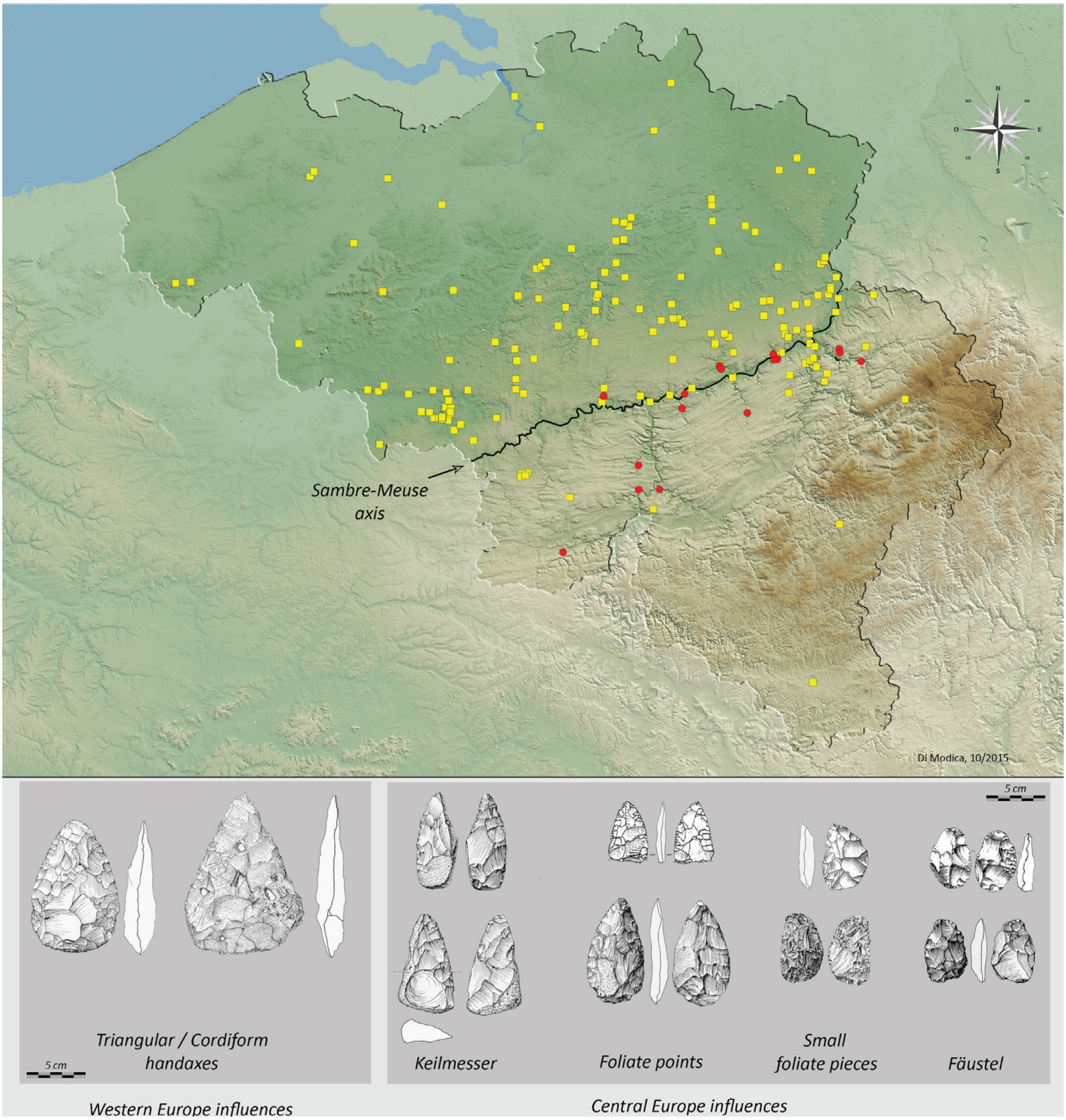

FIGURE 14. Distribution map of the sites containing bifacial tools (red circles: caves; yellow squares: open-air sites) and representative examples of the Bifacial tool variability. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

beginning of MIS 8. Despite discussions and divergent opinions concerning the definition of the Levallois (Boëda, 1990; Chazan, 1997; Guette, 2002; Otte, 1995a; Rolland, 1995; Scott and Ashton, 2011; Van Peer, 1992; White and Ashton, 2003), one might consider Mesvin IV and Kesselt/Op de Schans Pit as being part of a trail of sites with fully Middle Palaeolithic characters during the MIS 8, together with Botany Pit, Salouel, Saint-Valéry-sur-Somme and Ariendorf 1 (Ashton and Scott, 2016; Locht et al., 2016; Richter, 2016). Recent research based on aminostratigraphy however suggested the Maastricht-Belvédère sites relate to MIS 9, which would imply the Levallois concept and sophisticated prepared-core technologies were mastered earlier than MIS 8 (Meijer and Cleveringa, 2009; Roebroeks et al., 2012; Verpoorte et al., 2016).

11.2. Middle Palaeolithic sites from MIS 7 to the MIS 4 desertion

Northwest Europe yielded important sites related to MIS 7, such as Rheindahlen (Richter, 2016), Ebbsfleet or Crayford (Ashton and Scott, 2016), Biache-Saint-Vaast or Etricourt-Manancourt (Locht et al., 2016). In Belgium however, very few data exist for MIS 7, probably because deposits of this age have generally not been explored. Within the Haine Basin, the MIS 7 part of the Mesvin terrace has only been identified in some specific situations (e.g., (Cahen et al., 1979; Di Modica et al., 2014)). Artefacts were recently recovered on the surface of these deposits in a MIS 7/6 transition context (Di Modica et al., 2014). Similarly, in the loess sequences, MIS 7 deposits are rare; this period is mainly recorded as a truncated palaeosoil in sequences in the lower Meuse Valley (Meijs, 2002), with associated artefacts in only two cases (Van Baelen and Ryssaert, 2011). No major site has been found yet.

Data related to MIS 6 are rare in Belgium, with the site of Saint-Symphorien/Hélin Pit (gravel C) being the only one to provide thousands of artefacts probably reflecting repeated human settlements (de Heinzelin, 1959; Figs. 5 and 6). Other limited discoveries in MIS 6 sedimentary contexts in Walou Cave, Harmignies and Veldwezelt/Hezerwater Pit could document human settlements in various environments, including caves (Figs. 5 and 6). These data are in harmony with those from northern France (Locht et al., 2016) and Germany (Richter, 2016) where few sites are documented for that period. On the contrary, Great-Britain lacks evidence of human occupation at least during the glacial maximum of MIS 6 (Ashton and Scott, 2016; Richter, 2016). Researchers have proposed that this region was deserted at that time, due to harsh climatic conditions (Ashton and Lewis, 2002). The scarcity of the data related to this period in continental north-western Europe is probably due to a low human settlement density under full peri-glacial conditions, but issues related to site preservation processes should not be neglected.

While several archaeological data across NW Europe document occupations under the Eemian (Ashton and Scott, 2016; Locht et al., 2016; Richter, 2016), no human activity clearly relates to the MIS 5e in Belgian territory (Figs. 5 and 6). Anyway, the presence of sites in neighbouring areas demonstrates that the hypothesis of a complete desertion by Neandertals under optimal climatic conditions (e.g., (Ashton, 2002; Bringmans, 2006b; Gamble, 1986)) should be rejected (Antoine et al., 2003; Gaudzinski-Windheuser et al., 2014; Gaudzinski-Windheuser and Roebroeks, 2011; Roebroeks et al., 1992; Roebroeks et al., 2011; Roebroeks and Speleers, 2002; Wenzel et al., 2007).

The scarcity of Eemian sites in NW Europe, and their absence in Belgium might be due to the bad preservation of Eemian deposits. In most of the loess sequences as well as in Walou Cave, the top horizon of the Eemian soil has been eroded. Eemian deposits of any other nature, such as tufa formations like in France (Caours; (Antoine et al., 2003)) or lacustrine formations like in Germany (Neumark-Nord 2; (Gaudzinski-Windheuser et al., 2014)) are un-common. Eemian deposits from the bottom of the Flemish Valley (e.g., (Paepe and Vanhoorne, 1967)) might be a place to investigate.

Many Belgian sites are related to the Weichselian Early Glacial. Most of the sites are from an open-air context, with only Scladina and Walou caves attesting to human settlement in a karst context Figs. 5 and 6. Such an abundance of sites has also been noticed in the north of France (Locht et al., 2016), while very few German sites are related to this period (Richter, 2016) and Great Britain seems deprived of human occupation (Ashton and Scott, 2016). No clear evidence exits yet for such differences among regions. Further research is required to decipher if this results from either human settlement density variation across NW Europe, varying site preservation conditions, or even prehistoric research frameworks, with researchers using different chronostratigraphic schemes from one region to another. This last hypothesis might explain e at least partially e a surprising difference between the records from Belgium and northern France. In Belgium, human settlements occur frequently in the stadial contexts of Weichselian Early Glacial, with no occupation clearly attributed to the interstadials (Pirson and Di Modica, 2011; Fig. 5). On the contrary, sites from the North of France are related mainly to the two interstadials while data attributed to the MIS 5d are scarce, and no human settlement is documented for the MIS 5b (Locht and Depaepe, 2011; Locht et al., 2016).

The rigorous conditions of the second half of MIS 4 are probably related to the absence of human occupation in Belgium during that period, between ca 70,000 and the onset of MIS 3, around 60,000 (Figs. 5 and 6). This period corresponds to the first major climatic degradation for the Upper Pleistocene, with the development of a continuous permafrost associated with large ice-wedges. This period is followed by a cold and dry phase during which a first important allochthonous loess cover is recorded (Haesaerts, 1984a; Haesaerts et al., 2016; Haesaerts and Van Vliet, 1973; Pirson et al., 2009b). The same observation has been made for Germany (Richter, 2016) and the north of France (Locht et al., 2016).

11.3. Recolonizing the high latitudes: MIS 3 sites older than 42,000 uncal BP

After the desertion of the northern regions during the second half of MIS 4, NW Europe is settled again during MIS 3. Up to now, the oldest evidence for a recolonization of these latitudes is the site of Beauvais (France, Locht, 2004; Locht et al., 1994; Pirson et al., 2009b), attributed to the end of MIS 4, but with a direct date of ca. 55,000 BP which is also compatible with the onset of MIS 3. In Belgium, human settlements for this period occur both in open-air sites and in caves, but no data currently suggest human settlements older than ca 45,000 BP (Figs. 5 and 6). Dating issues, and more specifically the limit of the radiocarbon method, is probably at least partially responsible for this situation.

11.4. Discussing the transition: MIS 3 sites younger than 42,000 uncal BP

The end of the Middle Palaeolithic period and the so-called Middle-to-Upper Palaeolithic transition is one of the most dis-cussed issues in Prehistoric archaeology (i.e., Discamps et al., 2015; Flas, 2011b; Higham et al., 2014; Hublin, 2015; Roebroeks, 2008).

Radiocarbon dating on Neandertal remains in Spy and Goyet caves (Semal et al., 2013a; Wißing et al., 2016), multidisciplinary approaches for final Middle Palaeolithic assemblages in Walou Cave, Trou de l'Abîme and Scladina Cave (Pirson et al., 2012) as well as critical reviews of archaeological data on some cave sites (e.g., Di Modica et al., 2013; Flas, 2013) provide interesting data related to this volume. Indeed, the archaeological data points to a continuation of Middle Palaeolithic cultures until 40,000–38,000 uncal BP both in Scladina and Walou caves, while the Spy individuals constitute the youngest known Neandertal remains for NW Europe with an age around 36 ka uncal BP (Higham et al., 2014; Semal et al., 2013a). A possible association with the LRJ has been proposed given the very young age of the two adult individuals (Semal et al., 2013a; Semal et al., 2009). However, the radiocarbon dates obtained in Nietoperzowa and Glaston for the LRJ (ca 38,000 uncal BP) are the only reliable dates for that culture (Flas, 2011b). The Spy Neandertals thus postdate both the most recent Middle Palaeolithic settlements and the well-dated LRJ. Therefore, association of these fossils with a specific cultural facies, either Middle Palaeolithic or LRJ, remains unclear (Di Modica et al., 2013; Pirson et al., 2013).

The current estimate for the time of the last Neandertal settlements in Belgium is therefore around 36 ka uncal BP while the earliest Aurignacian settlements in Belgium are dated around 33,000 uncal BP (Flas et al., 2013; Pirson et al., 2012).

11.5. Cave and open-air settlements: a diachronic perspective

For the Middle Pleistocene, the very few Middle Palaeolithic sites discovered do not facilitate the development of a regional pattern relative to the site dispersal and settlement intensity across the territory. Regarding the Upper Pleistocene, some trends can be delineated despite the limited available chronological data. For instance, a comparison can be established between two large periods of occupations, Weichselian Early Glacial and Middle Pleniglacial, which are separated by a hiatus in human presence during part of Lower Pleniglacial (see 7).

During the Early Glacial, 10 out of 13 find-sites are in loess sequences from Middle Belgium, 2 are in caves and 1 in the Flemish valley (Figs. 5 and 6). For the open-air sites, all but Zemst-Bos van Aa and Soignies/Le Clypot Quarry are in environments with easy access to autochthonous flint sources. In the matter of the two cave sites, Scladina is distant from the autochthonous flint sources, while Walou Cave is in a valley where flint is abundant both in autochthonous and allochthonous contexts. Altogether then, 10 of 13 find-sites are in environments with easy access to flint sources, while 3 sites are 6 km (Scladina Cave), 8 km (Soignies/Le Clypot) and >50 km (Zemst/Bos van Aa) away from the closest autochthonous flint sources.

During the Middle Pleniglacial, only 2 out of 10 find-sites are in loess sequences, while 8 are related to a cave (Figs. 5 and 6). The open-air sites of Veldwezelt/Hezerwater Pit and Huccorgne are both located in geological settings characterized by an easy access to autochthonous flint sources. Regarding the cave sites, only Walou Cave benefits by proximity to flint sources. All the other sites are in environments where the distance to the closest autochthonous flint sources range from 6 km (Scladina cave) to 30 km (Trou de l'Abîme). Therefore, open-air settlements are more frequently related to the Weichselian Early Glacial, while most of the cave settlements are related to the Middle Pleniglacial. Historically, a young age has been proposed for human occupation of caves, mainly thanks to techno-typological arguments. A relationship between cave site occupation and cold climatic conditions has been hypothesized (Rutot, 1926; Ulrix-Closset, 1975, 1990). However, this assumption should be qualified as 1) it relies on only 8 cave sites, 2) the antiquity of the excavations in most of the caves prevents any chronostratigraphic and paleoenvironmental analysis, and 3) chronostratigraphic data were mainly obtained by radiocarbon dating, which artificially in-creases the proportion of sites related to the end of the Middle Palaeolithic period. According to present documentation and considering the current limitations, the proposition that caves were frequently used as refuges against the cold climatic conditions of the Middle Pleniglacial cannot be substantiated. Moreover, typological characteristics of the archaeological material together with comparisons to neighbouring regions suggest some early excavation of cave sites yielded material older than the Middle Pleniglacial (Di Modica et al., 2013; Ruebens and Di Modica, 2011).

11.6. Mobility and landscape exploitation

Altogether, data related to lithic industries, pigments and archaeozoological assemblages (cf. 8.2) permit the development of a scheme of resource exploitation and inter-regional variability.

Numerous open-air find-sites are concentrated in Middle Belgium, on plateaus and valleys where Cretaceous chalks are exposed. The same situation can be observed for some cave sites, particularly in the Mehaigne and Vesdre Basins. Even though the influence of other parameters linked to site preservation and history of research should not be neglected, this geographic distribution seems to reflect a preference for areas characterized by good lithic raw material sources: flint nodules and pebbles are available in an autochthonous context on the plateaus as well as on the valley slopes. They are also available in an allochthonous context (sensu Turq, 2005) in both fluviatile gravels and in marine formations.

The type of cortex observed on the artefacts from sites close to good quality flint sources suggests the lithic resources were collected from contexts such as slope or fluvial deposits. Lithic analysis, including refitting, indicates the lithic resources were then completely or incompletely processed at the site. The average size of the nucleus and the techno-morphological characteristics of the flakes indicate a great degree of standardization of the lithic tool production according to specific concepts (mainly Levallois, Discoid and Volumetric blade debitage) and an abandonment of the nucleus before complete exhaustion (Fig. 15). In such cases, no constraints (availability, blank morphology) limit the stone tool production and the quality of the produced tools prevails over the frugal conservation of raw material.

Activities, in these regions at least, concerned lithic resource exploitation. However, the scarcity of the faunal data in open-air sites due to taphonomic factors, together with the poor conservation of the faunal collections from old excavations, prevent the appreciation of the full range of activities performed in these find-sites. As indicated by the sites of Remicourt/En Bia Flo I and Walou Cave (CV-2 and CI-8), sites located close to good quality flint sources were not oriented exclusively toward lithic resource exploitation but were also places where other activities occurred such as fire production, woodworking, butchery, bone tool utilization or food consumption.

Other find-sites, either in caves or in open-air are away from the Cretaceous outcrops, with a distance reaching up to 50 km (e.g., Zemst/Bos van Aa). where, good quality flint nodules are absent and the only exploitable raw materials consist mainly of Carboniferous chert and limestones, Devonian sandstones, and river pebbles (quartz, quartzite and sometimes even flint) where good quality flint was transported from the source to the site and/or locally available raw materials were used (Fig. 11); no link can be established between the settlements and the presence of good quality flint sources.

The examination of the cortex indicates that secondary contexts such as slope or fluvial deposits were favoured for flint collection before its transportation to the site. The flint was brought to the site sometimes as rough nodules (Scladina Cave, archaeological assemblage 5), but also as nuclei and flakes (Soignies/Le Clypot, Trou du Diable). This evidence indicates a planned mobility of populations bringing lithic resources required for their activities from one region to another where its absence was known. Once at the site, the reduction processes were adapted to the shape of the blanks and aimed at maximizing the tool production at the expense of the tool standardization. Aside from the use of im-ported flint, locally available raw materials were also exploited for stone tool production (Fig. 15). In some cases, small flint pebbles were available in the area surrounding the site and were used preferentially. In other cases, flint pebbles were not available and other raw materials such as phtanite, sandstone, quartz, and quartzite were used.

For the archaeological assemblage 5 from Scladina Cave, re-searchers proposed (Bonjean and Otte, 2004) that the use of multiple raw materials would be related to a functional complementarity for quartz, quartzite, chert and flint. In such a scenario, each raw material would have been selected for its own mechanical or physical properties and would have been used for specific functions (Bonjean and Otte, 2004). Although the functional complementarity hypothesis cannot be totally rejected, the exploitation of quartz, quartzite and chert only occurs south of the Sambre-Meuse axis. By contrast, Cretaceous flint has been used in all kinds of environments, implying transportation strategies to the sites where flint sources are not available (Fig. 11). If raw materials other than flint had been selected for their own properties, Neanderthals might have employed transportation strategies for these raw materials to sites where they were naturally missing, just as they did for flint (Di Modica, 2010).

Investigators should consider that gathering and processing of non-flint raw materials for stone tools production is not the reason for settlement away from flint sources. Other hypotheses can be advanced, such as the use of caves as shelters, the attractiveness of deep and narrow valleys in Upper Belgium, the exploitation of specific mineral resources, easier access to certain organic resources, or even cultural reasons. Each of these hypotheses is not exclusive, and multiple motivations might explain human settlements distant from autochthonous flint sources.

Apart from those originating from the lithic industries, data related to site function(s) in environments distant from Cretaceous outcrops are not numerous. In Scladina Cave, Trou du Diable and Trou de l'Abîme, archaeozoological data indicates a broad range of activities, including fire production, butchery, bone tool production and utilization (see 8.2.2). Other data, such as dental calculus analysis of teeth from the Spy Cave Neandertal adults (Henry et al., 2011) and micro-wear analysis of some Mousterian points from Spy Cave (Jungels et al., 2013) indicated plant and animal consumption in cave sites. Finally, the black pigment retrieved from Scladina Cave (see 8.2.3) indicates the area of Franquenies e far from flint sources e was prospected at least for collecting this mineral pigment.

Altogether, these elements suggest a complementary occupation of contrasting environments with a circulation from one region to another according to need, either for lithic resources or for plant and faunal resources. Some movements are easily traceable thanks to flint transportation evidence as well as to the black pigment recovered from the archaeological assemblage 1A of Scladina Cave. Strontium analyses have been performed on Belgian Neandertals (from Walou, Scladina and Engis caves) and might provide useful data in this discussion. However, the results have just been published (Verna and Toussaint, 2014).

11.7. Cultural variability

Numerous facies have been described among the European Middle Palaeolithic. These facies contributed to the definition of various cultural groups (i.e., Bordes and Bourgon, 1951; Bosinski, 1967; Ulrix-Closset, 1975). The validity of these groups as well as their cultural meaning and chronological distribution have

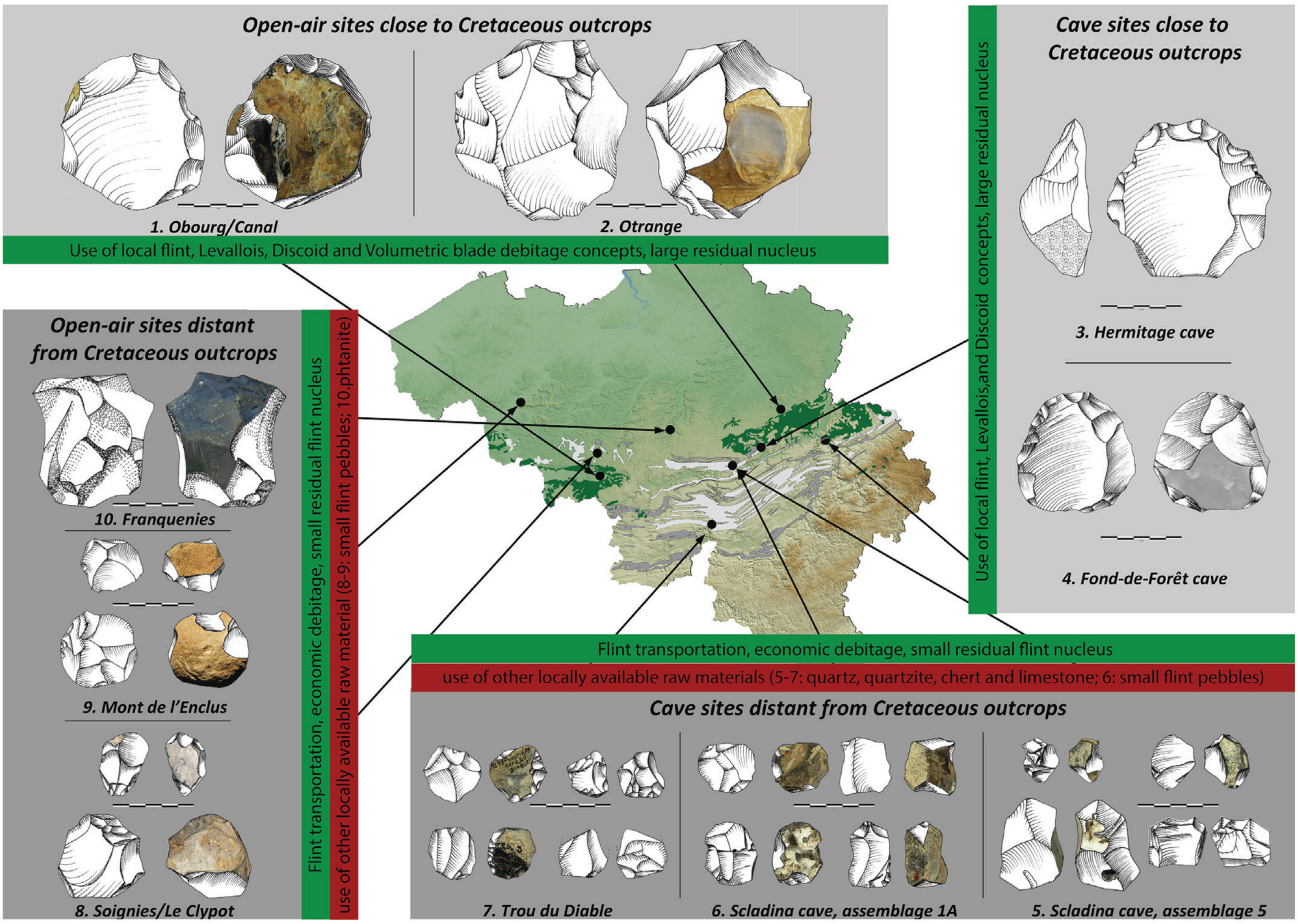

FIGURE 15. Variability of lithic production according to their geographic distribution.

been debated since their definition. Some of them have been repudiated as chrono-cultural entities (Depaepe and Goval, 2012; Richter, 2016), while some others seem to be more convincing (i.e., Bourguignon, 1997; Soressi, 2002; Thiébaut, 2005). In Belgium, only the bifacial productions potentially reflect cultural trends: they occur in both open-air and cave sites, they seem to be independent from the lithic raw material acquisition systems, and they are comparable with productions occurring in neighbouring regions.

Continentally speaking, the differences in Middle Palaeolithic bifacial production has been observed for a long time. In Western Europe MTA traditions have been recognized, while Central and Eastern Europe are characterized by Micoquian traditions (i.e., Otte, 1995b, 2001). In Belgium, the two traditions occur: some sites related to MIS 5 and MIS 3 yielded MTA handaxes while other undated sites yielded Keilmesser and Fäustel related to the Micoquian or Keilmessergruppen (Fig. 14). Therefore, the Belgian territory appears to lie at the boundary of the two cultural complexes (Otte, 2001). A recent proposal suggests that some archaeological assemblages reflect a mix of the two, resulting in a "MTB" (Ruebens, 2013). However, no Belgian site supports this hypothesis as no secure archaeological assemblages clearly show the coexistence of Keilmesser and MTA handaxe or contain "intermediate" types.

The Volumetric blade debitage attested to by multiple Weichselian Early Glacial open-air sites in Belgium, Germany and north-ern France has been referred to as a "Technocomplexe du Nord-Ouest" (Depaepe, 2007) and might also represent cultural trends as its extent is geographically and chronologically limited. However, contrary to the bifacial tools production, this debitage concept occurs only in sites with an easy access to good flint sources (Fig. 13).

12. Conclusion

The richness of the Middle Palaeolithic documentation in Belgium is linked to the number of find-sites spread across the whole territory, but also to the variety of data represented and its distribution in various settings such as caves, alluvial contexts, and loess sequences. In addition, hundreds of lithic assemblages, a rich palaeontological and archaeozoological documentation is represented and numerous Neandertal remains have been found. How-ever, this dataset suffered from a long tradition of research, with most of the cave and open-air sites investigated during the 19th Century. Fortunately, several sites were excavated over the last 30 years, and therefore benefited from modern and multidisciplinary approaches. These projects allow more detailed studies concerning site formation processes, archaeological assemblages, paleoenvironmental reconstructions and chronological attribution, leading to a better understanding of human behaviour. These mod-ern results also shed a new light on the old collections by illustrating the likely complexity of the situation prior to the early excavations and the stark contrast of present documentation to the simplistic records of the past. Critical reanalyses performed on historic collections however demonstrated the great potential for reassessment, particularly in relation to the anthropological re-mains. The re-examination leads to a better understanding of archaeological and anthropological vestiges, including their context and their dating. Re-examination of sites still offers promise for information recovery.

Altogether, this large amount of data permits the development a chronostratigraphic framework for the Middle Palaeolithic occupation in the territory of Belgian from the MIS 8 to the MIS 3 and indicates sites are particularly related to two periods: the Weichselian Early Glacial and the Middle Pleniglacial. The significance of this overrepresentation for these two periods still must be discussed in a wider context, with data from the neighbouring areas. Of particular interest is the number of sites related to the MIS 3, with both archaeological assemblages and Neandertal remains. These contribute to the Middle to Upper Palaeolithic transition, as notably illustrated by the discussion on the Spy radiocarbon dating in the framework of the Middle to Upper Palaeolithic transition (Discamps et al., 2015; Higham et al., 2014; Semal et al., 2013a).

The archaeological documentation also reveals a close link between Neandertal behaviour and the mosaic character of the Belgian landscape. The variation between lithic industries appears to be partly related to the availability of good lithic raw material sources. The proximity of some find-sites to good flint sources and the distance of others from flint sources allows researchers to identify land-use management strategies and to sketch mobility patterns from one region to another. This resource management system combined transportation of raw materials and exploitation of the local environments which suggest rapid movements from one area to another with the goal of exploiting the natural resources from these contrasting environments.

Besides this environmental-related variability, the dataset also reveals other factors influencing the archaeological assemblage composition, such as site function and cultural aspects. If the first one is very difficult to decipher given the scarcity of the valuable documentation, the second one is clearly illustrated by the presence in Belgium of bifacial production related to distinct continental-scale cultural units.

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