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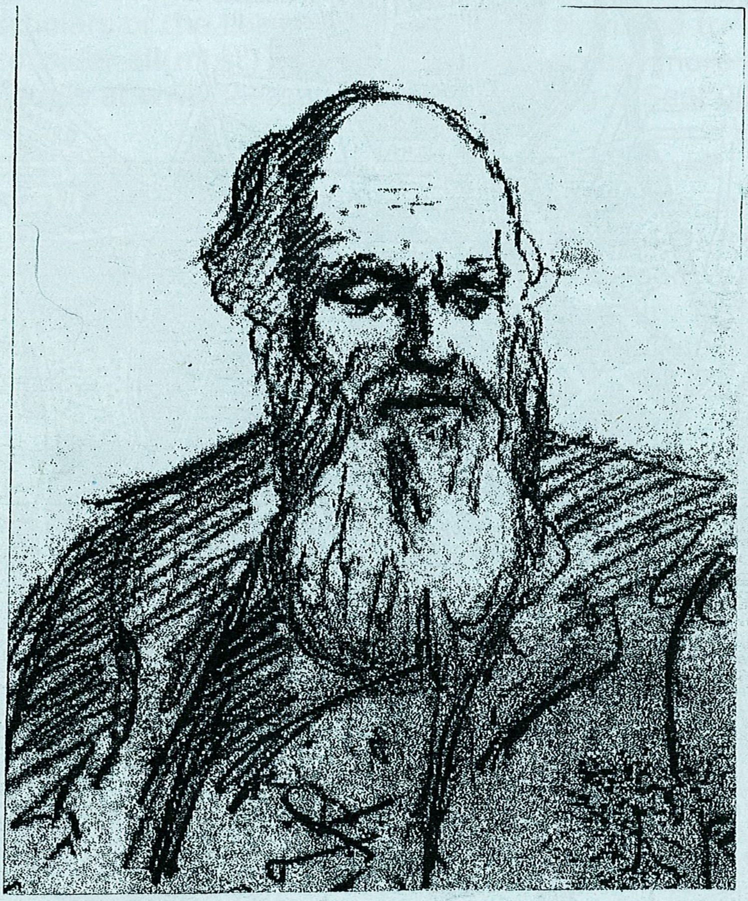
LOESS LETTER 62

An INQUA Newsletter for Students of Loess Material, Loess Deposits, Loess Ground, Loess Soils & Loess as a 'Climate Register'. Founded in 1979 at the New Zealand Soil Bureau.



LoessFest 2009 Novi Sad
30 August- 3 September

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Leicester *(continued).*

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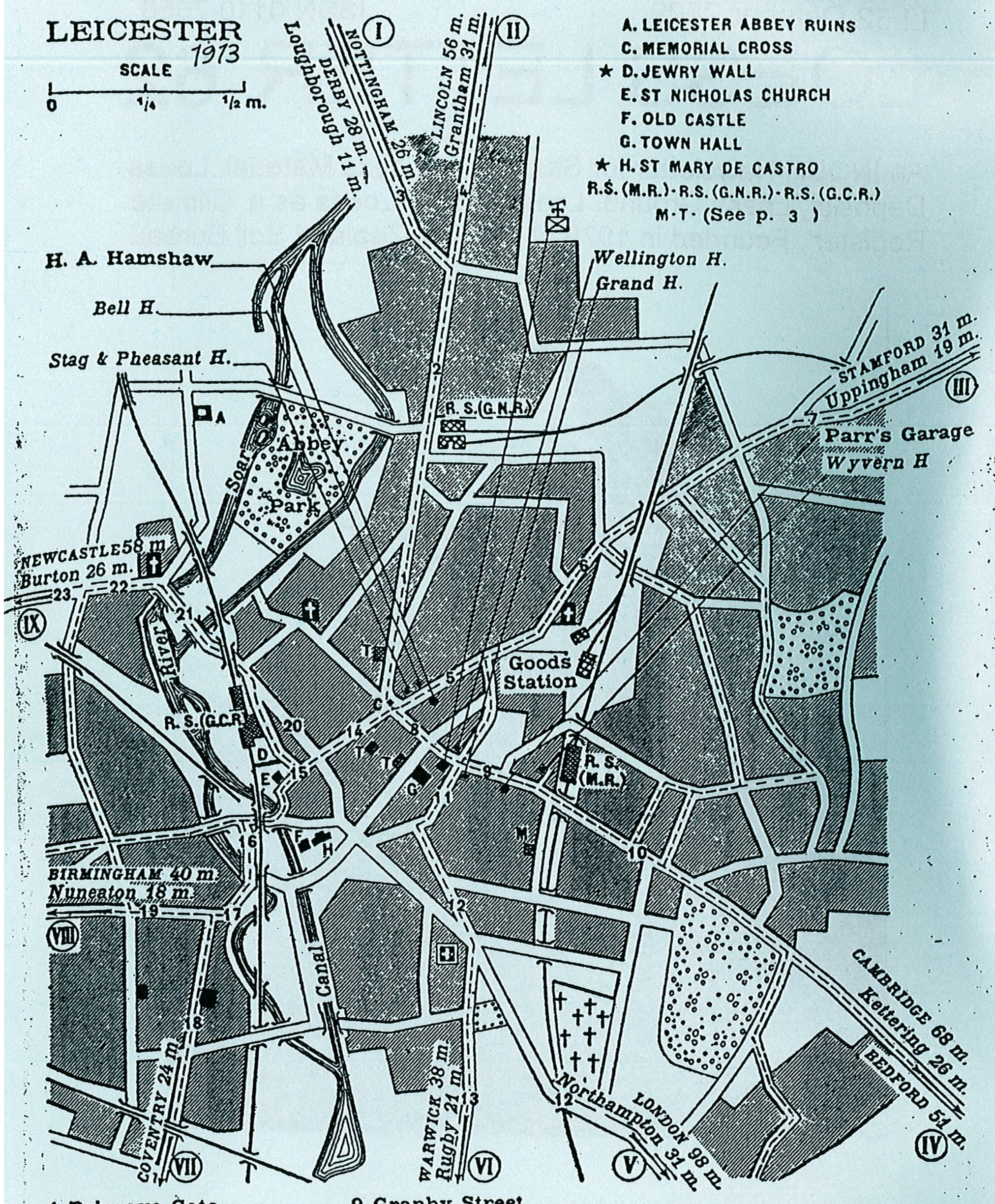
Syston 5, **Melton Mowbray** ⊕ 15, Waltham 20, **Grantham** ⊕ 31, **Lincoln** ⊕ 56 (*v. gd. rd. hilly, 1/12 desc. at 54 m.*).



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Loess Letter LL62 October 2009

LoessFest 2009. Ten years after LoessFest 1999 LL celebrates another LoessFest- this time in Novi Sad (the first one was in Heidelberg & Bonn). The scholars of the Loess World gather in Novi Sad to consider all(most) aspects of Loess. (access more details at www.loessandust.org).[30 Aug-3 Sept'09]

QI. Quaternary International- an INQUA journal which publishes papers on Loess- many papers on Loess. LL62 is the QI issue; we congratulate QI for publishing so many excellent Loess papers and demonstrating the health of loess scholarship. We direct your attention to three recent QI Loess special issues:

Loess & Palaeoenvironments across Eurasia; dedicated to the memory of Marton Pecsi. Ed. A.A.Velichko, A.E.Dodonov, N.R.Catto. QI 152/153, pp. 1-201, Aug/Sept. 2006.

Lower Latitudes Loess- Dust Transport Past & Present. Ed. Ludwig Zoeller, Dominik Faust. QI 196, pp. 1-160. 1 March 2009.

Loess in the Danube region and surrounding loess provinces: The Marsigli memorial volume. Ed. S.B.Markovic, I.J.Smalley, U.Hambach, P.Antoine. QI 198, pp.1-254, 1 April 2009.

In LL62 we focus on the Danubian volume and, in best Current Contents tradition, reproduce all the abstracts (to be appreciated by the delegates at LoessFest 2009- in Novi Sad in the heart of the Danubian loess lands).

Crayford Brickearths. You may remember that in LL12 there was an article on the Crayford Brickearths, some loess like deposits near the River Cray, south of the Thames – but more in Erith than in Crayford. Not an impressive deposit, but in England small loess is appreciated. Now we revisit the Crayford Brickearths via a piece reproduced from Quaternary Newsletter; it is encouraging to see attention being given to the Crayford Brickearths again.

Loess Letter. LL is a newsletter of the INQUA Loess & Dust Community –for students of loess & dust. It is published twice a year by the Giotto Loess Research Group at Nottingham Trent University (editor: ian.smalley@ntu.ac.uk). **Loess Letter Online** can be accessed at www.loessletter.co.uk; LLO contains an amazing definition of loess, and some interesting thoughts on the Danubian Loess Project 2000-2025, and the diagrammatic history of loess.

Covers/Figures. The front cover is Charles Darwin because we are still in the Year of Darwin, and we promised to put Darwin material in LL61 and LL62. The back cover is the mature Karl Caesar von Leonhard. The most commonly encountered picture

of KCvL is of him in his youth- here is an older version, taken from the Neues Jahrbuch Festband which was published in 1907. The Festband marked the centenary of the journal established by KCvL- the first real earth science journal. KCvl did other things besides naming Loess. Maps inside the covers come from a 1913 Michelin Handbook which turned up at the LL office; the Handbook also supplied the advert. for baggy trousers- ideal for fieldwork in brickpits. The LLO Partial History of Loess is also reproduced in LL62.

INQUA. The International Union for Quaternary Research (www.inqua.tcd.ie). The next INQUA Congress (18th) will be at Bern in Switzerland in 2011- details on INQUA website. Note to all concerned- 18 is XVIII not XXVIII; the topic is 'Quaternary & Mountains'. LL heard a rumour about a Loess excursion heading east- starting in Nussloch.

A man from Bendery. Lev Semenovich Berg (1876-1950) was born in Bendery (also Bender, also Tighina) in Bessarabia (now Moldova). From 1940 to 1950 he was President of the USSR All-Union Geographical Society, but his lasting fame is as an ichthyologist – and he was also interested in geology and soil science and climatology and limnology and palaeogeography and geobotany and zoogeography and ethnography and the history of geography- AND the problem of loess formation. That's why he gets a mention in an issue of LL devoted to Central European loess- he was a Central European loess person. LL is interested in L.S.Berg, and the influences which shaped his loessic opinions.

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Quaternary International 198 (2009) 5–6

Editorial

Loess in the Danube region and surrounding loess provinces: The Marsigli memorial volume

This special issue of *Quaternary International* is a ›llection of papers contributed to the Danube Loess ymposium held in Novi Sad, Serbia, from 29 September › 2 October 2006, organised by the INQUA Loess ıbcommission and the University of Novi Sad. The ›anube loess symposium celebrated the 280th anniversary f the publication of the first scientific description of uropean loess–palaeosols by Luigi Fernando Marsigli 726).

This editorial highlights the importance of our Danube ›ess belt to loess research in Europe, beginning with the ork of Luigi Ferdinando Marsigli. During the last decade f the 17th century, Marsigli was employed to survey the oundaries between the Turkish and Austrian Empires. As high officer of the Austrian army he spent a lot of time in ıe Petrovaradin, Titel and Stari Slankamen fortresses ›ery close to significant loess deposits). An Italian soldier ıd scientist, at the same time as he worked at his military ıties he was able to investigate loess–palaeosol exposures tuated close to the fortifications. Noticeable loess–alaeosol exposures along the Danube river valley were rawn by Marsigli in his outstanding six volume book ›anubius Pannonico Mysicus (1726). Count Marsigli described the lithology of the loess banks of the Danube river showing respectively, modern soil (marked as A in Fig. 1) as *Terra fructifera pinguis nigra et creatacea* (black fertile carbonate soil), palaeosol (B) as *Terra nigra fructifera pinguis* (black fertile soil) and between them loess layer (C) as *Terra lutosa cinerive et in fragmento creatacea priabilis* (yellow-cinerary/ashy layer with carbonate fragments, i.e. concretions; Fig. 1). To summarise, it is evident that many sedimentological characteristics of loess–palaeosol sequences as recognised by Marsigli remain valid to this day (Marković et al., 2004).

The observations of Marsigli were not appreciated by his contemporaries. There was no intellectual structure available within which they could be placed and developed. Serious scientific investigations in the Danube basin began in the 19th century, but it was not until the 1960s that an organised and comprehensive programme of research came into being. During the 1960s Julius Fink of the University of Vienna was inventing and organising the INQUA Loess Commission and a large part of the work of this Commission was focussed in the Danube basin. Fink wished to assemble a stratigraphy for all of Europe, as this was a major aim of the Loess Commission, and he gathered

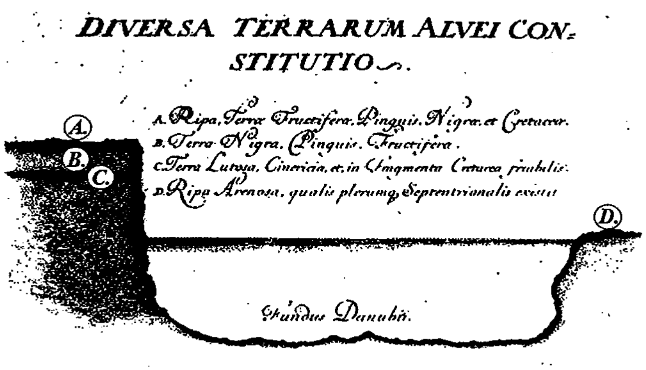

Fig. 1. Description of loess–palaeosol occurrences in the bank of the Danube river (Marsigli, 1726, modified).

ı:10.1016/j.quaint.2009.02.001

a large multi-national team to carry out comprehensive stratigraphical investigations. When he set out the plan (Fink, 1969) over 100 sites were indicated, and 28 of these were in the Danube region. The work reported in this special volume is essentially a continuation of the programmes initiated by Fink, and we gratefully acknowledge this. Some details of the work of the Loess Commission can be found in Smalley et al. (2001) and on the website www.loessandust.org.

Marsigli's observations of loess–palaeosol sequences were published one century before the pioneering work of von Leonhard (1823/1824) about the characterisation of loess deposits (Smalley et al., 2001; Zoeller and Semmel, 2001). Ever since the initial studies of Marsigli, loess research around the world has become established as one of the most promising tools for the understanding of Quaternary palaeoclimatic evolution. At the Danube loess symposium there was participation by loess researchers from 11 countries. There were contributions related to Austrian, Belgian, Croatian, Hungarian, Iranian, Polish, Romanian, Russian Serbian, and Ukrainian loess and loess-like sediments, as well as two conceptual papers about the relations between large rivers (e.g. the Danube) and loess, and about European dust and the contribution of African material. As indicated by the contributions in this volume, the field of Danubian loess research has a remarkable past, and a very promising future.

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Marsigli, L.F., 1726. Danubius Pannonico Mysicus; Observationibis Geographicis, Astronomicis, Hydrographicis, Physicis; perlustratus. Grosse, P., Alberts, Chr., de Hoodt, P., Herm. Uytwert and Franc Changuion; The Hague and Amsterdam.

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Zoeller, L., Semmel, A., 2001. 175 years of loess research in Germany—long records and 'unconformities'. Earth Science Reviews 54, 19–28.

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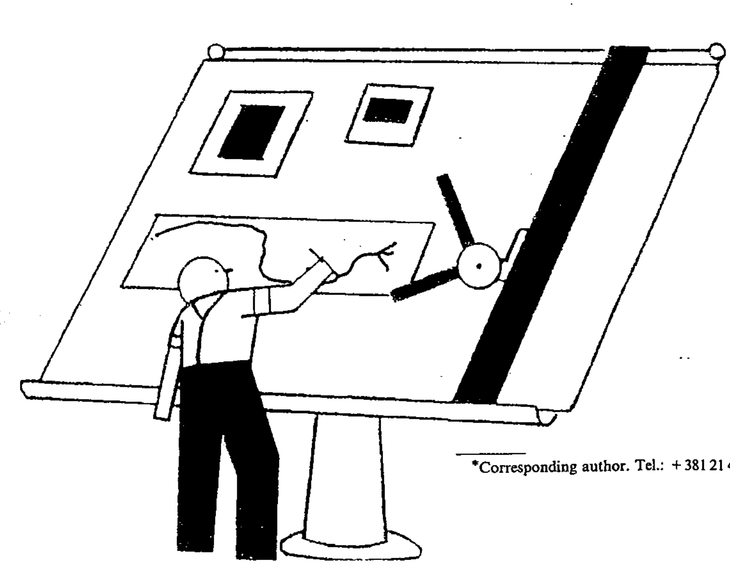

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Quaternary International 198 (2009) 7–18

INQUA 1928

Rivers and loess: The significance of long river transportation in the complex event-sequence approach to loess deposit formation

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Available online 15 July 2008

Abstract

Rivers are essential for loess deposit formation. River systems which relate directly to loess deposit formation include the Danube and :he Rhine; the Mississippi and the Missouri; the Thames and the Medway; the Indus, Ganges and Brahmaputra; the Dnepr, Don and Volga; the Clutha, Mataura and Rakaia—New Zealand rivers; the Yellow River; rivers in South America; Siberian rivers (flowing north); the Odra and the Wisla (between the mountains and the ice); the Syr-Darya and Amu-Darya (into the desert).

The contention is that rivers are not just important in major loess deposit formation, they are mandatory (necessary, imperative, obligatory, essential, indispensable, requisite). For a complete and satisfactory study of a loess deposit, we need to know how the material is produced; how it is transported and distributed across the landscape; how intermediate deposits are formed; how transportation provides the defining properties (i.e., open structure, collapsibility, draping across the landscape); and what may happen post-deposition (e.g., chernozemisation, fragipan formation, increased collapsibility, etc.).

If rivers are essential then it would appear that the British loess is probably Alpine material delivered by the proto-Rhine and the Polish loess is not derived from the ice-sheet to the north but from the mountains to the south. The lack of loess in Canada is explained by the absence of suitable rivers. The loess in Russia and neighbouring countries can be classified (as Jefferson et al. [Jefferson, I.F., Evstatiev, D., Karastenev, D., Mavlyanova, N.G., Smalley, I.J., 2003b. The engineering geology of loess and loess-like deposits: a commentary on the Russian literature. Engineering Geology 68, 333–351] suggested) on the basis of associated rivers. A 'new' deposit of glacial loess is recognised—associated with the Dnepr, Don and Volga rivers (the USWR loess). The Smalley–Leach [Smalley, I.J., Leach, J.A., 1978. The origin and distribution of the loess in the Danube basin and associated regions of East-Central Europe: a review. Sedimentary Geology 21, 1–26. Available from: ⟨www.geo.edu.ro/sgr/mod/downloads/PDF/Smalley-SedGeo-1978.pdf⟩] vision of the loess in the Danube basin and East-Central Europe is probably misconceived. They assigned a great significance to glacial action and put loess in a 'northern band'. It appears that this proposed glacial influence is minimal and that the Danube loess is essentially mountain loess—derived from the Alps, the Carpathians, the Sudeten mountains and other high regions. The Danube system is a classic example of a river controlling loess distribution.

1. Introduction

The formation of a loess deposit is a complex process, or even a complex series of processes. Material has to be formed—a source of silt is required; and this silt has to be transported, and eventually aeolian deposition has to occur to give to loess its characteristic properties. The story can be continued as loess ground participates in chernozemisation processes or is involved in fragipan formation or possibly takes on more collapsibility. Loess is a sediment, but it is also a geomorphological entity covering the landscape, and it is of course, latterly a record of climatic and environmental change during Quaternary times and

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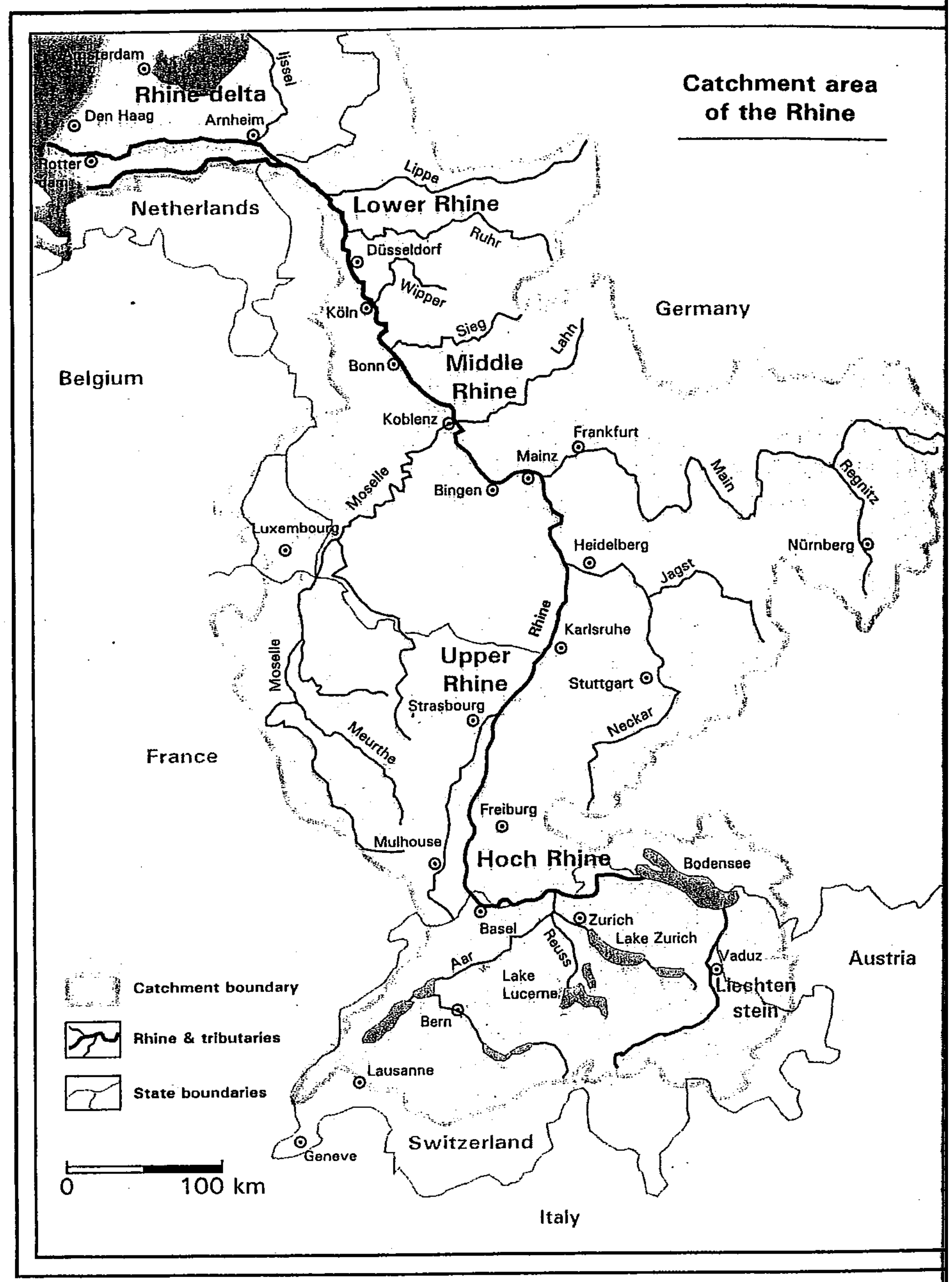

chment area of the Rhine (see Hill, 2005; Lang et al., 2003): map redrawn and modified after Deutsche Komm

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Quaternary International 198 (2009) 19–36

High-resolution record of the last climatic cycle in the southern Carpathian Basin (Surduk, Vojvodina, Serbia)

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Available online 7 January 2009

ɔstract

High-resolution study of the Surduk loess palaeosols sequence in Serbia (Vojvodina) has been performed within a research project .OLE) focusing on the impact of rapid climatic changes during the last climatic cycle in the European loess belt. The methodology used r this multidisciplinary approach is based on a continuous sampling column that allows a very accurate correlation between all studied oxies (magnetic susceptibility, grain size and organic carbon) and the dated samples (IRSL, ^{14}C). According to the stratigraphical and dimentological data, the Surduk loess sequence appears as a very complete record of the last climatic cycle (19 m), and exhibits a similar .ttern than other contemporaneous loess sequences from Western, Central and Eastern Europe. The main difference is the evidence of a ier environment all over the last climatic cycle (sedimentological and palaeopedological data). The high-resolution grain size record cm) is well correlated with stratigraphical boundaries, and highlights a strong variability within the loess deposition, especially during e Upper Pleniglacial between ca. 33 and 15 ka. During the Upper Pleniglacial, a succession of millennial-timescale events, characterised ' the deposition of coarser loess, are particularly well evidenced by grain size data as in some west-European records. Finally, an tempt to correlate the variations of grain size parameters at Surduk with the Greenland GRIP dust record is proposed. According to is study, millennial-timescale climatic events that characterise the North Atlantic area during the last climatic cycle have thus been corded in the environments located at the southern border of the European loess belt.

Introduction

For considerable time, research has been focused on ratigraphical correlation, palaeopedology, periglacial ocesses and dating within the European loess belt (e.g. ·onger, 1976; Kukla, 1977; Sommé et al., 1980; Haesaerts, '85; Lautridou, 1985; Rousseau, 1987; Zöller et al., 1988, '94, 2004; Antoine et al., 1999, 2003b; Frechen, 1999; ·echen et al., 2003). These investigations have yielded a ıified high-resolution stratigraphical framework for the Upper Pleistocene in Western and Central Europe (Antoine et al., 2001, 2003a, 2003b; Haesaerts et al., 2003; Gerasimenko, 2006). Relying on this background, new research focusing on both variability and impact of rapid climatic events and variability on European loess environments during the Last Glacial has been accomplished (e.g. Hatté et al., 1998; Rousseau et al., 1998, 2001, 2002; Vandenberghe et al., 1998; Antoine et al., 2001, 2003a; Moine et al., 2005, 2008).

Following the investigations on grain size variations in Chinese loess (Liu, 1985; Xiao et al., 1995; Vandenberghe et al., 1997; Ding et al., 1998, 2002; Nugteren et al., 2004), grain size records have been obtained from Last Glacial

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European Middle Pleistocene loess chronostratigraphy: Some considerations based on evidence from the Wels site, Austria

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Available online 31 July 2008

Abstract

A combination of site logging, luminescence dating and comparison with different long and continuous records of past environmental conditions is used to elaborate an age model for the Wels loess/palaeosol site, Austria. According to this model, Marine Isotope Stage (MIS) 7 is reflected in the development of three red forest soils (luvisols) at this particular site. This is contrary to previous assumptions that suggested the development of such soils in the region at 100 ka cyclicity. If these results are correct, this may question some previous conclusions regarding the general loess stratigraphy in many parts of Europe.

1. Introduction

Central Europe is a crucial region for understanding the impact of past climate change on continental environments due to its location downwind of the North Atlantic Oscillation (NAO), one of the most important circulation systems on Earth. Within this region, the Alps represent the major weather divide separating the warm Mediterranean climate with pronounced summer aridity and winter humidity from the cooler and all year wet conditions to the northwest of the mountain chain. The marine influence decreases from west to east and changes to pronounced continental conditions dominated by the Russian High across the Eastern European plains. Past changes in atmospheric circulation, i.e. a southward shift of the polar front (Florineth and Schlüchter, 2000) and/or a strengthening or weakening of the Russian High, would have led to different climatic gradients over Europe in the past (e.g., Zagwijn, 1990). Deciphering such changes is an important contribution towards a better understanding of the general mechanisms forcing climate change.

The effect of past climate changes has been recorded in a variety of geological archives. Beside the information that is derived from terrestrial deposits of, for example, glacial or fluvial origin, pollen records and loess/palaeosequences are particularly important archives of past environmental conditions. The Late Pleistocene environmental evolution of Europe is relatively well known from a variety of pollen records (e.g., Grüger, 1989; Allen et al., 1999; Caspers and Freund, 2001; Preusser, 2004) as well as from loess/palaeosol sequences (e.g., Frechen, 1999; Frechen et al., 1999, 2007; Antoine et al., 2001; Marković et al., 2008) (Fig. 1). However, terrestrial records older than the Last Interglacial are generally sparse and mainly fragmentary, in particular to the north of the Alps (cf. Litt et al., 2007), resulting in a rather controversial chronology for the Middle Pleistocene (e.g., Geyh and Müller, 2005; Nitychoruk et al., 2006). Long and continuous pollen records in Europe are so far limited to sites in the Massif Central in France (e.g., de Beaulieu et al., 2001), the volcanic area of central Italy (Follieri et al., 1988) and Greece (cf. Tzedakis et al., 2001) (Fig. 1), but independent age control is rarely available in all of these records. The same applies for loess/palaeosol sequences due to the lack of suitable dating approaches, especially considering the upper dating limit of multiple aliquot luminescence dating (e.g., Frechen et al., 1997; Frechen, 1999) and the limitations of amino acid racemisation (AAR) geochronology with regard to the production of numerical ages (cf. Oches and McCoy, 2001).

In loess research, the so-called counting-from-the-top approach has been commonly applied to constrain

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Quaternary International 198 (2009) 46–50

Loess deposits and the conservation of the archaeological record—The Krems-Wachtberg example

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Prehistoric Commission, Austrian Academy of Sciences, Fleischmarkt 22, 1010 Vienna, Austria

Available online 30 July 2008

act

cent archaeological excavations at the Upper Palaeolithic open-air site of Krems-Wachtberg in eastern Austria exposed a late tocene loess sequence. An interdisciplinary sampling strategy was applied to the 8-m high North profile. The extraordinary ervation of a Gravettian living floor with several complex features is discussed in this paper.

ntroduction

he Prehistoric Commission of the Austrian Academy of nces has been focussing its research on Palaeolithic n-air sites in the Middle Danube region around Krems ower Austria for a decade. In 2005 a new research ject, supported by the Austrian Science Fund, aimed at investigation of Gravettian settlement patterns in the s deposits of Krems.[1] Since then, archaeological avations have taken place on the Wachtberg promon-, which is situated overlooking the confluence of the nube and the Krems River (Fig. 1). Here, the Danube es the narrow Wachau valley, where it transects the emian Massif, and flows into the Tullnerfeld basin, ming a wide alluvial fan, which presumably was an open vel plain in the Late Pleistocene. The fieldwork exposed oess sequence of more than 8 m, with a well-preserved avettian find layer in a depth of 5.5 m.

ower Austria is well known for the loess profiles of lfried (Fink, 1954, 1962, 1976–1978; Peticzka et al., in p.), Paudorf, Göttweig-Furth (Götzinger, 1936; Fink, 6–1978), Krems-Schießstätte (Verginis and Rabeder, 9) and Schwallenbach (Haesaerts et al., 1996) with their classic palaeosoils. The profiles of Willendorf II (Brandtner, 1950, 1954, 1959; Haesaerts, 1990; Haesaerts et al., 1996) and Krems-Hundssteig (Strobl and Obermaier, 1909) are more commonly known for their archaeological record.

During the exploitation of loess at Krems-Hundssteig between 1893 and 1904, tens of thousands of stone artefacts as well as animal bones representing a Late Pleistocene fauna were recovered. The lithic inventory was classified as Early Upper Palaeolithic (Aurignacian) (Strobl and Obermaier, 1909; Broglio and Laplace, 1966; Laplace, 1970; Hahn, 1977). A small collection of the same area was identified as younger, belonging to the Gravettian (Hahn, 1972). Recent excavations of the Austrian Academy of Sciences at Krems-Hundssteig confirmed the existence of several archaeological layers of the Aurignacian and the Gravettian period (Neugebauer-Maresch, 2008).

Explorative drilling was not only carried out behind the profile of the historic loess quarry, but also on other accessible plots on the Wachtberg promontory (Neugebauer-Maresch and Peticzka, 2008). Near the Gravettian site, which J. Bayer excavated in 1930 (Einwögerer, 2000), drilling-core analyses substantiated the existence of a compact archaeological horizon in a depth of 5.5 m. An interdisciplinary research project started in 2005 with an excavation at the Krems-Wachtberg site.

2. Stratigraphy

The stratigraphy of the site shows a sequence of loess, which in general confirms a continuous sedimentation.

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2005-2006: FWF P-17258-G02: Gravettian Settlement Patterns in ems, Lower Austria; project director: Dr. C. Neugebauer-Maresch. ce 2007 FWF P-19347-G02: Social structures of gravettian hunter-herer societies; project director: Dr. C. Neugebauer-Maresch.

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Quaternary International 198 (2009) 51–61

Palaeoecology of Quaternary periglacial environments during OIS-2 in the forefields of the Salzach Glacier (Upper Austria)

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Abstract

Palaeopedological, sedimentological and palaeoecological investigations were carried out on the Pleniglacial loess deposits of Duttendorf (Austria) in the area of the Pleistocene Salzach glacier. Detailed insights into the past climate, topography and vegetation, especially during the Oxygen Isotopic Stage 2 (OIS 2), were obtained. According to the results it seems that alluvial processes played a more important role for the genesis of the loess deposits during the late glacial maximum (LGM) than previously assumed. The pollen record, plant macro-remains and malaco-fauna yield the occurrence of hygrophilous taxa as well as of water plants. By consequence, the sediment can be regarded as alluvial loess. Furthermore, the results show that the landscape corresponded not only to a cold and dry loess steppe environment, but was also partly influenced by humid conditions and that probably even (small) water bodies may have existed.

Keywords: Loess/paleosol sequence; Quaternary; Austria; Palynology; Carpology; Palaeoecology

1. Introduction

Loess/palaeosol sequences are a valuable source of information about past climatic and environmental conditions. Important efforts in loess research were made throughout Europe and other parts of the world during the 20th century, especially since the INQUA (sub)commission on loess was established under J. Fink in 1962 (Smalley et al., 2001; Zöller and Semmel, 2001), and recently a loess map for Europe was presented (Haase et al., 2007). But despite all these progresses, many questions regarding stratigraphical correlations and dating of loess/palaeosol sequences are still unclear. Although palynological analyses of loess sediments were performed with quite some efforts in Central/Western Europe (Frenzel, 1964a; Bastin, 1969), Eastern Europe (Rousseau et al., 2001; Bolikhovskaya and Molodkov, 2006), China (Sun et al., 1997; Feng et al., 2007) and South America (Quattrocchio et al., 2008), among others, their number still remains relatively small compared to studies from other types of deposits.

In this work we present the detailed, multi-proxy re-investigation of the loess section in Duttendorf (Upper Austria), situated in the forefields of the Pleistocene Salzach glacier. In 2005 some few sediment samples were tested for their palaeoecological content, resulting in first vegetation insights during the accumulation phase of the upper loess at Duttendorf (Starnberger et al., 2008). The great potential of these sediments gave decision to proceed further studies in more detail and for the entire profile. The pollen and plant macro-fossil analyses as well as first OSL datings shed new light on this classical Quaternary location.

The northern alpine foreland in Europe has always been one of the "hot spots" for Quaternary research, since Penck and Brückner (1909/11) established their fundamental theory of the four major Pleistocene glaciations. The central part of the (northern) Eastern Alps is defined

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Luminescence and amino acid racemization chronology of the loess–paleosol sequence at Süttő, Hungary

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stract

The loess–paleosol sequences in Hungary provide an excellent Upper Pleistocene climate archive of the Carpathian Basin. Loess ɔosits up to 20 m thick cover the Süttő travertine complex, located in the very northern part of Hungary, next to the right bank of the ınube River. The loess is intercalated with two weakly developed greyish horizons, two thinner-brownish steppe-like soils and a docomplex, including a reddish-brown clay-enriched horizon covered by a chernozem-like paleosol. Infrared optically stimulated ninescence (IRSL) dating was applied on polymineral fine grain material to determine the depositional age of the loess. The uppermost ss yields IRSL age estimates ranging from 15 to 40 ka. The loess on top of the pedocomplex yields IRSL age estimates ranging from 48 60 ka. The pedocomplex most likely correlates with the Marine Oxygen Isotope Stage (MIS) 5 interglacial period. The loess from low the pedocomplex was deposited during the penultimate glaciation, as evidenced by amino acid racemization (AAR) results. ırther independent age control is provided by radiocarbon dating for the upper part of the profile and by uranium-series ($^{230}Th/^{234}U$) es correlating the travertine below the loess with MIS 7–8. The magnetic susceptibility record through the sequence shows a strong rrelation with the loess layers and soil horizons.

Introduction

The chronostratigraphy of Hungarian loess is based on hological, sedimentological and pedological units, in- uding intercalated paleosols, tephra layers, loess and loess rivatives. A generalised chronostratigraphy was devel- ɔed for interglacial–glacial timescales (Pécsi, 1965, 1986, ı90; Singhvi et al., 1989) using paleosol characteristics, dimentological features and thermoluminescence (TL) ;e estimates for the correlation of different sites. The)–35 m thick "Young Loess Series" contains two humus ɔrizons (h_1 and h_2), which are poorly developed soils, and ıur mainly forest steppe-like soils or pedocomplexes (Pécsi ıd Richter, 1996). These pedocomplexes from the top to bottom are: Mende Upper (MF_1 and MF_2), Basaharc Double (BD_1 and BD_2), Basaharc Lower (BA) and the Mende Base (MB_1 and MB_2). The lower part of the MB is a well-developed brown forest soil, which was interpreted by Pécsi (1975, 1979, 1990) as the product of the last interglacial period. In light of TL dating results (Zöller and Wagner, 1990) Pécsi later interpreted the BD_1 paleosol as the last interglacial paleosol and suggested that the MB soil represents the penultimate interglacial period (Pécsi and Richter, 1996). Later TL and IRSL results, carried out by Wintle and Packman (1988) and Frechen et al. (1997) as well as amino acid racemization (AAR) investigations (Oches and McCoy, 1995b) and tephrochronology (Juvigné et al., 1991; Horváth, 2001), indicated that the lower boundary of the last glacial period should be shifted from the MB paleosol to the lower MF paleosol near the top of the loess series. The luminescence investigation of Frechen

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Application of anisotropy of magnetic susceptibility (AMS) for the determination of paleo-wind directions and paleo-environment during the accumulation period of Bag Tephra, Hungary

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Abstract

This study provides the first application of anisotropy of magnetic susceptibility (AMS) measurements for the study of Pleistocene wind directions and the environment during the deposition of dust and lithifaction of loess in the Carpathian Basin. A total of 67 samples were taken from seven loess–paleosol outcrops to test this method on loess–paleosol sequences. The samples were collected from the loess overlying the Bag Tephra, a characteristic marker horizon of the middle Pleistocene age in the Hungarian loess sequences.

Statistical analysis of AMS is a good tool to distinguish between redeposited and the undisturbed loess. The first measurements indicated a N/NE–S/SW direction dust transport. In two outcrops, when the principal susceptibilities were placed into a stereographic projection, the effect of local slope proved to be important in determining the magnetic fabric. The AMS results were completed by isothermal remanent magnetization (IRM) measurements to determine the main magnetic mineral components of the samples. The dominant magnetic mineral which determines the AMS character of the sample was magnetite (or maghemite).

1. Introduction

Anisotropy of magnetic susceptibility (AMS) was mentioned as a good tool to determine paleocurrent or paleodirection by Graham (1954). This geophysical method was first applied by Fuller (1963), Uyeda et al. (1963) and Rees (1965). AMS measurements were mostly used in the investigation of igneous, metamorphic and sedimentary rocks (Hrouda, 1982) with an increasing number of applications in Quaternary loess and paleosol studies since the end of the1980s.

The first investigations of loess magnetic fabric on the Chinese Loess Plateau (Liu et al. 1988; Zhu et al., 2004) were followed by AMS studies in Alaska (Begét et al., 1990; Lagroix and Banerjee, 2002), Siberia (Matasova et al., 2001) and Poland and Ukraine (Nawrocki et al., 2006). Hus (2003) compared the anisotropy parameters of numerous loess–paleosol sequences from Europe (Remicourt and Kesselt section (Belgium), Roxolany (Ukraine)), Siberia (Kurtac section) and China (Huangling).

According to Derbyshire et al. (1988), a true eolian deposit is isotropic and any anisotropy found in loess is secondary, created after deposition. On the contrary, AMS studies proved that elongated grains adjust to the direction of the paleocurrent during dust deposition (e.g. Lagroix and Banerjee, 2002; Zhu et al., 2004). During diagenesis, the grains preserve their original orientation in the loess fabric. The oriented crystallographic and anisotropic magnetic grains form the primary magnetic fabric of the loess. The primary magnetic fabric of the loess may be influenced by the following processes, which create the secondary magnetic fabric (Hrouda, 1982; Ellwood, 1984; Liu et al., 1988; Hus, 2003):

- paleo-environment during the deposition: undisturbed (wind-blown) or reworked loess;
- character of diagenesis (eg. rate of compaction);
- post-depositional and post-diagenetic processes (eg. wetting–drying, freezing–thawing, development of paleosols, bioturbation);
- deformation due to tectonics and mass movements;
- deposition on slope. (The magnetic fabric of the loess mirrors the slope angle).

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Loess chronostratigraphy in Eastern Croatia—A luminescence dating approach

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tract

ı Eastern Croatia, impressive loess-palaeosol successions up to 30 m thick are exposed along the steep cliffs of the Danube River veen Zmajevac and Šarengrad. The Croatian loess record provides an excellent high-resolution archive of climate and environmental nge, providing evidence for the interaction between accumulation and erosion of aeolian and fluvial sediments during the Middle and e Pleistocene. Sedimentological and pedological investigations, including granulometry, carbonate content and total organic carbon tent, and infrared optically stimulated luminescence (IRSL) dating were carried out on samples collected from the loess sections at ajevac, Erdut and Šarengrad. The loess successions are intercalated by at least four palaeosols or pedocomplexes, which very likely elate with Middle and Upper Pleistocene interstadials and interglacials. In all sediment successions investigated, alluvial sediments intercalated in the loess deposits, indicating periods of fluvial activity. The stratigraphically youngest alluvial sediments are exposed he Erdut section. Loess sandwiching these alluvial sediments yielded IRSL age estimates of 61.5±6.2 and 53.8±5.4 ka. The IRSL estimates give evidence for periods of increased accumulation of dust during the middle and late pleniglacial, correlating with gen-isotope stage (OIS) 3 and OIS 2, respectively, during the penultimate glaciation and at least the antepenultimate glaciation. vever, it is likely that IRSL age estimates >60 ka are underestimated.

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ı Croatia, Quaternary sediments are up to 300 m thick. ss and loess derivatives cover about 35.7% of the atian territory (Bognar, 1976). The loess deposits are nly situated in the eastern part of the country, where ׳ reach a thickness up to 30 m. Steep loess cliffs are osed at the west of the Danube River. These loess cessions are excellent archives of environmental and ate change for the Middle and Late Pleistocene time ods. The famous loess sections from Vukovar, near St. and Jacob's church, are situated on the west bank of Danube River and have been extensively investigated about 100 years by means of mineralogical, palaeonto-cal, chronological, geomorphological, pedological and atological studies (Gorjanović-Kramberger, 1912; Bronger, 1976, 2003; Rukavina, 1983; Galović and Mutić, 1984; Poje, 1985, 1986; Singhvi et al., 1989; Mutić, 1990). Similar investigations were carried out for the loess-palaeosol sequences from Erdut, Šarengrad and Bansko brdo (= Bansko hill) (Bronger, 1976, 2003; Čičulić-Trifunović and Galović, 1983a, b; Poje 1985, 1986; Trifunović, 1985; Velić et al., 1985; Pikija and Šikić, 1991; Pikija et al., 1995; Bačani et al., 1999). At least six palaeosols are intercalated in the loess successions from Eastern Croatia, spanning the Middle and Upper Pleistocene intervals, according to Bronger (1976, 2003).

As part of an ongoing study, the sections of Erdut, Zmajevac and Šarengrad, located along the Danube River, were re-examined. The aim of this paper is to develop a more reliable chronological framework of loess-palaeosol sequences in Eastern Croatia using infrared optically stimulated luminescence (IRSL) dating. IRSL is widely used in the Carpathian region and has proved to be a suitable tool for the dating of loess (Frechen et al., 1997,

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Episodic build-up of alluvial fan deposits during the Weichselian Pleniglacial in the western Transylvanian Basin, Romania and their paleoenvironmental significance

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Abstract

A Weichselian Pleniglacial cyclic sedimentation sequence at Floresti, near Cluj-Napoca in western Transylvania, Romania represents an alternation of slope deposits (coarse fan structures and reworked loess-like sediments) and paleosols. Detailed grain-size analysis together with pedological, pollen and malacofaunal investigation allows the recognition of four main morphoclimatic cycles similar to those of stadial–interstadial nature. Boreal forest-steppe to periglacial steppe oscillations developed during the Weichselian Pleniglacial. According to the U/Th and radiocarbon ages, the period between 70 and 26 ka BP was cool and variably dry after which the climate became colder, probably in response to the Last Glacial Maximum. The Floresti section shows strong similarities to other Central and South-Eastern European pedocomplexes of Pleniglacial age, notably the Moravian section of Dolní Věstonice and loess sections from Vojvodina, Serbia.

1. Introduction

Cyclic sedimentation processes responsible for loess–paleosol formation in Central Europe display a close relationship with climate variability in the Northern Hemisphere during the Pleistocene (Kukla, 1975; Fink and Kukla, 1977; Smalley and Leach, 1978; Frechen et al., 2003). Numerous Central and Eastern European studies have focused on classification of loess deposits and the genetic context of loess–paleosol sequences (e.g., Smalley and Leach, 1978; Tillmanns and Brunnacker, 1987; Pécsi et al., 1987; Pécsi, 1990, 1993; Velichko, 1990; Bogutskiy et al., 2000; Cilek, 2001). All of these studies distinguish between primary or eolian loess and reworked loess, the latter being further classified according to sediment structure, grain size or redepositional agent (slope wash, solifluction, turbulent flow). Some authors (e.g., Pécsi, 1993) assign the reworked deposits to the general notion of loess derivatives, including sand pellets and rock detritus intermingled in the loess–paleosol sequences. In Bohemian and Moravian loess sequences (Frechen et al., 1999) the terminology employed is colluvial sediments or reworked loess of predominantly colluvial origin. An interesting insight into the dynamic behavior of loess environments in Ukraine is provided by Balandin (1984) who concludes that the so-called loess mantles are frequently represented only by "loess-like eluvial-deluvial facies". More-detailed sedimentological studies, especially from Western Europe, emphasize the role of slope wash in the formation of loess-like deposits and, in general, the translocation of loess material by flowing water (e.g., Mücher and Vreeken, 1981; Mücher, 1986; Vandenberghe et al., 1998). In other cases, solifluction processes are an important genetic factor for

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Pedo-chemical climate proxies in Late Pleistocene Serbian–Ukranian loess sequences

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bstract

The last glacial–interglacial loess–paleosol sequences of Serbia and Ukraine provide a good climate reconstruction potential for this art of Europe. Four loess sections distributed over an area with present-day moist to semi-arid climates were studied. In addition to aditional paleoclimate proxies, such as grain-size distribution as proxy for wind-strength and source aridity, and magnetic susceptibility ; proxy for precipitation (and temperature), pedo-chemical elemental ratios, obtained by selective sediment leaching procedures, ınction as sensitive recorders of variations in weathering intensity due to changes in precipitation and temperature. Especially, the earth kaline element ratios of Ba/Sr and Sr/Ca are subject to strong variations as a result of carbonate dissolution/precipitation and variable ıtion exchange capacity on clay minerals along the elemental sequence of Ca–Sr–Ba. As shown by the close similarity to the magnetic ısceptibility records in the different loess sections, these ratios reflect the effects of weathering intensity as a result of precipitation ıanges. The fact that Ba/Sr unequivocally shows higher values in both soils and paleosols in the four studied sections over the present-ıy climate gradient, singles this elemental ratio out as an interesting paleoclimate proxy.

Introduction

Detailed climate information from terrestrial records of st glacial age can be a major key in investigating the ographical extent and significance of millennial scale ımate oscillations. Loess deposits are locally relatively ick in Central and Eastern Europe, containing 10–20 m last glacial deposits (e.g. Rousseau et al., 2001; arković et al., 2008; Novothny et al., 2008). This implies at the sedimentation rates were high enough for the gistration of millennial scale paleoclimatic variations. ɔur sections in Central and Eastern Europe were vestigated (Fig. 1). Studies on the paleoclimatic records the Titel section in Serbia and on the Pyrogove section in rthern Ukraine are published in this paper for the first ıe, while sections in the region have been studied for its paleoclimatic significance (e.g. Rousseau et al., 2001; Marković et al., 2004, 2005, 2006, 2007, 2008; Gerasimenko, 2006). The section Stari Bezradychy in northern Ukraine was studied for its pollen content before by Gerasimenko (2001, 2006). Compiled pollen records of many sites in the area resulted in a detailed temporal and vegetational succession interpretation of the complex loess–paleosol record at this location. The stratigraphy of the fourth section, Sanzhijka in southern Ukraine, was described by Matviishina et al. (1990). This paper presents the ratios of chemically leached (or 'free') elements that were tested on their potential application as proxies for interstadial climate conditions.

The grain-size distribution in loess research can be a good climate proxy for changes in wind intensity (Vandenberghe et al., 1985, 1997, 1998; Vandenberghe and Nugteren, 2001; Sun et al., 2002). The grain-size distribution serves as an allogenous proxy, as its compositional change is a direct result of climate change. Temperature and precipitation

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Periglacial markers within the Late Pleistocene loess–palaeosol sequences in Poland and Western Ukraine

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Abstract

Stratigraphic loess–palaeosol sequences represent exceptional, climate-controlled, terrestrial records of interglacial–glacial cycles. One of the most spectacular features within the northern part of the European loess belt is the occurrence of well-preserved relicts of the periglacial structures. From a variety of periglacial structures, three types are especially useful to reconstruct the former periglacial environment: cryogenic wedges with primary mineral infilling, cryoturbation and gelifluction structures; and ice-wedge casts. These structures form well-distinguishable horizons within loess–palaeosol sequences and their stratigraphic positions are not random. Periglacial horizons recorded in the Late Pleistocene loess–palaeosol sequences in the study area were formed as a result of extreme climatic conditions and/or rapid environmental changes during cold events of the Last Glacial period. These horizons are noted in almost all investigated sections, and thus they can be used as stratigraphic markers. The number of periglacial horizons and their morphological features vary, depending on their geographical settings and local conditions. The periglacial record indicates the occurrence of four main cold stages during the Last Glacial period. Two earlier stages are recorded in the last interglacial–early glacial palaeosol complex. Their onset was probably rapid. These short cold periods can be correlated with MIS 5d and 5b. The next two periglacial stages most probably correspond with MIS 4 and 2. Only during the last two stages were ice-wedges formed in the northern zone of the investigated loess area. This record indicates the twofold expansion and disappearance of the permafrost during the Last Glacial period.

1. Introduction

Simply defined, loess is a terrestrial, aeolian silt deposit (e.g., Pye, 1987, 1995; Follmer, 1996; Muhs and Bettis III, 2003; Smalley and Jary, 2004). Because of its aeolian nature, loess is an important archive of Quaternary climate changes. The link between loess and climate, first recognized by John Hardcastle (1890) on Timaru (Smalley, 1983; Smalley et al., 2001), was further developed by Kukla (1970, 1975, 1977, 1987). Nowadays there is no doubt that stratigraphic loess–palaeosol sequences represent one of the most complete, climate-controlled, terrestrial records of interglacial–glacial cycles (e.g., Muhs and Bettis III, 2003; Jary, 2007).

One of the most spectacular features within the northern part of European loess belt is the occurrence of well-preserved relicts of periglacial structures (Jahn, 1975, 1977; Karte, 1987; Van Vliet-Lanoë, 1989, 1998; Vandenberghe and Pissart, 1993; Huijzer and Isarin, 1997; Huijzer and Vandenberghe, 1998; Van Vliet-Lanoë, 1998; Vandenberghe, 2001).The record of periglacial environments in loess–palaeosol sequences makes it possible, in combination with other proxy data, to obtain detailed insight into the history of the Last Glacial (Vistulian in Poland = Weichselian in western Europe = Wisconsinan in America).

Permafrost changes in Polish and Ukrainian loess areas during the Last Glacial may seem to be well-documented (Velichko, 1965, 1990; Jersak, 1973, 1975, 1976; Maruszczak, 1980, 1987, 1990; Maruszczak et al., 1982; Velichko and Nechaev, 1984; Velichko et al., 1984, 2006; Bogutsky, 1986, 1987; Jary, 1996, 2007; Morozova and Nechaev, 1997; Madeyska, 2002; Dolecki, 2003). However, there is little agreement on some crucial questions (e.g., in the number of ice-wedge cast horizons and palaeoclimatic interpretation of individual periglacial structures).

Here, the results of current field investigations performed on many loess outcrops in Poland and western part of

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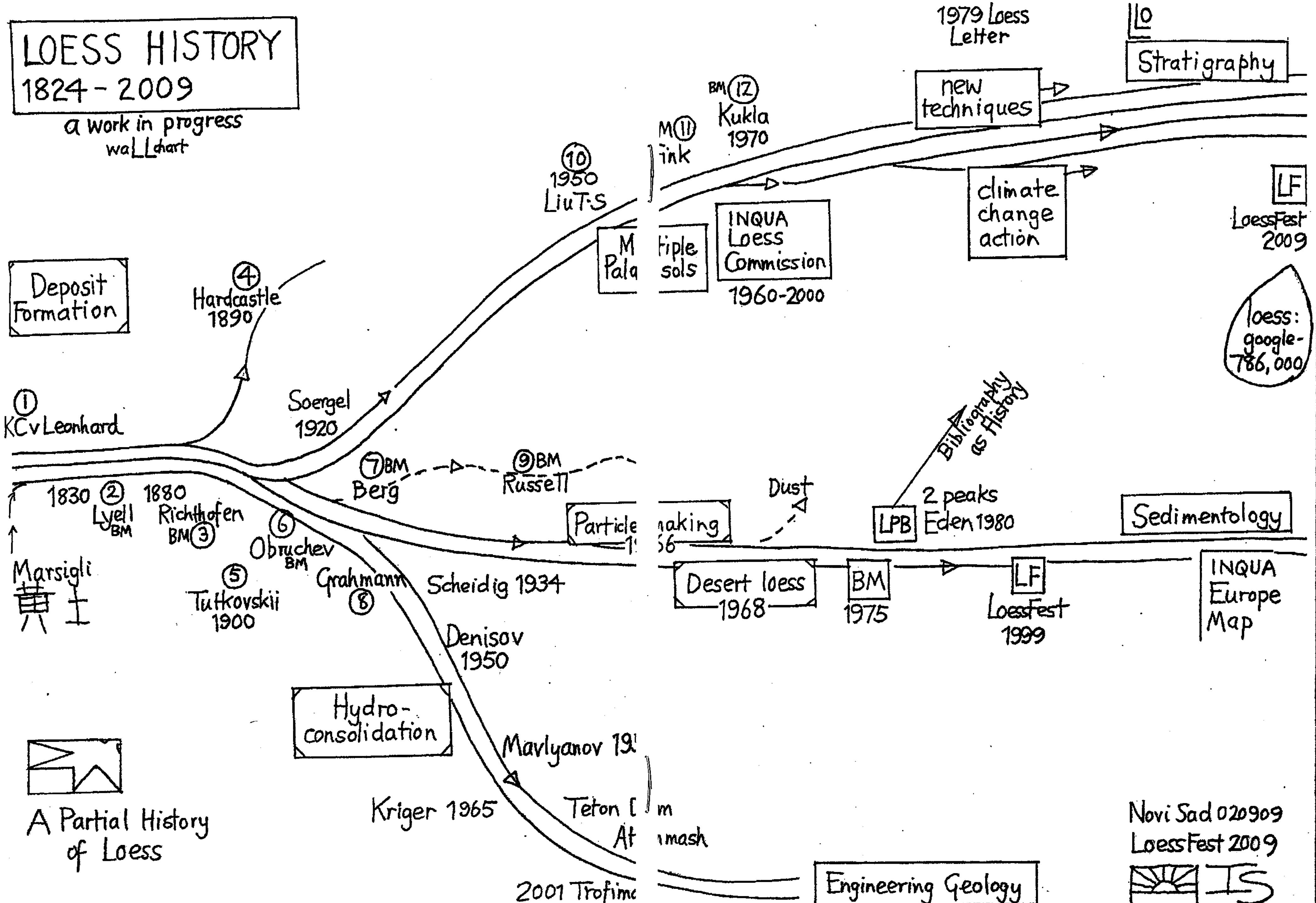
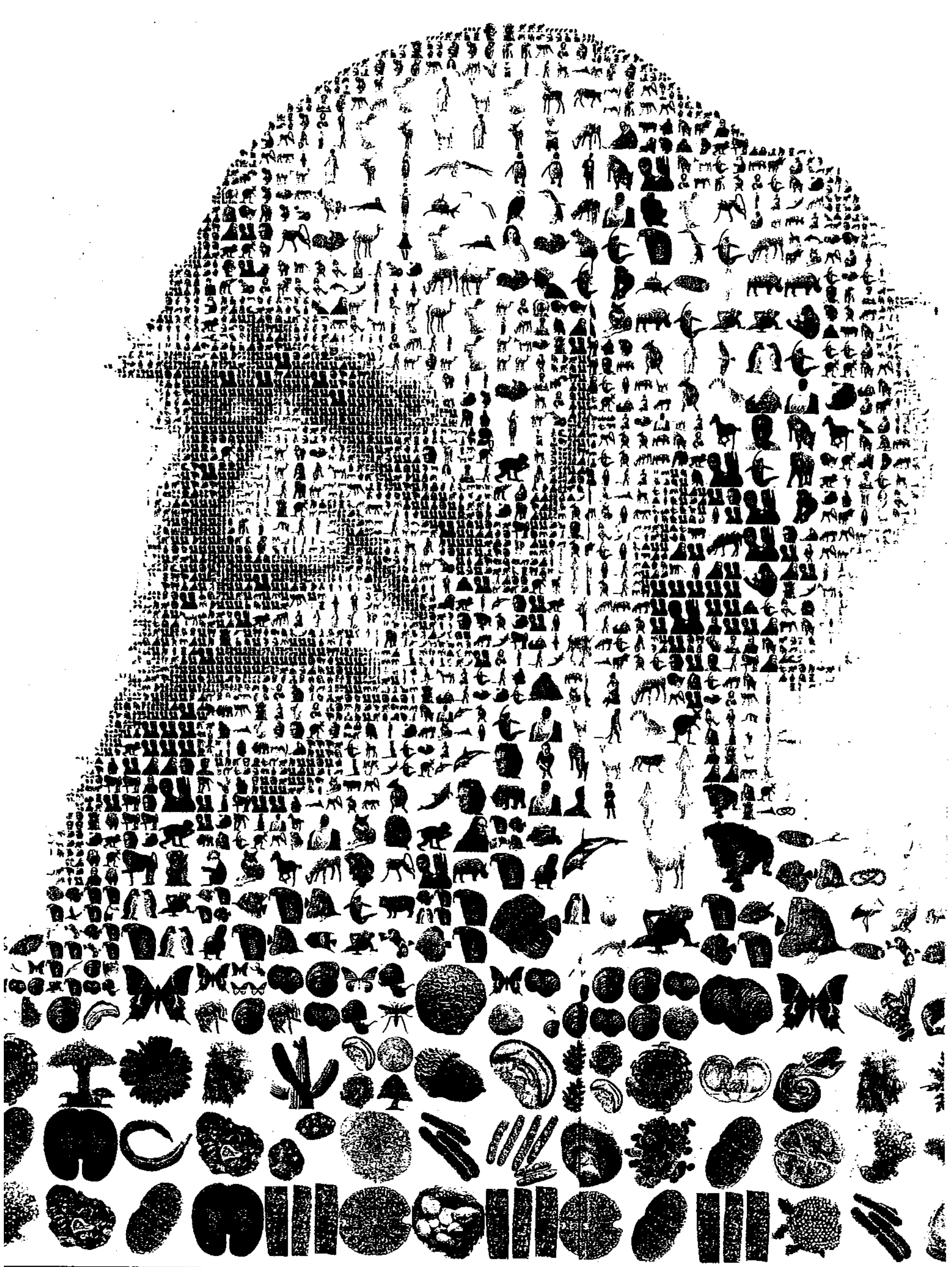

LOESS HISTORY
1824 - 2009
a work in progress
waLLchart
Deposit Formation
① KCvLeonhard
Marsigli
黄土
④ Hardcastle 1890
1830 ② Lyell BM
1880 Richthofen BM ③
⑤ Tutkovskii 1900
⑥ Obruchev BM
Soergel 1920
⑦BM Berg
⑨BM Russell
Grahmann ⑧
Scheidig 1934
Denisov 1950
Hydro-consolidation
Mavlyanov 19
Kriger 1965
Teton Dam
Atommash
2001 Trofim
Engineering Geology
⑩ 1950 LiuT-S
M⑪ Fink
BM ⑫ Kukla 1970
Multiple Palaeosols
INQUA Loess Commission 1960-2000
1979 Loess Letter
LLo
new techniques
Stratigraphy
climate change action
LF LoessFest 2009
loess: google-786,000
Particle making 1956
Dust
LPB
Bibliography as History
2 peaks Eden 1980
Sedimentology
Desert loess 1968
BM 1975
LF LoessFest 1999
INQUA Europe Map
A Partial History of Loess
Novi Sad 020909
LoessFest 2009
IS



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Oxygen and carbon stable isotope composition of authigenic carbonates in loess sequences from the Carpathian margin and Podolia, as a palaeoclimatic record

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Abstract

Samples were collected from the outcrops situated in the north and east of the Carpathian Margin, in the transition zone between the area of loess covers of Eastern and Western Europe. The chosen localities include two zones of temperate climate with slightly different prevailing wind directions. These loess–palaeosol sequences formed and develop in different time intervals: Early Quaternary Epoch (Podolia, Ukraine) and Late Quaternary Epoch (Carpathian Foothills, Poland).

The isotopic analysis was carried out on many types of authigenic soil carbonates, including nodules, rhizoliths, rhizocretions, calcified root cells and bioclasts. The carbon isotopic compositions ($\delta^{13}C$) of different types vary markedly. These differences seem to be more important than the variations within one type of carbonate at a particular section.

The $\delta^{13}C$ values for authigenic carbonate cements (rhizoliths, rhizocretions and nodules) vary in a narrow range from about −11‰ to −8‰, suggesting that calcite cements were.precipitated under roughly similar conditions, with a considerable supply of CO_2 derived from biomineralization of organic matter, predominantly from C_3 plants. The $\delta^{18}O$ record of the calcite cements within the upper Quaternary deposits exhibits relatively slight variability, suggesting that $\delta^{18}O$ values in soil water were homogeneous.

The significant depletion of ^{13}C as well as ^{18}O in calcite from calcified root cells (−12‰ and −7‰, respectively), and to a lesser extent from calcitic globules with respect to calcite cements, points to different environments of formation. The morphology of calcite crystals replacing root cells, and their carbon and oxygen isotopic composition indicate that they may precipitate inside the root cells from fluids with organic compounds.

In general, the temperature reconstructions yield an average MAT about 11 °C for the upper Quaternary sediments deposited during MIS 2. The estimated MAT for sediments of MIS 3–5 range from 12 to 14 °C. Mean annual temperatures estimated for the lower Quaternary of Podolia fall in the range from 9 to 11 °C with two single minimums (about 7 °C) probably corresponding to short-lived environmental changes. The MAT curve throughout the lower part of lower Quaternary is more variable and shows several local shifts (up to 3 °C).

1. Introduction

The aim of this study is to make an attempt to estimate the possibility for the application of isotopic composition of pedogenic carbonates as palaeoclimatic indicators, which could be useful in the reconstruction of palaeoclimatic changes during loess sedimentation and fossil soil development. Pedogenic carbonates, a common component of soils, are usually found in soils developed under arid to sub-humid conditions, where soil pH is equal or above 7, and mean annual precipitation is less than 1000 mm, particularly under 750 mm (Cerling, 1984). It is assumed that in soils they precipitate in isotopic equilibrium with the soil solution and the soil CO_2 gaseous phase. The carbon isotopic composition of pedogenic carbonates is mainly controlled by the vegetation type in the local ecosystem, and the oxygen isotopic signature is

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Spatial vegetation patterns based on palynological records in the loess area between the Dnieper and Odra Rivers during the last interglacial–glacial cycle

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stract

ollen analysis was done on loess–palaeosol sequences situated to the north of the Carpathians and Sudetes, in the belt characterized stronger influence of oceanic climate in the West and continental climate in the East. This fact conditioned the occurrence of loess as lated patches in the West and thick continuous covers in the East, as well as the diversity of natural vegetation cover from deciduous ests and mixed coniferous forests, through forest-steppe to steppe zone. Three loess sites were examined in Poland (Biały Kościół, rnawce, Polanów Samborzecki), and three in Ukraine (Yezupil, Velyka Andrusivka, Stari Kodaky). Local pollen zones, distinguished each site, were correlated in order to define the phases of vegetation development from the end of the penultimate glacial, through the nian Interglacial to the end of the Vistulian. The obtained picture of vegetation changes supplements the analysis results of anogenic deposits with the description of flora in cold periods when aeolian deposition occurred.

n the area under study, the common features of vegetation development were conditioned by a general trend of climatic changes ring the last interglacial–glacial cycle. They overlapped with the vegetation changes, expressed by the eastward rising proportion of en landscape elements, which resulted from the increasing continentality of climate. The proportion of trees and shrubs in plant nmunities during interstadials was also influenced by the proximity of refuges occurring in the Carpathians and Sudetes, and the ation of the examined profiles in river valleys, which were also natural refuges. Other differences in vegetation composition between ividual sites resulted from their different meso- and micro-palaeomorphologic situation.

Introduction

The reconstructions of the palaeogeographical condi- ns of the last interglacial–glacial cycle are useful for derstanding of modern natural processes and the pected changes in them. Pollen analysis of loess–palaeo- deposits is very helpful in vegetation reconstructions for areas without organic deposits. This study was nducted to shed light on the evolution of vegetation, laeoenvironments, and climate in the loess zone between Dnieper and Odra Rivers. This area is characterized by diverse conditions of loess occurrence. Loess cover in the Dniester and Dnieper River basins is continuous and thick, in the Vistula River basin the dissected loess patches occur on uplands, and in the Odra River basin the loess deposits form rather small, isolated patches. Such a spatial diversity of loess occurrence is interpreted as the result of periglacial climate, more and more maritime westwards. Samples for pollen analysis were taken from six representative loess profiles situated along a transect from south-western Poland to Ukraine (Fig. 1).

2. Description of sites

Three of the examined profiles occur in Poland, and three in Ukraine (Fig. 1). They represent two types of loess areas: mountain foreland and foothill (Biały Kościół, Tarnawce, Yezupil) and upland–plain (Polanów Samborzecki, Velyka

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Quaternary sediment sequence at Skala Podil'ska, Dniester River basin (Ukraine): Preliminary results of multi-proxy analyses

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Abstract

The terrestrial deposit sequence of the Skala Podil'ska site in the Middle Dniester area provides high-resolution records of the older part of the Quaternary. The profile represents a unique environment of sedimentation on the undulated palaeosurface of the Podolian plateau, characterized by relatively weak intensity of loess accumulation processes, and relatively strong intensity of post-deposition processes (pedogenesis and erosion). The Skala Podil'ska succession contains fluvial, paludal–fluvial, and loess sediments, the latter with seven well-developed interglacial palaeosols which were studied in catenas.

The palaeoenvironmental information is based on the results of multi-proxy studies. Based on palaeomagnetic (the MBB, the Blake event) and palaeobiologic evidence, a regional chronological scheme was made. The stratigraphic division of the Skala Podil'ska profile is tentatively correlated with the main stratigraphic units of the pre-Pleistocene and Pleistocene in Ukraine, Poland, and Western Europe.

"*... studies on the Quaternary should be carried out separately for each area with local provisional division applied because it is very risky to look at any cost and everywhere for the stages found anywhere else on the basis of other methods. Maurice Gignoux (1956)*"

1. Introduction

The limited record of the Central-European loess profiles containing older loess units has been recently enriched with the unique site in the Skala Podil'ska on the Zbruč River, in the Middle Dniester River basin, Ukraine (Fig. 1A). The loess outcrop at Skala Podil'ska (48°50'N, 26°10'E) is located in a large quarry of Silurian limestones (Fig. 1B). The limestones are overlain by about 20 m thick cover composed of Neogene marine deposits and Quaternary terrestrial deposits of different origins. The sequence contains loess deposits with palaeosols, intra-loess series of loams indicating paludal–fluvial sedimentation, and alluvial deposits. The Quaternary deposits are exposed along long sections of landslide head-walls, allowing examination of their vertical and horizontal variability. The importance of the Skala Podil'ska site is enhanced because it is the third profile in the Dniester River catchment (after the Zahvizdja and Roxolany sites) in which the Matuyama–Brunhes boundary (MBB) has been found (Tsatskin et al., 1998; Nawrocki et al., 2002). MBB with an age of 778 ka occurs in the middle part of the profile. The second important palaeomagnetic datum, the Blake event, occurs in the near-surface soil indicating its Eemian age. These two data, together with the occurrence of Eopleistocene malacofauna in the bottom alluvia, allow recognition of the formation periods of the Quaternary deposits in the site.

Detailed research allowed determination of the mechanisms of natural palaeoenvironmental changes in the Dniester River catchment, and reconstruction of the main/global

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Heterogeneity in homogeneous Brabantian loess during the Late Pleniglacial

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'stract

The Brabantian loess is often seen as a homogeneous sediment package, deposited under cold and dry climatic conditions (Haesaerts al., 1981). However, in 1981 two small tundra gleysols were discovered in the Brabantian loess (Haesaerts et al., 1981). To unravel ıer possible changes in the sedimentary system during deposition, a more detailed look at the homogeneous Brabantian loess is carried t. The loess transporting process is reconstructed based on the combination of both grain size and grain shape parameters. These rameters are defined with automated dynamic image analysis and statistically compared with the two-dimensional Kolmogor- -Smirnov test. As suggested by Vandenberghe et al. (1998), our gleysols are generally correlated to a period of reduced grain size. Most ely, the more subtle the gleysols, the weaker the link between their formation and grain size reduction. Mazzullo et al. (1992) already ted that aeolian transport was very selective regarding grain size and sorting capacities. Our research points toward an extremely ective aeolian transport regarding the shape of the grains. Therefore, combining both particle size and particle shape can be very useful en reconstructing aeolian transport processes. This combination can also discriminate samples with a different transport and limentation history.

Introduction

The studied section is located in the Nelissen Brickyard, ır Kesselt, Belgium (Fig. 1). The Brabantian loess is en seen as a homogeneous sediment package, deposited der cold and dry climatic conditions (Haesaerts et al., 31). For this reason, it did not receive much attention so . Vandenberghe et al. (1998) described it as a loess without laminations or traces of deformation. Van Den Haute et al. (1998) called it a quite homogeneous silt, lacking distinct sedimentary structures.

Haesaerts et al. (1981) discovered two small tundra gleysols in the Brabantian loess (Fig. 2a). These gleysols could form in a synsedimentological process. Alternatively, tundra gleysols can develop because of a decrease in sedimentation rate (Vandenberghe et al., 1998), resulting in a decrease of sediment size. Therefore, it could be interesting to take a more detailed look at the homogeneous Brabantian loess to unravel possible changes in the sedimentary system during deposition.

The shape of silt particles may give an idea of the particle formation processes (Assallay et al., 1998). Differences between results of laser granulometry and sieving are partly caused by particle shape. Considering both particle size and shape could contribute to a better understanding of the transport and sedimentation history (Blott and Pye, 2006).

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Progressively cooler, drier interglacials in southern Russia through the Quaternary: Evidence from the Sea of Azov region

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Abstract

Loess-palaeosol exposures along Taganrog Bay, Sea of Azov, in southern Russia, reveal a complex succession of Quaternary palaeoenvironments over the past 0.7 million years. The deposits overlie marine sediments of Tiraspolian (Cromerian) age. At the key section of Semibalki-1, four palaeosol complexes are identified within the series. The earliest palaeosol complex in the Semibalki-1 section is correlated with the late Muchkap Interglacial (the Vorona palaeosol). The soil type resembled modern subtropical Mediterranean region soils. The later Middle Pleistocene palaeosols bear evidence of soil-forming processes typical of various temperate zone environments, with a gradual transition to increasingly cooler, drier conditions. Soils suggesting transitional development between kastenozems and chernozems developed during the Likhvin Interglacial (Inzhavino PC). PC 2 (Kamenka Interglacial) is typified by eluviated Luvic Chernozemic soils, possibly formed under prairie parkland conditions. Finally, the Mikulino Integlacial of the Late Pleistocene (Mezin PC) is represented by chernozems similar to the modern (Holocene) soils of the region, but showing enhanced podzolization and fewer seasonal frost features.

A succession of environmental changes has been traced in the study region, from semi-humid subtropical environments at the end of the Early Pleistocene to prairie environments, then to boreal-mild temperate during the Middle Pleistocene, and finally towards landscapes with typical steppe soils in the Late Pleistocene and Holocene. The sequence indicates that moisture supply and temperatures during successive interglacials shifted progressively towards increasingly cooler, somewhat drier climates, influencing soil formation.

1. Introduction

The Azov Sea coast has long commanded the attention of many investigators, as it furnishes an opportunity to gain a better understanding of the interrelation between marine and continental deposits in southern European Russia. Different series of marine, lagoonal, and fluvial sediments and overlying subaerial formations (including palaeosol horizons) have been described and discussed in numerous papers by Lisitsyn (1925), Moskvitin (1932), Gromov (1933) and many others (Khokhlovkina, 1940; Lebedeva, 1965; Agadjanian et al., 1972; Bolikhovskaya and Dobrodeev, 1972; Velichko et al., 1973, 2006a, b; Dodonov et al., 2005).

This contribution presents some results of research on the project "Historical reconstruction of the chernozem steppe formation in arid zones", part of the Russian Academy of Sciences Program (Earth Science Division), "Monitoring technology development, ecosystem modeling and forecast in studies of natural resources in arid environments", under the direction of G.G. Matishov. The project is aimed at multi-disciplinary studies of loess-palaeosol series which contain several fossil soils dated from early Quaternary to Holocene. This approach provides a means for estimating environmental changes, including variations of temperature and water supply, soil formation processes, and degree of aridity in southern European Russia, through the Quaternary glacial and interglacial epochs to the present day.

One of the most thoroughly studied key sections is Semibalki-1, located on the southern coast of Taganrog

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Loess chronology of the Caspian Lowland in Northern Iran

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ɔstract

The loess/palaeosol sequences of the Caspian Lowland in Northern Iran provide detailed archives of climate and environmental ange showing a close relationship to global cooling and warming trends for the Quaternary period. The magnitude of these changes is ıder discussion owing to uncertainties in the chronologies for individual sites. A chronological frame was set up for the last glacial loess ɔord for three Upper Pleistocene key sections by infrared optically stimulated luminescence (IRSL). In the Caspian Lowland, IRSL ting gives reliable ages for sediments covering at least the past 60 ka. However, for sediments older than 60 ka, a significant age derestimation is likely. The first strongly developed buried Bt/Bwt horizons or pedocomplexes at the three sections under study rrelate most likely with the last interglacial (MIS 5). At least four periods of increased sediment accumulation were determined for the ıt glacial period intercalated by periods of weak soil formation. The loess/palaeosol sequences in Northern Iran recorded coeval and nilar major climatic changes as in South-Eastern Central Europe and Central Asia.

Introduction

The Caspian Lowland of Northern Iran is part of the ırasian loess belt extending from Northwest Europe to ɜntral Asia and China. During the Pleistocene glacia-ɔns, Northern Iran was an extensive area of increased ıst accumulation and loess formation. These sediments e widespread covering slopes and interfluves of the edmont region of the Alborz Mountains (Fig. 1). Loess ımprises a high sensitivity archive of regional climate and ıvironmental changes in the terrestrial record and shows a ɔse relationship with cooling and warming trends for the uaternary period. The well-developed loess/palaeosol quences reflect changes in mass accumulation rates silt-rich sediments and is thus a measure to determine e palaeo-dust content of the atmosphere for the ological past – an important parameter for climate odeling (Tegen, 2003). Furthermore, the loess record of orthern Iran provides a missing link for the correlation tween Central Asian and European loess archives. The ost complete loess/palaeosol sequences of the Caspian Lowland covering at least the time span of the Middle and Late Pleistocene are located in the area between the Rivers Gorgan and Atrek in Golestan province (Agh Band section) and on the northern foothills of the Alborz Mountains between the cities of Sari and Minodasht (Neka section and Now Deh section) (Fig. 1).

Little information has been published on records of past climate change in Northern Iran. During the 1960s and the 1970s, loess and the intercalated palaeosols were correlated with moist and dry periods of the Holocene (Barbier, 1960; Ehlers, 1971). Lateef (1988) suggested that brown palaeosols and loess correlate with the last interglacial period and the last glacial period, respectively. In the study area, several well-developed palaeosol horizons intercalated in the loess record indicate an alternation of comparatively dry and cool climate phases with increased dust accumulation including loess formation, and moist and warm phases with soil formation, respectively (Kehl et al., 2006). However, the origin, nature and absolute age of the loess and palaeosol members are still inadequately known and under discussion.

Infrared optically stimulated luminescence (IRSL) was applied to set up a more reliable chronological frame for the last interglacial/glacial loess record of the Caspian

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Aeolian dust in Europe: African sources and European deposits

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Dedicated to Prof. Dr. D.H. Yaalon
Recollecting Dust, Loess & Deserts

Abstract

A conceptual model is presented for the provenance and dispersal patterns of small dust that falls on Europe. Generally its sources are in North Africa, and it is distributed across all Europe. Several key sources can be distinguished: 'Sahelian' dust comes largely from the old Lake Chad region—this is a clay-rich unimodal material. 'Saharan' dust comes from the great sand sheets—it contains small monomineralic particles and may have a bimodal size range. Three simple deposition zones can be recognised; a D1a zone where sufficient dust is deposited to form a discrete soil layer (not well classified as a Rendoll), in the extreme south of Europe; a D1b zone where the airborne dust simply provided a silty admixture to soil systems—across Middle Europe; and a northern zone D1c where the dust is a fugitive cloud, but very occasionally forms noticeable deposits. Two particle formation methods can be noted. Particle control in Sahelian dust is via the sedimentation in the original lake. This gives an open structure which can be modelled using a simple Monte Carlo approach. The open structure ensures that only small particles are produced; size control is via particle packing. A chipping mechanism can produce fine quartz particles from sandy deserts. The aeolian energy is, by and large, not sufficient to cause major impact fracturing but small mineral chips can be produced in the small dust size (fine and very fine silt), which go into high-level suspension and travel to Europe and beyond. The Saharan material can have a wider, more variable size distribution than the Sahelian material. The Canary Islands 'loess' is largely Sahelian material; the Cape Verde Islands deposits, from the nearby sandy regions, are Saharan deposits. Large dust has fallen on Europe, and produced widespread loess deposits. Large dust is essentially an 'in-continent' deposit; small dust comes from outside—from Africa.

1. Introduction

Europe is not a particularly dusty continent, compared to Australia or Africa, but there is a dust history to be considered and widespread loess to be examined and explained. Furthermore, there is contemporary dust activity, mostly involving dust from North Africa. A continent wide study is mostly an exercise in simplification and generalization and this review will concentrate on the nature of dust materials associated with the European environment, their sources and transportation routes, their zones of deposition, and various consequences and palaeoclimatic implications.

Dust is defined as material transported in suspension in the atmosphere, and this is material, which, predominantly, falls into the silt category (2–63 μm). This study of airborne silt, follows Friedman and Sanders (1978) in recognising five silt categories, each separated by 1 phi (ϕ) interval (9–4ϕ; 2–63 μm). Although the authors do not support the phi (ϕ) system of measurement, it provides a convenient way of demarcating the silt range, and facilitating a discussion on dust.

A major size distinction is observed in the world of dust; crudely expressed as a division into large dust and small dust (see Livingstone And Warren 1996). Failure to appreciate this fundamental dichotomy has caused much confusion in the study of dust and loess. Large dust is

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traced deposition events back to three main areas: Western Sahara; Moroccan Atlas, and central Algeria. These source areas have also been identified for transport of dust to the British Isles (Tullet, 1978; Wheeler, 1986). A common trajectory for transport to Britain is over the Bay of Biscay, in mid-tropospheric winds skirting an anticyclone over western Europe.

Less commonly, dust is transported from Algerian sources over the Mediterranean and France in association with a low-pressure system centred over the Bay of Biscay (Wheeler 1986, Coudé-Gaussen et al., 1998).

A graphical summary of the major sources recognised by d'Almeida (1986), Middleton and Goudie (2001), Blanco et al. (2003) and Engelstaedter and Washington (2007) is provided in Fig. 2. Goudie and Middleton (2006) state that the problems with source identifications may have to do with the fact that different methods and definitions are used. Nevertheless, roughly four dust sources can be identified (after d'Almeida, (1986) and Molinaroli (1996)), from west to east: (1) Morocco to north Mauritania, (2) south Algeria, (3) south Libya and Chad, and (4) Egypt and north Sudan. By monitoring dust observations on the island of Corsica for a year, Bergametti et al., (1989) mapped out three different sources of Saharan dust from 20 events, originating from eastern Algeria, Tunisia, and western Lybia (sector 1), Morocco and western Algeria (sector 2), and "south of 30 °N", called the Sahelian source by Littmann (1991). Two additional sources were proposed by Middleton and Goudie (2001) in north Mali, after Kalu (1979) and central Chad. The use of back trajectory models (e.g., Draxler and Rolph, 2003) and satellite imagery (e.g., Prospero et al., 1970) has brought a major step forward to the provenance of the dust outbreaks.

A further complication of this observation is the fact that the aerosol at any one point can be a complicated mixture

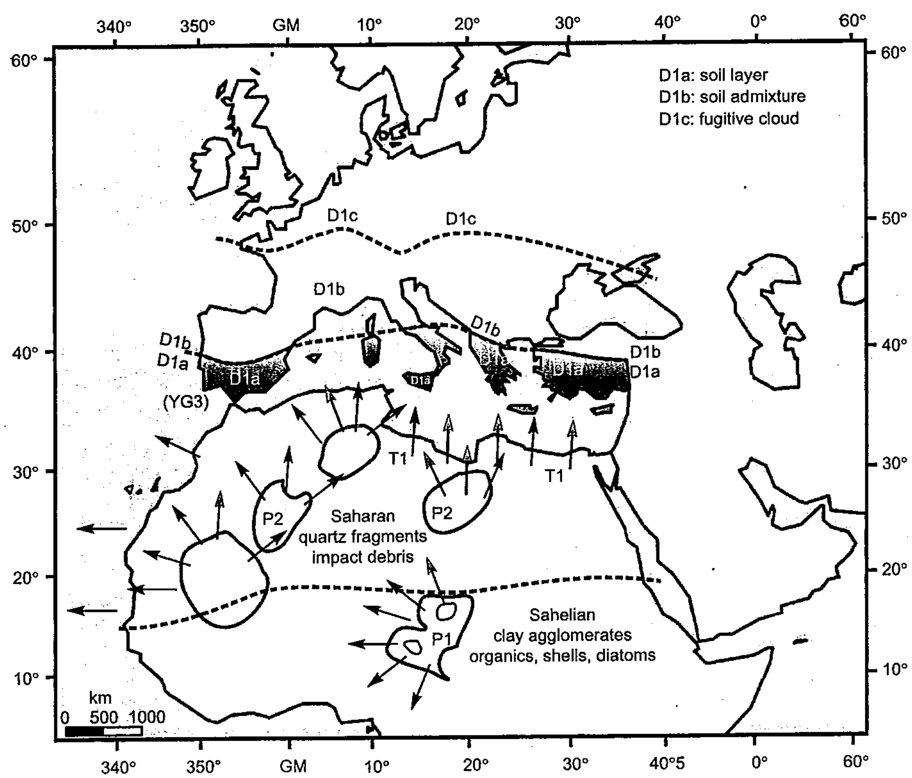

Fig. 3. North Africa and southern Europe. The three soil zones D1a, D1b and D1c are definable dustfall regions. The major clay mineral agglomerates Sahelian dust particle source is indicated. T, P and D zones, after Evans et al., (2004).

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Differences among sub-orbital time scale events recorded in two high-resolution loess sections, China, during the last deglaciation

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Abstract

Acquisition of high-resolution loess sections allows study of climate change events on sub-orbital time scales. Two high-resolution loess section records from China (Wangguan and Shagou, located east and west of the Liupanshan Mountains, respectively) are compared with the GRIP record to evaluate climatic changes during the last deglaciation. The results show that both sections recorded the Younger Dryas, the Heinrich-1 and the Bølling and Allerød events of the last deglaciation. Loess records of those events occurred almost simultaneously with those recorded in the GRIP. The characteristics of the climate change events in the two loess sections were quite different. It was found that (1) the Heinrich-1 event was more obvious in the Shagou section than in the Wangguan section; (2) the Bølling and Allerød events recorded in the Shagou section have more fluctuations than in the Wangguan section; (3) the Younger Dryas terminated suddenly in the Shagou section whereas in the Wangguan section it came to a gradual end; and (4) the records show a larger fluctuation range and higher frequency on the millennium scale in the Shagou section than in the Wangguan section. It is suggested that the differences were caused by the effects of latitudinal differences.

1. Introduction

Temperatures were extremely variable during the last deglaciation. Study of the processes and mechanisms affecting the changes during that period can contribute to a more thorough understanding of the earth system and also can help to estimate and forecast future global changes (Jian et al., 1998). The Younger Dryas is the most notable event during the last deglaciation, and so far is the most intensively studied rapid climatic event in ice cores (Lorius et al., 1985; Taylor et al., 1997; Yao et al., 1997), terrestrial records (Clark et al., 1996; Zhou et al., 1997; Buks et al., 2000; Lotter et al., 2000; Wang et al., 2000; Qin et al., 2005) and marine records (Boyle and Keigwin, 1987; Wang et al., 1996; David et al., 2003; Takeshi et al., 2003; Yamamoto et al., 2005). The Younger Dryas event was first found in the North Atlantic and its nearby areas (Boyle and Keigwin, 1987; Johnsen et al., 1992; Alley et al., 1993), and was subsequently found in many paleoclimate records all over the world (Wang et al., 1996; Yao et al., 1997; Zhou et al., 1997; Wang et al., 2000; David et al., 2003; Qin et al., 2005; Yamamoto et al., 2005). The Younger Dryas event is a climate event with global significance (Zahn 1992). However, the observation of the Younger Dryas and its climate characteristics differ among the geologica records in different areas (Singer et al., 1998; Rodbel and Seltzer, 2000). As the high-resolution paleoclimate records have been obtained continuously, some researchers (Taylor et al., 1997; Chen et al., 2004) have already started to study the detailed characteristics and discuss the forming mechanism of this event.

As a result, the problem of spatial variability and th underlying mechanisms behind the Younger Drays stil needs to be investigated. While it is clear that the rapid climatic shift occurred in the East Asian monsoon regio during the last deglaciation, the reason for its changing and the relations it has with the climate transformation in th high- or low-latitude areas are still not clear. In this article two loess section profiles are discussed regarding th forming mechanisms of millennium scale climate event during the last deglaciation including the Younger Dryas

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Middle and Late Pleistocene loess sequences at Batajnica, Vojvodina, Serbia

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Abstract

Loess sequences in the Vojvodina region (Northern Serbia) reveal a continuous record of paleoclimatic variations during the Middle and Late Pleistocene. The most detailed stratigraphic information comes from remarkable exposures on the cliffs of the right Danube bank from Vukovar to Belgrade. The Batajnica loess section has been recognized as one of the most complete Middle and Late Pleistocene records in this region. A more than 40 m thick loess–paleosol succession represents environmental transition from relative thin loess layers and rubified soils in lower part of profile to thick loess and fossil chernozems characterizing the last three glacial–interglacial cycles.

The proposed stratigraphic model is based on a detailed magnetic susceptibility (MS) record which is related to the deep-sea isotope stratigraphy and on correlation with other Eurasian loess records using the distinct MS pattern of selected loess–paleosol couplets. This new stratigraphic model suggests serious revision of previous chronological interpretations. MS as function of depth shows a well-known pattern of low values in loess and high values in paleosols indicating strong enhancement of magnetic minerals during soil formation. With the exception of the recent soil (V-S0) which is strongly contaminated by archaeological artifacts, the third paleosol V-S3 reveals the highest values in MS and a very distinct double peak. The rock magnetic signal at Batajnica resembles the typical pattern of the enviromagnetic record determined from other Eurasian loess sites. The paleopedological interpretations, rubification index values and rock magnetic record at Batajnica yield valuable data for the reconstruction of paleoclimatic fluctuations for the last 5 glacial–interglacial cycles at least. Moreover, the record provides an important link between the classical Central European loess sites and the Central Asian and Chinese loess provinces.

1. Introduction

Aeolian dust was deposited worldwide during the cold/dry periods of the recent geological past. It underwent pedogenesis when more humid conditions predominated, which is reflected in physical–chemical alteration of the sediment. The product of these alterations is a pedohorizon (paleosol) which shows enhancement of magnetic minerals. In contrast, during dry periods loess was formed with magnetic properties similar to the unaltered dust. Therefore, magnetic parameters (e.g. magnetic susceptibility, MS) as function of depth in loess–paleosol sequences can serve as a proxy for palaeoclimatic variations, allowing a close match with all kinds of high-resolution palaeoclimatic archives.

Loess is by far the most important terrestrial archive that provides detailed palaeoclimatic information for the whole Quaternary and in China goes back to even the Pliocene. Heller and Liu (1984) first used magnetic susceptibility variations in Chinese loess to correlate the loess deposits to marine records. The MS variations in the loess–palaeosol couplets in the Chinese loess plateau resemble the pattern

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THE CRAYFORD BRICKEARTHS PROJECT

Background and rationale

The Palaeolithic settlement history of the British Isles has been debated increasingly in recent years. A progressively robust chronometric framework now allows patterning in technological behaviour, hominin habitat preference and demography during this period to be investigated. For instance, artefact numbers from terraces of the ancient Thames have been used to model population density throughout the Middle Pleistocene, suggesting that MIS 7 (c.230-180 Ka) was witness to a dramatic crash, humans being absent from Britain by late Marine Isotope Stage (MIS) 7/ early MIS 6 (Ashton and Lewis 2002). This pattern may relate to changes in human habitat preference and favoured exploitation of the productive, open environments of early MIS 7. Others, however, would argue that this picture is complicated by changes in technology which occur at the same time, and particularly the widespread adoption of Levallois flaking (Scott 2006, White *et al*., 2006).

The site of Crayford in North Kent is central to such debates; here, expansive spreads of brickearth were extracted between the late 19th to early 20th century. Significantly, the lower part of these brickearths produced exceptional collections of refitting Levallois reduction sequences (Spurrell 1880a,1880b, Chandler 1916) – the only such assemblages known from this period in Britain. Whilst the brickearths themselves form part of the Taplow-Mucking terrace of the Thames (MIS 8-7-6; Table 1), comparatively little is known of the specific chronological and environmental context of the archaeological material.

1. Trail.	<2.1 m.
2. Upper Brickearth.	< 6 m., including Trail
3. *Corbicula* bed; frequent small mammalian and molluscan remains.	0.25 – 1.5 m.
4. Lower Brickearth. Fine yellow fluvial sand, frequent fossils.	< 9 m.
5. Crayford Gravel. Coarse fluvial gravel, some fauna.	< 4.5 m.
6. Chalk/Thanet Sand, mantled by soliflucted material in places.	

Table 1. Summary of sequence in Crayford/Erith area (from Kennard 1944 and Chandler 1914)

Faunal and molluscan material has been recovered from the Crayford/Erith brickearths in prodigious amounts, most notably from the "*Corbicula*" bed - a sandy layer rich in molluscan material towards the top of the Lower Brickearths. Analysis of old faunal collections from the entire depth of brickearth has been argued to indicate a late MIS 7/early MIS 6 date for the aggradation of these sediments – and hence for the archaeology contained therein (Schreve 2001) – although attributing many specimens to sedimentary level is problematic. However, different proxies reflect potentially different environmental pictures; whilst apparent cool/cold elements are well-represented amongst the mammalian fauna (ground squirrel, lemming, musk ox), Kennard (1944, p153) describes the *Corbicula* as large and therefore not environmentally stressed reflective of warmer conditions. Reanalysis of new samples from the Crayford brickearths is therefore necessary in order to accurately locate the Crayford sequence within the existing British chronostratigraphic framework, to reconstruct the environment within which humans were active at Crayford, and to better understand the nature and structure of MIS 7 environments.

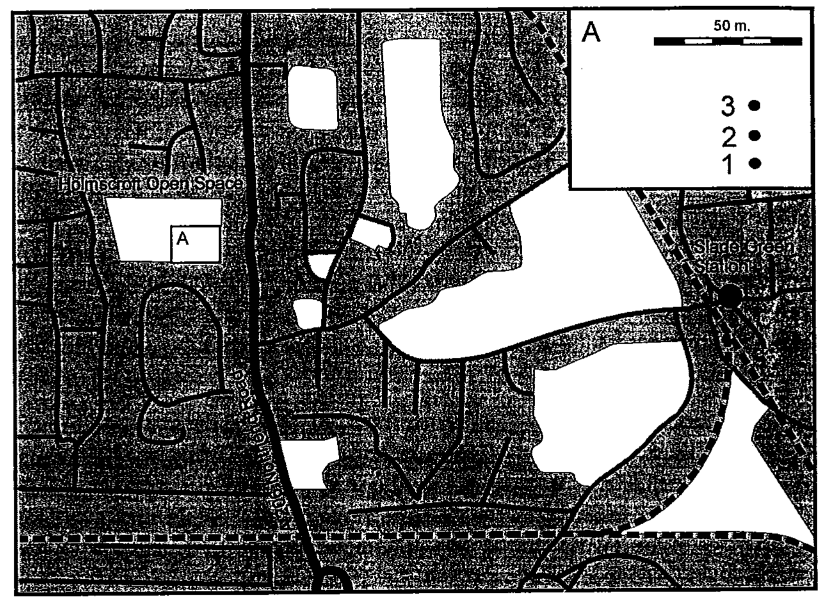

Figure 1. Location of boreholes drilled within Holmescroft Open Space, Erith.

Methodology and results

Quarrying and building work have rendered the Crayford-Erith brickearths largely inaccessible, and hence potential for resolving these questions has, until

Topsoil		<0.5 m
Trail	Rounded flints in dark brown clayey-sand matrix	<1.2 m
Upper Brickearth	Yellowish-brown silty clay, becoming more clay-rich towards base. Occasional calcium carbonate nodules and visible shells.	<3.8 m
Corbicula Bed	Yellow-buff fine-medium grained sand. Occasional visible shells	<2.5 m
Lower Brickearth	Compact orange brown sandy clay, passing into horizontally laminated yellow-brown sands and silts at depth of 10.73 m.	>4.0 m

Table 2. Description of sedimentary units of Crayford sequence observed during Cobra drilling at Holmescroft Open Space, Erith (see Figure 2).

now, been somewhat limited. However, one area of intact Pleistocene sediments was delimited through examination of archive borehole records (Wessex Archaeology 1998), within a recreation ground known as Holmescroft Open Space in Erith (Figure 1). The recreation ground clips the southernmost edge of Norris' Pit, from which a single retouched Levallois flake is known (Wessex Archaeology 1996), and is located immediately to the North of Rutter's New Pit West, from which Chandler recovered a number of refitting Levallois artefacts (Chandler 1916). Both pits were extensively studied in the early 20th Century and the entire Crayford Brickearths sequence (Table 1) has been recorded at both. Initial fieldwork at the site was funded by the Quaternary Research Fund and the Ancient Human Occupation of Britain in its European Context Project (AHOB 2) and sought to establish, on one hand, whether the entire Crayford sequence was in fact still preserved, and, on the other, the state of environmental preservation.

Three boreholes were drilled at 10 m intervals on a north-south alignment between Rutter's New Pit West (to the south) and Norris' Pit to the north, using two petrol driven Cobra augers; the deepest borehole (BH 2; see Figures 1 and 2) reached a depth of 12.30 m. Boreholes 1 and 3 reached depths of over 8 m, all three boreholes revealing a sedimentary sequence consistent with that historically described for the Crayford-Erith area (Table 1; Figure 2); a compacted gravel in a clay-rich matrix ("Trail") overlying a homogenous, orange-brown silty clay ("Upper Brickearth"), surmounting a fine-medium, yellow-buff sand. Some molluscan material was visible in the field from the latter deposit, which equates to the "*Corbicula* Bed" traced along the eastern edge of the Crayford Brickearths in this area. The "*Corbicula* Bed" overlay an orange-brown coarse sandy clay ("Lower Brickearth"), which in its deepest part (between 8.63 -7.06 m. OD) passed into yellow-brown laminated sands

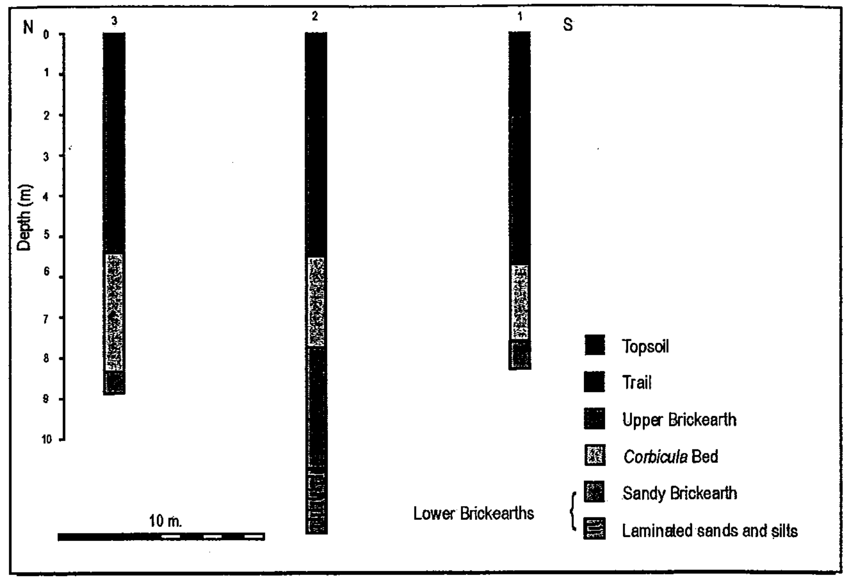

Figure 2. Deposits recorded in boreholes drilled at Holmescroft Open Space, Erith.

and silts. Calcium Carbonate nodules were visible within both the Upper and Lower Brickearths, but were more common within the upper unit. Samples from all units were taken for preliminary micropalaeontological investigations. This phase of investigations has therefore confirmed that the classic Crayford sedimentary succession is preserved beneath the southern side of Holmescroft Open Space.

Future prospects

The presence at Holmescroft Open Space of undisturbed Pleistocene sediments equivalent to those historically described throughout the area may allow some of the questions concerning the human environment and chronostratigraphic position of the site to be addressed. Initial assessment indicates that molluscs and ostracods are well-represented within the Upper Brickearths and *Corbicula* bed, including *Bithynia* opercula (J. Whitaker pers.comm.). There is, therefore, excellent potential for obtaining AAR determinations throughout the sequence, together with OSL dating, and detailed environmental sampling. A further phase of geotechnical core extraction has subsequently been undertaken, using a sonic drilling rig to aid preservation of sedimentary structures within the cores extracted, and analyses of the material obtained from these cores is currently underway.

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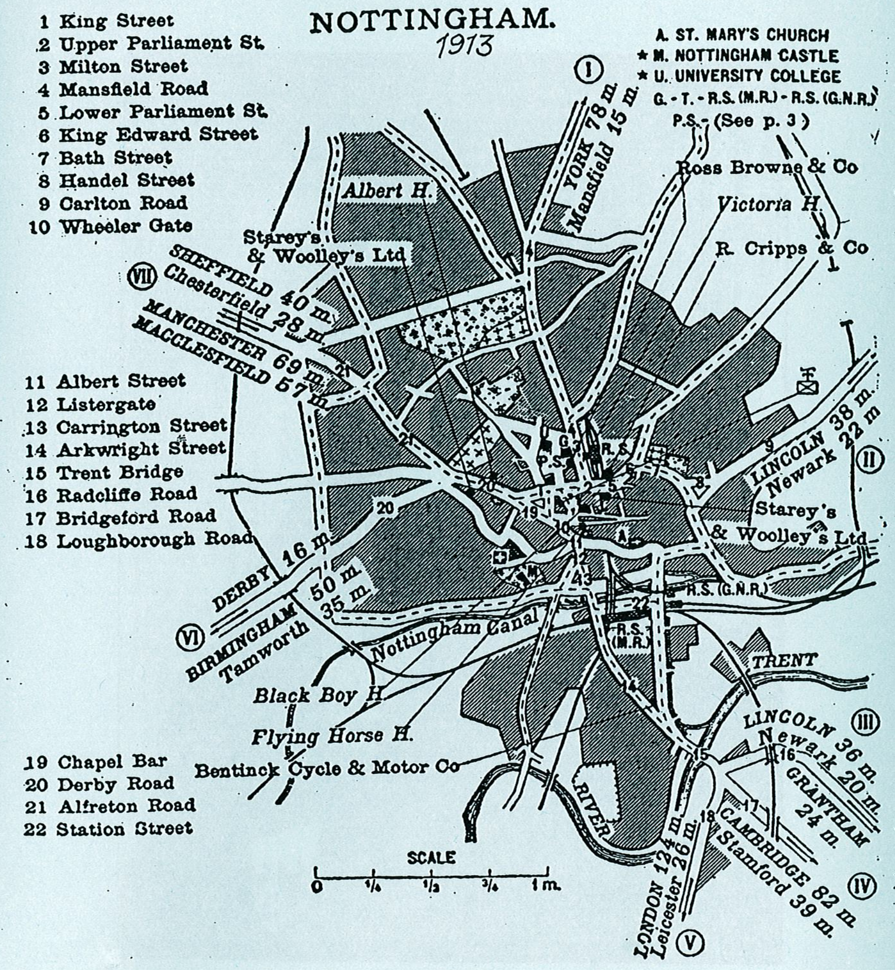

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