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Loess has been studied for 175 years. Loess was known about by the Chinese for thousands of years- but for the last 175 years it has been studied. One of the outcomes is the INQUA Loess Commission- to encourage and stimulate the study of loess ground in all its aspects. The 175 year period was celebrated by the great ‘LoessFest’ held in Heidelberg and Bonn in 1999. The ripples from LoessFest are still spreading; in LL47 we have samples from the special LoessFest issue of Earth Science Reviews; LL46 had material from the special issue of Quaternary International (both specially edited by Ed.Derbyshire).

Loess est omnis divisa in partes tres. But only for convenience; it is a very rough three part division into: 1 study of origins and formation- of loess material, loess deposits and loess ground; once a region of active discussion- now fairly quiescent. 2 loess as a palaeoclimatic indicator for the whole 2.4 Myr of the Quaternary, loess stratigraphy, loess as a matrix for snails and mammoths; busy here- this is the 2002 focus of worldwide loess research. And we should include here
dust as a climatic influence. 3 engineering problems, in particular collapsibility and subsidence, but also landslides and related problems. It is this third division which gives us our contact with Commission 18 Collapsing Soils of the International Association of Engineering Geology and the Environment IAEG. Loess ground is collapsing material; foundation engineers encounter more collapse problems with loess than with any other ground type. So we cooperate with C18, and receive valuable support from NTU. Via the C18 link we support the 9th IAEG Congress ‘Engineering Geology for Developing Countries’ Durban, South Africa, 16-20 September 2002 (see back cover).

Loess in Russian. Not just loess in Russia, we are talking about loess in Russian; loess literature in the Russian language. The LC has targets and interests in this area. Check the Russian loess section of LLO for some ideas and statements of intent. The LC wishes to close the gap between literature in Russian and literature in English. The Russian literature is vast, but even in these post-Soviet times, is not appreciated in the English speaking world (particularly by those lazy monoglot English speakers- you know who we mean).


Uzbekistan. LL46 featured loess in Uzbekistan; the map by Mavlyanova, Shermatov & Kasymov and the paper by Jefferson et al from the Tashkent 2001 ‘Resources’ conference. Since the conference a small LC group has visited Tashkent to discuss cooperative ventures in loess research. The eastern part of Uzbekistan is fantastic loess country and there is space and opportunity for joint projects. The Uzbek Academy of Sciences is keen to develop cooperative research. Contact Nadira Mavlyanova (nadira@seismic.com.uz). A small study group (D.Evstatiev, D.Karastenev, N.Mavlyanova, I.Jefferson) has been formed to consider joint projects on the loess in the former USSR; their first report should appear in Engineering Geology or Earth Science Reviews by the end of 2002.

Ukraine. The 2001 SEQS meeting in Ukraine was very successful. LL45 gave notice of this meeting; and LL47 prints a sort of report. The front cover shows a mammoth bone house and we print a few sections from field guide and abstracts volume. The LC buildings group has prepared an outline paper on the Monastery of the Caves (Pecherskaya Lavra) built in/on the loess on the banks of the Dnepr in Kyiv. The paper was presented at the SCICAP meeting in Rhodes in April 2002 (C.Page et al 2002). The Caves Monastery is now the official LC building. Our official singer is aLLa Pugacheva. Our official bird is the sand martin.

Sun Jimin. Two papers to look out for: Sun Jimin has been looking at the origin of loess on the Loess Plateau and nearby. It looks as though loess material (the actual silt) is formed in the cold mountains of High Asia; stored in the great deserts of N & NW China – and then blown down to form loess deposits. Could this mountain source: desert storage: aeolian deposition model apply in Central Asia? ‘Provenance and forming mechanisms of the loess sediments on the high mountain regions of NW China’ Quaternary Research- in press.
Onset of Asian desertification by 22 Myr ago inferred from loess deposits in China


* Institute of Geology and Geophysics, Chinese Academy of Sciences, PO Box 9825, Beijing 100029, China
† Department of Environmental Science, Clark Hall, University of Virginia, Charlottesville, Virginia 22903, USA

The initial desertification in the Asian interior is thought to be one of the most prominent climate changes in the Northern Hemisphere during the Cenozoic era1-4. But the dating of this transition is uncertain, partly because desert sediments are usually scattered, discontinuous and difficult to date. Here we report nearly continuous aeolian deposits covering the interval from 22 to 6.2 million years ago, on the basis of palaeomagnetic measurements and fossil evidence. A total of 231 visually definable aeolian layers occur as brownish loesses interbedded with reddish soils. This new evidence indicates that large source areas of aeolian dust and energetic winter monsoon winds to transport the material must have existed in the interior of Asia by the early Miocene epoch, at least 14 million years earlier than previously thought5. Regional tectonic changes and ongoing global cooling are probable causes of these changes in aridity and circulation in Asia.

Uplift of the Himalayan–Tibetan plateau1-3 and changes in land–sea distribution4 have been invoked as driving forces behind long-term Cenozoic climate deterioration. One problem in understanding these links is defining the timing of major tectonic and climatic changes, including the onset and development of aridification in Asia. Continuous long-term records with well constrained chronologies are especially important.

Desert loess is particularly valuable as an indicator of dryland evolution because sizeable deserts are needed as sources for aeolian deposits5-7. As a result, most studies focus on regions which receive wind-blown sediments produced in or near deserts. In northern China, nearly half a million square kilometres are covered by aeolian deposits7.

The well known loess–soil sequences of the last 2.6 million years (Myr) contain more than thirty major soil units interbedded with loess8-9. These are underlain at some localities in the eastern Loess plateau by the Hipparchion Red–Earth Formation (also called Red Clay)9-11. Palaeomagnetic measurements date the lower boundary of the Red–Earth Formation to 2.6–8 Myr ago12,13. Detailed studies confirm that at least the portion of this sequence younger than 6.2 Myr is of aeolian origin9. This places the minimum age of initiation of sizeable deserts in Asia in the late Miocene13.
Thick silty deposits with numerous palaeosols are also widely distributed in the western loess region, an area between the Liupan mountains and the Tibetan plateau, representing one-fifth of the area of the Loess plateau (Fig. 1). Neither the origin nor stratigraphy of these layers has been investigated in detail. The sequences reported here were found in Qinan county (Gansu province), about 160 km northeast of the Tibetan plateau and about 300 km south of the Tengger desert (Fig. 1). The present-day climate at Qinan is semi-arid with a mean annual rainfall of 400 mm and an annual mean temperature of 10.4°C.

The region has experienced strong erosion, and its topography is characterized by valleys flanked by elongated hills with thick and relatively flat sedimentary sequences deposited on metamorphic bedrock of early Palaeozoic age. At the bottom of the sedimentary sequences lies a waterlain deposit 10–30 m thick, consisting of reddish clay and containing abundant stratified sandy layers and bedrock fragments. Hill tops are unconformably mantled by pale-brown Quaternary-period loess up to 30 m thick. In between lies the Miocene loess sequence reported here.

Figure 1 Maps showing the Loess plateau, Tibetan plateau, deserts in northern China and location of sites studied.
**LATE PLEISTOCENE LOESS-SOIL AND VEGETATIONAL SUCCESSIONS OF THE MIDDLE DNIEPER AREA**

Natalia GERASIMENKO

Institute of Geography of National Acad. of Sci. of Ukraine, 44, Volodymyrska str., Kyiv, 01034, Ukraine, e-mail: geras@gs.kiev.un

According to the Ukrainian Stratigraphical Framework of the Pleistocene (Veklich et al., 1993), there are 4 main loess units and 4 paleosol units above the Dnieper (Santanian) unit. From bottom to top, the soil units are Kaydaky, Prylucky, Vytaichiv and Dofinivka, loess units are Tyasym, Uday, Bug and Prychernomorsk. The following sequence of soils and the corresponding vegetational succession is characteristic for the complete sections of Kaydaky unit (kd): ferrigenous gley or turf gley soils - *Picea* forest (*kd*1), light loam - *Pinus-Betula* forest (*kd*1a), Bt and A2 horizons of brown podzolized soil (parabraunerde) - *Pinus* forest with admixture of *Ulmus* and *Quercus*, then *Ulmus-Quercus* forest/forest-steppe (*kd*1b), A1 horizon, or chernozem - *Herbetum* mixtum-Gramineae steppe (*kd*1c), Bt and A2 horizons of grey forest soil - *Quercus-Carpinus* forest, A2 horizon - *Pinus* forest with broadleaf species and *Picea* (*kd*2), chernozem - *Betula-Pinus* forest-steppe (*kd*2). The vegetational succession of the Kaydaky unit resembles that of the Mikelino (Eemian) interglacial (Grichuk, 1972; Bolikhovskyaya, 1995), though shows features of vegetational development in a drier climate (NAP is higher). *Tyasym* unit (ts) is a thin loess/loam formed under *Atemisia-Chenopodiaceae* steppes (Turko, 1973) which corresponds to the Early Glacial stadial.

The soil-vegetational succession of Prylucky unit (pl) is as following: turf-chernozem soil - meadow steppe (*pl1*), B horizon of forest soil - *Carpinus-Quercus* forest/forest-steppe (*pl1a*), A1 horizon, or chernozem - meadow steppe (*pl1b*), loess/loam - *Gramineae* steppe (*pl1c*), turf-carbonate soil - *Artemisia*-*Gramineae* steppe (*pl1d*), boreal brown soil - *Betula-Pinus* forest with few broadleaf species (*pl2b*), turf-carbonate soil - *Gramineae* steppe (*pl2c*). The *pl1* and *pl2* subunits can correspond to the Early Glacial interstadials, separated by a stadial (*pl3*). Uday unit (ud) is TL-dated to about 70 kyr BP (Goshnik et al., 2000). The loess was formed under *Herbetum*-*Gramineae* herbetum mixtum steppe. Few acro-boreal plants appeared.

The soil-vegetational succession of Vytaichiv unit (vt) is as following: brown gley soil - *Pinus* forest with admixture of broadleaf species (*vt1*), loam - *Herb-betum* mixtum-Gramineae steppe (*vt1a*), boreal brown soil - *Pinus* forest with admixture of broadleaf species (*vt1c*), loess - *Gramineae* steppe (*vt1d*), turf soil - *Nardus* in gullies (*vt1e*). As the upper soil is "C-dated to 31-32 kyr BP (Gerasimenko, 1999), the Vytaichiv unit possibly corresponds to the interstadials of the Middle Pleniglacial, separated by the stadials. Bug unit (bg) consists of the lower subunit (bg1) which includes several embryonic soils separated by loesses, and of the upper subunit (bg2) of homogenous loess. The embryonic soils were formed under boreal forest-steppe, bg1 loesses - under *Gramineae* steppe, bg2 loesses - under *Artemisia*-*Gramineae* steppe. Dofinivka unit (df) is a thin chernozem formed under *Artemisia* steppe, or a thin brown soil of boreal forest-steppe. Prychernomorsk unit (pc) is a thin loess formed under *Artemisia* steppe. The above three units have pollen of arco-boreal plants, and can be correlated with the Upper Pleniglacial and Late Glacial.
THE MIDDLE AND LATE PLEISTOCENE PALEOSOLS OF UKRAINE

Zhanna MATVIISHYNA

Institute of Geography, National Academy of Sciences, 44 Volodymyrska, Kyiv 01034, Ukraine, phone: 38-044-2249357, e-mail: matvishnya@manowar.kiev.ua.

Rhythmic alternation of warm stages of soil formation and cold stages of loess formation is one of the principal regularities of the Pleistocene environmental development. The interglacial warm stages were recorded by soil suites or individual soils, as well as by alluvium. The glacial cold stages were recorded by tills, glacio-fluvial deposits, loesses and alluvium. The warm stages (Martunusha, Lubny, Zavadivka, Kaydaky, Pryluky, Vytyachiv, Dofinivka, Holocene) are represented by suites of 1–5 soils, more often of 1–2 soils. Initial, optimum and final phases of the soil formation reflect a change of climatic conditions from cold and dry during the initial phase, humid and warm during the optimum, to more continental and arid at the end of the stage. The soils change according to the geographic zonality. Genesis, soil suites structure and changes of soils in time and space are shown in the Regional scheme of the palaeogeographical stages of the PlIOCene and Pleistocene of Ukraine (Velyktyk, Sirenko, Turlo, Melnychuk, Matviishyna, Gerasymenko et al., 1993), in monographs and papers of the Ukrainian palaeogeographical team by M. F. Velyktyk. Soil processes changed evolutionary, zonally and regionally.

The change of the pedogenic processes during warm stages: from subtropical (or similar to them) during the Early Pleistocene (formation of red- and brownish-cinnamonic soils, red-brown soils) to temperate-warm, temperate conditions during the Mid Pleistocene (formation of brown, grey forest soils, chernozem-like, chernozem, cinnamon-grey and greyish-cinnamonic soils of more humid variants than the recent ones) is one of the trends of the Pleistocene soils development. The Late Pleistocene pedogenesis shows the trend to increase of climatic continentality and aridity (formation of common and southern chernozems, chestnut, reddish- and greyish-brown soils in the south of Ukraine). Chernozems in the territory of Ukraine appeared during the Lubny time. Only during the late Pleistocene, soil zonality became similar to the recent one (but not completely analogous).

None of the Pleistocene soils suites duplicates another suite as for a suite structure and soil types. Even the soils of the Middle and Late Pleistocene, regarded to be most similar to the recent soil types, still show specific pedogenetic features. The Vytyachiv soils are the most special and have no analogues in the present soil cover of Ukraine.

Soil formation was intensive during the warm stages but it also did not stop during the cold stages, if to consider a loess as a particular soil formed under accumulative processes prevailing over the pedogenetic ones. Initial soils of a tundra genesis (from 1 to 5) are often observed in loesses and in deposits of cold stages. A trend to continentalization and aridization from the Early to Late Pleistocene is also recognized for the cold stages (the most typical “loessic” features are characteristic for the Bug deposits, but not for the Lower Pleistocene loesses).

Fig.17. Mammoth-bone dwelling from the Mezhyrich site, reconstructed under the supervision of Acad.I.Pidoplichko (a - the entrance, b - the back). The structure (Dwelling No.1) was about 5 meters across at the base. Skulls are placed in a semicircular to form the interior base wall. The outer and upper part of the wall consisted of 93 mandibles arranged “chin down”. The roof may have been made of hides supported by a wood frame and held in place by an assortment of bones. The upright bones in front of the entrance came from the legs of the mammoth. A skull decorated with designs in red ochre can be seen just behind them (Korniets et al., 1984)
EARTH-SCIENCE REVIEWS—Volume 54—Nos. 1–3

Special Issue

RECENT RESEARCH ON LOESS AND PALAEOSOILS, PURE AND APPLIED

Selection of Keynote Addresses presented at "LOESSFEST '99", an international conference held in the University of Bonn, 25 March–1 April 1999. The meeting was sponsored by the International Union for Quaternary Research (the Commission on Loess) and the International Geological Correlation Programme (Project 413—'Understanding Future Dryland Changes from Past Dynamics').

Edited by

EDWARD DERBYSHIRE
Centre for Quaternary Research, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK

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Some major events in the development of the scientific study of loess

I.J. Smalley a, I.F. Jefferson a, T.A. Dijkstra b, E. Derbyshire a,c

a GeoHazards Group, Faculty of Construction and the Environment, Nottingham Trent University, Burton Street, Nottingham NG1 4BU, UK
b School of Built Environment, Coventry University, Coventry, UK
c Centre for Quaternary Research, Royal Holloway, University of London, London, UK

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Abstract

A European view of loess history is presented. The major events, or ‘great moments’, considered are: (1) Karl Caesar von Leonhard names loess; (2) Charles Lyell popularises loess; (3) Richtofen solves ‘The Loess Problem’; (4) John Hardcastle relates loess to climate; (5) Pavel Tuktovskii makes clear the role of glaciers in loess genesis; (6) V.A. Obручев makes the case for desert loess; (7) L.S. Berg propagates the ‘in-situ’ theory of loess formation; (8) Rudolf Gräbmann maps loesses in ‘Europe’; (9) R.J. Russell adopts the ‘in-situ’ idea; (10) Liu Tungsheng pioneers Chinese loess stratigraphy; (11) Julius Finkel focuses loess research in the INQUA Loess Commission; and (12) George Kukla renews the Quaternary by way of loess research. The need for Chinese, Russian, and North American accounts to balance an authoritative view of loess history is recognized. The truly critical moment in the 20th century was the discovery by Liu Tungsheng and his colleagues of multiple palaeosols within the Chinese loess and the associated realization that these implied a multi-event Quaternary. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: loess; scientific investigation; theories of formation; loess maps; stratigraphy; Quaternary events; climatic links; major loess investigations; loess history

I. Introduction

There are two possible starting points for any history of the study of loess. There is an ancient beginning, sited in China, over a thousand years ago, and not well documented in western languages, and there is a more recent origin. We can put a finger on the beginnings of the scientific study of loess in Heidelberg, around 1820. There are references to loess (Chinese huang-tu: the yellow earth) in the ancient Chinese literature, but this aspect has been neglected until very recently: it certainly requires further study. On the other hand, the 175 years of ‘European’ loess history are fairly well documented.

* Corresponding author. Fax: +44-115-9486650.
E-mail address: ian.jefferson@not.ac.uk (I.F. Jefferson).

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175 years of loess research in Germany—long records and "unconformities"
Ludwig Zöller, Arno Semmel

Geographisches Institut, Rennweg-Str. 6, D-65119 Hefhlin, Germany
Theater-Kücher-Str. 6, D-65119 Hefhlin, Germany

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Abstract
Loess research in Germany has a long tradition dating back to the early works of von Leonhard (von Leonhard, K.C., 1823/1824. Charakterist. der Feisarten. 3 Bde., 772 S. Heidelberg (J. Engelmann).) and his contemporary geoscientists. Ever since that time, German researchers and loess research within Germany have provided important contributions to the international "state of the art". To date, however, perceptual "unconformities" have existed in both the continuity of loess research in Germany and the interpretation of the loess record in both the palaeoecological and the stratigraphic sense. This review briefly highlights some relevant periods of loess research in Germany and the approaches adopted, from the early days he present. The development of a refined stratigraphy of the last glacial loess in Germany during the second half of the 20th century is reviewed in the contribution by A. Semmel. Fundamental contributions were first published by Schindel, Ising and Brunnauer. In the course of the subsequent work of the Loess Commission of the International Union for Quaternary Research (QUA), the stratigraphy of the Würmian loess has since been refined in almost all loess regions of many, and schemes consistent in their fundamental features have been published. In recent years, contributions have aged on age determination, in particular those based on luminescence dating technique. © 2001 Elsevier Science B.V. rights reserved.

Introduction
There is a long tradition of loess research in Germany. Even before von Leonhard (1823/1824) coined the term "loess", this characteristic sediment was mentioned in older articles and books (as can be seen in the references in von Leonhard's volume). This paper highlights important German contributions to loess research, beginning with the work of von Leonhard. It focuses on the two aspects, namely "long records" and "discontinuities''. Both are understood in both a stratigraphical sense (i.e., constitution and refinement of loess stratigraphy; see also the contribution by A. Semmel, Section 6) and in a historical-scientific sense. With reference to the

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The role of dust in climate changes today, at the last glacial maximum and in the future
Sandy P. Harrison, Karen E. Kohfeld, Caroline Roelandt, Tanguy Claquin

Max-Planck Institute for Biogeochemistry, Postfach 100164, D-07701 Jena, Germany
Dynamic Paleoclimatology, Lund University, Box 117, S-221 00 Lund, Sweden
Laboratoire des Sciences du Climat et de l'Environnement, L'Orme des Merisiers, Batiment 701, F-91191 Gif-sur-Yvette Cedex, France
Euro Bosq SA, Tour Eiffel, 21 Young, F-92037 La Défense Cedex, France

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Abstract
Natural mineral aerosol (dust) is an active component of the climate system and plays multiple roles in mediating physical and biogeochemical exchanges between the atmosphere, land surface and ocean. Changes in the amount of dust in the atmosphere are caused both by changes in climate (precipitation, wind strength, regional moisture balance) and changes in the extent of dust sources caused by either anthropogenic or climatically induced changes in vegetation cover. Models of the global dust cycle take into account the physical controls on dust deflation from prescribed source areas (based largely on soil wetness and vegetation cover thresholds), dust transport within the atmospheric column, and dust deposition through sedimentation and scavenging by precipitation. These models successfully reproduce the first-order spatial and temporal patterns in atmospheric dust loading under modern conditions. Atmospheric dust loading was as much as an order-of-magnitude larger than today during the last glacial maximum (LGM). While the observed increase in emissions from northern Africa can be explained solely in terms of climate changes (colder, drier and windier glacial climates), increased emissions from other regions appear to have been largely a response to climatically induced changes in vegetation cover and hence in the extent of dust source areas. Model experiments suggest that the increased dust loading in tropical regions had an effect on radiative forcing comparable to that of low glacial CO2 levels.

Changes in land-use are already increasing the dust loading of the atmosphere. However, simulations show that anthropogenically forced climate changes substantially reduce the extent and productivity of natural dust sources. Positive feedbacks initiated by a reduction of dust emissions from natural source areas on both radiative forcing and atmospheric CO2 could substantially mitigate the impacts of land-use changes, and need to be considered in climate change assessments. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Dust cycle; Dust modelling; Radiative forcing; Biogeochemical cycles; Land-surface conditions; Last Glacial Maximum climates; Future climate changes

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DIRTMAP: the geological record of dust
Karen E. Kohfeld *, Sandy P. Harrison
Max Planck Institute for Biogeochemistry, Postfach 10 01 04, D-07701 Jena, Germany
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Abstract
Atmospheric dust is an important feedback in the climate system, potentially affecting the radiative balance and chemical composition of the atmosphere and providing nutrients to terrestrial and marine ecosystems. Yet the potential impact of dust on the climate system, both in the anthropogenically disturbed future and the naturally varying past, remains to be quantified. The geological record of dust provides the opportunity to test earth system models designed to simulate dust. Results of models can be obtained from ice cores, marine sediments, and terrestrial (loess) deposits. Although rarely equivocal, these records document a variety of processes (source, transport and deposition) in the dust cycle, stored in archives as changes in clay mineralogy, isotope, grain size, and concentration of terrigenous materials. Although the traction of information from each type of archive is slightly different, the basic controls on these dust indicators are the same. Changes in the dust flux and particle size might be controlled by a combination of (a) source area extent, (b) dust emission efficiency (wind speed) and atmospheric transport, (c) atmospheric residence time of dust, and/or (d) relative contributions of dry settling and rainout of dust. Similar changes in mineralogy reflect a source area change in mineralogy and (b) shifts in atmospheric transport. The combination of these geological data with process-based, wind-modeling schemes in global earth system models provides an excellent means of achieving a comprehensive picture of the global pattern of dust accumulation rates, their controlling mechanisms, and how those mechanisms may vary regionally. The Dust Indicators and Records of Terrestrial and Marine Environments (DIRTMAP) database has been established to provide a global palaeoenvironmental data set that can be used to validate earth system models simulating dust cycle over the past 150,000 years. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Dust; Palaeoclimate; Quaternary; Accumulation rates

Introduction: why is dust important?
The concentration of dust in the atmosphere (i.e. atmospheric dust loading) influences the climate system through affecting radiative forcing, through chemical reactions with other atmospheric constituents, and through acting as a source of nutrients to biological systems (Rahn et al., 1979; Swap et al., 1992; Duce, 1995; Lacis and Mishenko, 1995; Dentener et al., 1996; Li-Jones and Prospero, 1998; Zhang and Carmichael, 1999; Harrison et al., in press). Although the role of dust in the climate system is poorly understood in quantitative terms, it is clear that changes in atmospheric dust loading could potentially have a significant impact on future climate changes (Andreae, 1995; Tegen and Fung, 1995; Tegen et al., 1996; Shine and Foster, 1999).

Pedogenic modification of loess: significance for palaeoclimatic reconstructions
Rob A. Kemp *
Centre for Quaternary Research, Department of Geography, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK
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Abstract
This review considers the role of pedogenic processes in modifying wind-blown dust (loesses), concentrating particularly on the ways that resulting properties may be interpreted as indicators of past climatic conditions and changes. Emphasis is placed on the sequences of palaeosols developed within loess deposits that are frequently regarded as some of the best terrestrial equivalents of marine-sediment records of long-term global climatic change. A palaeosol is generally interpreted in terms of the broad pedogenic processes and environments assumed to be currently responsible for that type of soil forming at the present surface. Even the very presence of a palaeosol may have palaeoclimatic significance, however, in that it is often taken to indicate a period of relative land surface stability and warmer and/or moister conditions between cold and/or arid phases of loess accumulation. In reality, it may be more useful to consider many loess–palaeosol sequences in terms of changing balances between pedogenesis and loess accumulation over geological time. In most regions, it seems that the balance swings towards pedogenesis during interglacials or interstadials when sediment supply and transport are limited and the climate is warmer and/or wetter. Where accumulation rates are still appreciable during these 'still-forming intervals', however, the soils and palaeosols may be accretionary with surface build-up keeping pace with pedogenesis. Welding may also occur where covering sediments are insufficiently thick to isolate an underlying palaeosol from the effects of pedogenesis active at a new land surface. Further complications occur due to reworking of palaeosols and syndepositional pedogenic alteration of loess units. Generally, such pedocomplexes can only be deciphered if the different pedogenetic, geomorphological and sedimentary processes are identified and ordered within a pedosedimentary reconstruction. A recent trend has been to treat some loess–palaeosol sequences as quasi-continuous time series, particularly when comparing depth functions of climatic-proxy properties such as magnetic susceptibility and grain size with marine and ice-core isotope curves. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Loess; Palaeosol; Palaeoclimate; Pedosedimentary processes; Pedocomplex

1. Introduction
Loess can be defined simply as a terrestrial clastic sediment, composed predominantly of silt-size particles, which is formed essentially by the accumulation of wind-blown dust (Py, 1995, p. 653). Periglacial, perimontane and peridesert forms are often identified, their differentiation mainly based upon supposed source areas (Py, 1995). While disputing Pécé’s (1990) assertion that wind-blown dust necessarily has to undergo 'loessification' before it can be
Loess biostatigraphy: new advances and approaches in mollusk studies

Denis-Didier Rousseau*

Paléoenvironnement et Palynologie, Institut des Sciences de l’Évolution, Université Montpellier II, Place Eugene Bataillon, case 61, 34095 Montpellier Cedex 05, France

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Abstract

Since the beginning of the 20th century, loess biostatigraphy has been strongly influenced by investigations of mollusks, those shells constituting the major fossil remains found in loess sequences. The earlier studies mostly involved identifying species and determining biomes or assemblages with regard to the presence or absence of key species, using the classic concept of bioclines. Although this provided accurate elements with which to define an indicator biostatigraphy, the time resolution was not always sufficiently precise to connect those studies with the more recent and high resolution analyses that are now routine in Quaternary investigations. This paper reviews mollusk studies carried out in Northern Hemisphere loess sequences and shows that a consideration of them, as both biostatigraphic and palaeoclimatic indices, enhances their potential and opens up particularly interesting areas of research. The first example demonstrates that the last glacial mollusk assemblages in North America show compositional similarities to those in Europe. The climatic interpretation, however, appears more restricted by local conditions. The second example shows that climatic conditions can be used to infer variations in the composition of bioclines and, thus, address the significance of the distributional pattern of key species. The third example demonstrates the value of high-resolution studies and the potential of comparing the results of mollusk analyses with other proxies as an underpinning of the biological interpretation. Finally, the need for more high-resolution investigations in both North America and Asia is stressed. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Mollusk; Loess; Mollusk assemblages; Biotic stratigraphy; Palaeoclimatology; Northern Hemisphere

1. Introduction

Loess biostatigraphy has always been based on the very few faunal or floral remains that loess scientists have been lucky enough to find (Heim et al., 1982; Kukla, 1975; Veklich, 1969; Zhao, 1996). Although vertebrates provide a rather broad basis for such studies (Bouchud and Wernert, 1961), for years, other fossils such as pollen (Bastin, 1969; Frenzel, 1964, 1987; Gerasimenko, 1988; Sun et al., 1995; Zelikson, 1986), phytoliths (Wu et al., 1995) and mollusks provided reliable biostatigraphical references, applied according to the state of the art at the time of investigation. Numerous examples can be

* Paléoenvironnements et Palynologie, Institut des Sciences de l’Évolution (UMR CNRS 5554), Université Montpellier II, Place Eugene Bataillon, case 61, 34095 Montpellier Cedex 05, France. Tel: +33-667-144-652; fax: +33-667-042-032.
E-mail address: denis@itee.univ-montp2.fr (D.-D. Rousseau).

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Historical developments and recent advances in amino acid geochronology applied to loess research: examples from North America, Europe, and China

Eric A. Oches a,*, William D. McCoy b

a Department of Geology, University of South Florida, 4202 East Fowler Ave., SCA 528, Tampa, FL 33620-5201, USA
b Department of Geosciences, University of Massachusetts, Amherst, MA 01003-5820, USA

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Abstract

Amino acid geochronology provides important chronostratigraphic insight in the regional correlation and paleoclimatic evaluation of loess–paleosol sequences in the midwestern US, throughout western, central, and eastern Europe, and in China. In general, loess of the last four glacial cycles, corresponding to marine oxygen-isotope stages (OIS) 2–4, 6, 8, and 10, respectively, can be distinguished on the basis of allolsoleucine/isoleucine (A/I) ratios measured in fossil gastropod shells preserved in the loess. The racemization reaction is much slower in older samples, resulting in decreased temporal resolution. In the midwestern US and Europe, it is not possible to confidently subdivide the last glacial cycle on the basis of aminostratigraphic data. However, in China, where effective temperatures were higher during the Late Pleistocene, loess above and below L1SS1, the OIS-3 interstadial paleosol, can be distinguished using amino acid racemization data.

With improvements in analytical methods, multiple amino acid D/L-enantiomers are now being measured using reverse-phase liquid chromatography. Aiparic acid racemizes at a higher rate than the traditionally measured allolsoleucine/isoleucine diastereomers and can be measured more rapidly. This development offers hope for better temporal resolution and enhanced stratigraphic subdivision of loess units than has been achieved previously. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Amino acid geochronology; Pleistocene; Loess; Stratigraphy; Mollusks

1. Introduction

Chronostratigraphic investigations of loess–paleosol sequences, beyond the reliable range of radiocarbon or luminescence dating methods, have been limited by a lack of applicable dating techniques for assessing the ages and regional stratigraphic correlations of these sedimentary formations. In the past two decades, amino acid geochronology has been successfully applied to fossil gastropod shells from calcareous loess deposits in the stratigraphic correlation and paleoclimatic evaluation of loess–paleosol sequences in the Mississippi Valley.

* Corresponding author. Tel.: +1-813-974-7531; fax: +1-813-974-2654.
E-mail addresses: oches@chuma1.cas.usf.edu (E.A. Oches), wdmccoy@geo.umass.edu (W.D. McCoy).

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The agricultural importance of loess

J.A. Catt

Department of Soil Science, AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, UK

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Abstract

Loess soils are among the most fertile in the world, principally because the abundance of silt particles ensures a good supply of plant-available water, good soil aeration, extensive penetration by plant roots, and easy cultivation and seedbed production. Also micaceous minerals in the silt and clay fractions provide an adequate supply of potassium for most crops, and the large amounts of total nitrogen in chernozems can maintain moderate yields of cereals without fertilizer additions. However, loess soils often contain little clay, which leads to loss of organic matter from soil types other than chernozems under arable cultivation; the resulting structural instability of the surface soil causes problems of crusting, poor germination of crops and erosion. This paper reviews early opinions of the fertility of loess, and summarises later scientific assessments of loess soils in USA, China, eastern Europe and Britain. In regions of thin or barely extensive loess deposits, such as UK and parts of USA, loess probably plays an important role in maintaining yields of arable crops, and needs special measures to protect it from the increasing erosion noted in recent decades. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: loess; soil; agriculture; erosion; soil crusts; plant nutrients

1. Introduction

Throughout the world, soils derived from loess have long been regarded as among the most fertile. However, the exact meaning of this description is unclear. Soil fertility depends on a range of physical and chemical properties that are determined by present climatic and biological factors, past climatic and geomorphological history and recent human activities as well as by the nature of the soil parent material. One must also distinguish between natural (inherent) soil fertility sustained without use of fertilisers, organic manures, irrigation or special cultivation techniques and fertility that depends on one or more of these treatments. At low levels of soil and crop management, as in prehistoric periods or present-day underdeveloped regions, differences in inherent fertility have maximum effect on plant growth and crop yields. As management improves, differences in growth and yield between soil types become smaller and may even disappear. However, in conditions of uniformly high levels of management, productivity differences between soil types often re-emerge, sometimes because of the same inherent soil factors as influenced fertility under low or zero management. Statements and opinions concerning the high fertility of loess-derived soils may refer to any of these three stages, though it is likely that most reflect the success of primitive, low-management agriculture in early centres of civilisation, such as northern China, eastern and central Europe.

2. Early opinions

Early comments on the apparently high fertility of soils derived from loess were made in several countries in the middle of the 19th Century, not long after the first recognition of loess as a distinct sediment type. They were made about the loess in Germany (Foesterle, 1854; Von Guernel, 1861; Stur, 1869), Austria (Suess, 1865; Von Hauer, 1875, p. 640), USA (Hilgard, 1860; Hayden, 1867, 1872) and China (Von Richthofen, 1872, 1877, Chap. 2) and often included possible reasons for the fertility. Richthofen observed that the loess region of north China has been continuously cultivated for grain crops for over 4000 years almost without use of manure, and attributed the fertility to the porosity of loess, which enables it to absorb compound gases containing carbon and nitrogen from the atmosphere and to provide water and dissolved nutrients to plants by capillary rise in periods of dry weather. Pumppell (1879) supported this suggestion, and later Keyes (1898) commented: "Loess districts appear to be areas of exceptional fertility. Plant life flourishes luxuriantly..." when in adjoining tracts not covered by the deposit only a scant vegetation is supported. The peculiar porosity of the loess gathers in the maximum amount of water, holds it, and gives it out again gradually during the dry season. The dense vegetable growth well protects the loess from the destructive effects of wind and water."

Free (1911) added that the long-term fertility of the Chinese loess is partially explained by the prevalent use of night soil, and even more largely by the habit of spreading each year on fields located on the steps of the loess terraces fresh material dug from the perpendicular face of the next higher terrace. A certain amount of new soil material is thus regularly supplied. The material supplied by the frequent dust storms is no doubt also a factor in the maintenance of fertility; in fact the beneficial action of these storms is well known to the inhabitants both in China itself and in Central Asia. He also reiterated earlier opinions that loess soils have "a peculiarly good physical texture...which allows the free movement of and absorption of water, aids the maintenance of a good tilth, and encourages a proper sanitary condition of the soil."

Other early workers who commented in general terms on the apparent fertility of loess include Waehnschaffe (1885), Bömer (1889), Weltler (1893), Obučev (1895), Norten (1905) and Calvin (1906). Subsequently, Merrill (1921), Wooldridge and Linton (1933), Smalley (1968) and Chesworth (1982) have expressed similar opinions.

Free’s suggestion that dust storms increase soil fertility was based on earlier observations in various parts of Asia by Johnson (1867), Durand (1878) and others. Aeolian dust deposition has certainly continued throughout historic times in many parts of the world (Simonsen, 1995), including the loess areas of north China (Liu et al., 1981; Zhang, 1984), where it has averaged 100 mm/1000 years over the whole of the Holocene period (Pye and Zhou, 1989). However, many of the early observations of increased fertility applied to semi-arid areas with regosols and other coarse soils, in which the main advantage of any fine silt accumulations would be to increase soil water retention. Modern dust can have no beneficial effect in this way on soils in thick loess deposits. A more likely benefit in loess areas is an increase in organic matter where the dust is either derived from soils rich in organic matter or has been enriched in organic matter during transportation. The organic component of wind-blown dust can be up to 20 times greater than that of the parent soil (Delany and Zenzelskys, 1976), though the concentration factor depends on wind velocity (Zenzelsky et al., 1976).

Further possible beneficial effects of dust deposited on soils other than in thick loess are improved potassium, magnesium, calcium and mi-
Geological hazards in loess terrain, with particular reference to the loess regions of China

Edward Derbyshire
Centre for Quaternary Research, Department of Geography, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK
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Abstract

The considerable morphodynamic energy provided by the continuing tectonic evolution of Asia is expressed in high topographic potential and very high rates of sediment production that make this continent unequalled as a terrestrial source of loess. Many of these environments are hazardous, threatening human occupation, health and livelihood, especially in regions of dense population such as the loess lands of north China. Dry loess can sustain nearly vertical slopes, being fundamentally under-saturated. However, when locally saturated, it disaggregates instantaneously. Such hydrocompaction is a key process in many slope failures, made worse by an underlying mountainous terrain of low-porosity rocks. Gully erosion if loess may yield very high sediment concentrations (> 60% by weight). Characteristic vertical joining in loess influences the hydrology. Enlarged joints develop into natural sub-surface piping systems, which on collapse, produce "loess karez" terrains. Collapsible loess up to 20 m thick is common on the western Loess Plateau. Foundation collapse and cracked walls are common, many rapid events following periods of unusually heavy monsoonal rain. Slope failure is a major engineering problem in thick loess terrain, flow-slide and spread types being common. The results are often devastating in both rural and urban areas. An associated hazard is the damming of streams by landslides. The human population increases the landslide risk in China, notably through imprudent land use practices including careless land utilization. A number of environmentally related endemic diseases arise from the geochemistry of loess and its groundwaters, including fluorosis, cretinism, Catchin–Beck Disease, Keshan Disease and goitre. The Chinese desert margins also have a major atmospheric dust problem. The effect of such dust upon human health in these extensive regions, including many large cities, has yet to be evaluated, but pneumoconiosis is thought to affect several million people in north and west China. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Loess; Collapsing soil; Mass movement; Endemic diseases; Respirable dust

1. Introduction

Drylands cover vast areas of central, east and south Asia, including about 30% of the total area of China (Fig. 1). Many of China's deserts are of the warm type, with July temperatures > 24°C. However, most have severe winters, with mean minima for the coldest month < -8°C, with extensive areas < -12°C. Most of Asia's deserts lie at moderate to high altitudes. For example, the great Plateau of Tibet (Qinghai–Xizang), at an altitude of ca. 5000 m above sea level, is a cold desert. Loess terrain in central and eastern Asia is generally peripheral to the

deserts and piedmonts, as shown in the well-known map by Rozycki (1991), Fig. 2.

The past and present distributions of the drylands of central and eastern Asia are fundamentally related
to the Asian monsoon and its fluctuations. Over much of the region, cold, dry winds from between north and west dominate the region under the influence of the Mongolian–Siberian high-pressure sys-

Fig. 2. Loess distribution in Eurasia, after Rozycki (1991) with minor changes. Key to legend number: (1) loess and loess-like deposits; (2) alluvial plains of washed out loessic dust; (3) sand dunes; (4) stony desert (gobi); (5) alkaline flats and sabkha; (6) mountain areas above 1300 m a.s.l.; (7) northern margin of present-day permafrost; (8) southern margin of Pleistocene permafrost; (9) western limits of aeolian dust in the Aral and Caspian seas; (10) main tracks of polar air masses; (11) main tracks of Atlantic depressions; (12) local wind tracks.
provinces), much of it being loessic alluvium susceptible to little collapse. The transition zone from loess to sandy desert, north of zone IV, is a region of thin, sandy loess also with low collapsibility.

The collapsibility of loess has serious effects on gently sloping ground considerable distances from the loess hillslopes. Ground fissures more than 1 km long and as much as 14 m wide are known. Some of these result from faulting and others are a response to heavy rainfall. A series of fissure zones cuts across the gentle slope on which the ancient Chinese capital, Xian, is built. (Fig. 11) Some individual belts have been traced for distances up to 8 km. The effects of fissuring and subsidence have been made worse by abstraction of groundwater to supply urban populations in cities such as Xian and Taiyuan. Subsidence in parts of the Xian district between 1962 and 1983 reached 777 mm in places (i.e. 30–70 mm year\(^{-1}\)). Extreme rates of 123 mm/year have been recorded, with the pattern of subsidence closely following that of depression of the water-table. Around Taiyuan, in Shanxi Province, subsidence in the period 1980–1986 totalled 700 mm (Sun, 1988).

3.2.2. Slope instability: mass movements

Mass movements pose important engineering problems in many regions of loess-covered terrain in central and eastern Asia. Landslides, and associated loess debris flows, are a perennial threat to rural communities and their cultivated fields. The great Gansu earthquake of 1920, involving thick loess, was perhaps the most famous example, although the Chinese records contain thousands of similar events: few of these have been closely documented, and only rare examples have been analysed and modelled. Loess landslides are widely distributed in north China

17. The Kovnir Building (the bakery and bookshop). 17th–18th cc.; Museum of Historic Treasures of Ukraine.
19. Building of Flavian’s library (1908) and the residence of the Lavra Vicar (18th c.); Exhibition of M. Siadristy’s Microminiatures; the exhibition hall; cafe.
20. Ciborium over the former monastery well. Early 20th c.
21. The Metropolitan Residence (1727) and the Metropolitan Church (1904–1905); State Museum of Ukrainian Folk Decorative Art.
22. The Refectory Church and the Refectory. 1893–1895.
The International Association of Engineering Geology and the Environment (IAEG), the South African Institute of Engineering and Environmental Geologists (SAIEG) and the South African Council for Geoscience extend a warm invitation to engineering geologists, scientists and engineers from related disciplines and societies to attend the 9th IAEG Congress in Durban, South Africa, from 16th to 20th September 2002.

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Michel Bénet, Chairman - Local Organising Committee
Organising Committee, P. O. Box 1283, Westville, 3630, South Africa
Fax: +27.31.260.2280 - iaeg2002@nu.ac.za
http://stanfield.und.ac.za/Durban2002/

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