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Upper Pleistocene loess-palaeosol records from Northern France in the European context: Environmental background and dating of the Middle Palaeolithic

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ABSTRACT

In Northern France the loess cover from the Last glacial (Weichselian) is represented by a semi-continuous mantle up to 8 m in thickness in the best localities such as leeward slopes (E–NE expositions). In this large area, pedostratigraphic sequences from the last Interglacial-glacial cycle (Eemian-Weichselian) have been intensively studied, especially under the auspices of active rescue archaeological programmes that have provided hundreds of individual sequences from test-pits or excavations. In spite of variations in the thickness of the different stratigraphic units, driven by differences in geomorphological contexts, the pedostratigraphic sequences from the last Interglacial-glacial cycle exhibit a particularly constant pedosedimentary pattern, including well-identified pedological and periglacial marker horizons that can be followed towards the East in Belgium, in Germany and even in Central Europe. According to the newest data, it is shown that northern France loess-palaeosol sequences are well suited to record the response of Western European environments to rapid climatic changes (Dansgaard–Oeschger cycles). The main objective of this paper is to present a summary of the pedostratigraphic sequence from Northern France, supplemented by the data from the new reference sequence of Havrincourt and a global correlation scheme with surrounding areas. In Northern France, the synthesis of the observations carried out on ca. 100 sequences during the last 20 years allows the establishment of a highly detailed pedostratigraphic and chronostratigraphic scheme that represents a unique database for the discussion of the relations between Palaeolithic occupation and environment. In this context, a strong relationship between the intensity of human occupation and the climatic and environmental context is demonstrated. This relationship appears to be conditioned by the relative abundance of large mammal fauna, itself linked to vegetation density, as indicated by the extremely sparse biomass and the *hiatus* in human occupation that characterise *Upper Pleniglacial* loess.

1. Introduction

The great European plain Loess Belt is the most extensive and continuous continental archive of the Last Glacial period in Europe (Frechen et al., 2003; Haase et al., 2007; Antoine et al., 2009.). Located downwind of the North Atlantic Ocean and south of the Fenno-Scandinavian ice sheet, the western part of this great periglacial plain was ideally situated to record the impact of climatic fluctuations of the North Atlantic region during the period (Fig. 1).

In this area, the loess sequences from the last climatic cycle (Eemian – Weichselian) are the most important and best preserved, reaching an average thickness of 4–8 m from North-Western France (Brittany) to Belgium and Western Germany. They also show much more pronounced stratigraphic contrasts

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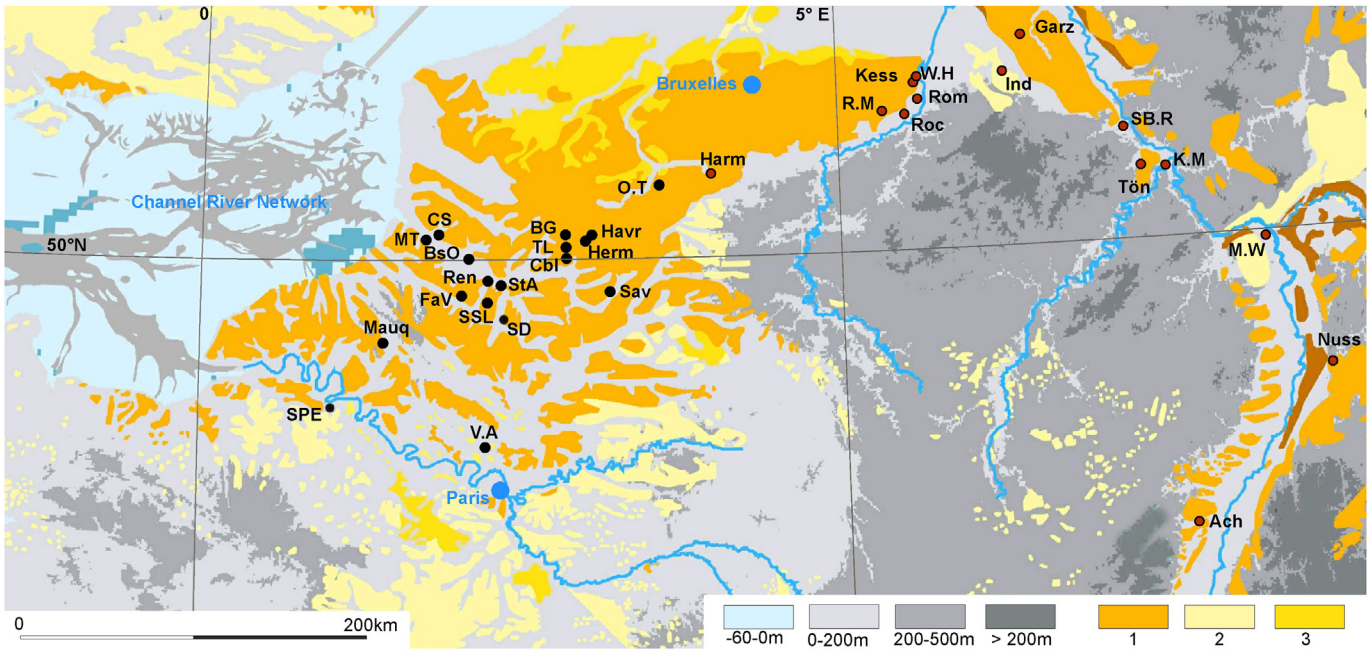

Fig. 1. Location of the study area in a palaeogeographic map of Western Europe during the Last Glacial Maximum (according to Antoine et al., 2013, modified). 1) Loess (>2 m). 2) loess (<2 m). 3) Sandy loess. Sites: SPE: Saint-Pierre-lès-Elbeuf, V.A-Villiers-Adam, Mauq: Mauquenchy, SD: Sourdon, SSL: Saint-Sauflieu, FaV: Fresnoy-au-Val, StA: Saint-Acheul, RNC: Renancourt, BsO: Bettencourt-Saint-Ouen, MT: Mautort, CS: Caours, Sav: Savy, Cbl: Combles-TGV, TL: Transloy-TGV, BG: Beugnâtre, Herm: Hermies, Havr: Havrincourt, O.T: Onnaing-Toyota, Harm: Harmignies, Rom: Romont, Kess: Kesselt, Roc: Rocourt, R.M: Remicourt-Momale, W-H: Veldwezelt-Hezerwater Garz: Garzweiller, Ind: Inden, SB.R: Schwalbenberg-Remagen, T.B: Tönchesberg, M.W: Mainz-Weisenau, K.M.: Koblenz-Metternich, Nuss: Nussloch, Ach: Achenheim.

than those from continental Central Europe (most diversified soils) and locally exhibit very rich records, such as in the Rhine Valley at Nussloch (40 units/18 m, Antoine et al., 2001, 2002) or Schwalbenberg II (13 m, ±40 units/Schirmer, 2011; Frechen and Schirmer, 2011). On the other hand, even in the best contexts, these loess sequences are definitely not continuous, since they include numerous hiatuses, the duration of which can reach several thousands of years.

Within this large geographical area, numerous studies over the past three decades have focused on pedostratigraphic approaches (Sommé et al., 1980, 1986; Lautridou et al., 1985; Haesaerts et al., 1981, 1999; Haesaerts and Mestdagh, 2000; Rousseau et al., 1998; Frechen, 1999; Juvigné et al., 1996; Antoine, 1989, 1991; Antoine et al., 1998, 1999, 2001, 2003a,b,c; Schirmer, 2000a,b; Meijs, 2002, 2011; Meszner et al., 2011; Terhorst et al., 2014, 2015). Meanwhile, major methodological developments in the field of geochronology (luminescence, ^{14}C on loess organic matter) allowed a gradual improvement in the detailed chronology of the sequences (Zöller et al., 1988; Zöller and Wagner, 1990; Van den Haute et al., 1998; Hatté et al., 1999, 2001; Frechen et al., 2001, 2003; Lang et al., 2003; Fuchs et al., 2007, 2013; Tissoux et al., 2009; Frechen and Schirmer, 2011; Novothny et al., 2011; Schmidt et al., 2011; Kreutzer et al., 2012). However, significant error bars, inherent to the various methods of luminescence dating, and the problems of accuracy of the ages (inversions, major underestimations) do not always lead to consistent chronostratigraphic schemes. They also make the correlations with the scale of rapid (millennial) climatic events very difficult.

Finally, since the mid-1990s, the identification of abrupt climatic changes in the Greenland ice cores (Dansgaard et al., 1993; NGRIP; Members, 2004; Blockley et al., 2012) has generated a major research effort focused on their record in sedimentary archives and the clarification of their impact on the European continental environments (Sánchez Goñi et al., 1999, 2002, 2008; Müller et al., 2003; Desprat et al., 2007; Seelos et al., 2009; Boch et al., 2011; Heiri et al., 2014; Moreno et al., 2014). In this context, investigations based on multi-proxy analysis and continuous high-resolution sampling have been developed on the loess sequences where sedimentation rates were the highest, such as in Nussloch in Germany (Antoine et al., 2001, 2009; Gocke et al., 2014). The research on the impact of rapid climate changes on loess sequences, as well as those in archaeological context (Haesaerts et al., 2003, 2009), led to the identification of the extreme sensitivity of European periglacial environments to millennial climatic cycles (Hatté et al., 1998; Vandenberghe et al., 1998; Antoine et al., 2001, 2009; Moine et al., 2002, 2008; Rousseau et al., 2002; Haesaerts et al., 2010). On the basis of correlations between changes in loess particle-size parameters and dust content in Greenland ice cores, the existence of a strong connection between the aeolian dynamics of North Atlantic high latitudes and Western Europe, via atmospheric circulation, has been proposed (Rousseau et al., 2007; Antoine et al., 2009; Sima et al., 2009).

Meanwhile, in northern France, research in rescue archaeology experienced an unprecedented expansion in connection with the implementation of major building works and the rapid development of a national research structure dedicated to rescue archaeology (INRAP). This context has supported an active research process involving specialists in Quaternary geology, palaeontology, dating and prehistoric archaeology (Locht et al., 2014a,b, 2015; Antoine and Locht, 2014; Antoine et al., 2014b).

This work has resulted in the discovery of a very large number of *in situ* Palaeolithic sites in loess context, particularly for the Middle Palaeolithic (Locht et al., 2002, 2003, 2006, 2013, 2014a,b; Antoine et al., 2003b, c; Locht, 2008; Goval et al., 2014; Hérisson et al., 2014). The results currently represent a unique database for the last climatic cycle in Europe (Locht et al., 2014a).

In this context, this article aims to provide an overview on the pedo-sedimentary budget of the last climatic cycle in the North

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