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Loess Letter: the newsletter of the INQUA Loess Focus Group (http://inqua-loess.org) edited by Ian Smalley (ijs4@le.ac.uk), produced by the Leicester Quaternary Environments Research Group in the Geography Department of Leicester University. Founded at the New Zealand Soil Bureau in 1979. Published twice a year for everyone interested in Loess. Observe the new online presence, courtesy of Michigan State University, at www.loessletter.msu.edu.

Leicester September 2013. The annual focus group meeting: ‘Loess & Dust: Geography-Geology-Archaeology’ 10-12 September 2013. Plan to attend. Field excursion to East Mersea and Walton on the Naze to examine the Essex loess; and to re-consider Dennis Eden’s results from 1980. Contact: Sue McLaren sjm11@le.ac.uk or Ken O’Hara-Dhand kod2@le.ac.uk or INQUA-LOESS13@mail.cfs.le.ac.uk.


LL70. Two parts: an essay on bricks, looking to answer Smith’s question; and some abstracts from the EGU 2013 meeting in Wien. There was no specific session on Loess at Wien but loess was mentioned in various presentations so we have gathered together the loess items - a convenient assemblage. The answer to Smith’s question is: Brick buildings are found in S.E. England because local loess was available for the making of bricks. Not provable, but suggestible: the paper is from the Bulletin of the Experimental-Firing Group 4, 55-66. 1965/6. A key Jane Wight map is on the inside cover. Outside front cover is Queens College, Cambridge - college brick at its best.
LOESS BRICKS IN BRITAIN

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The 'self-firing' Fletton brick came into widespread use in Britain at around 1900. Large-scale production, fuel economies due to the carbonaceous content of the clay, and the widespread system of relatively cheap transport, meant that the Fletton brick could reach most parts of the country and be cheaper than local products. Before the Fletton revolution bricks were made and used on a local scale, and many of the bricks made and used in London and the south east came from loessic deposits called brickearth.

Brickearth is an ancient term and it is still widely used. It is also the cause of much confusion and imprecision in the scientific study of the loess deposits and brick-making materials in Britain. The term was extensively used when the Geological Survey was mapping south east England at the end of the nineteenth century. It referred to a loamy surficial or near-surficial deposit, often found in river valleys. It was not a precise scientific term, but at the time it was an adequate mapping term. Unfortunately, the existence of this imprecise mapping term has hindered the development of more precise scientific terms. Brickearth suggests any deposit which is used to make bricks, but within this all-embracing term are what we might call the 'true' brickearths, materials which deserve to be geologically identified, which are the British occurrences of the widespread European loess.

During the Quaternary period much of Europe has acquired a complex cover of loess material. It was named Löss by Karl Caesar von Leonhard of Heidelberg in the early years of the 19th century. Von Leonhard recognised that deposits of loess material in the valleys of the Neckar and the Rhine had enough significant individual characteristics to warrant a special classification as geologically identifiable materials. Löss could be distinguished from other superficial materials (largely by particle size distribution and mineralogy) and was worthy of study. That loess became widely known, and a subject of much scientific study and speculation, is largely due to Charles Lyell, who included a few paragraphs on loess in his Principles of Geology (Lyell 1835). The loess in Europe made excellent bricks as it contained the right proportions of silt and clay for it to be fired without any difficult mixing or pretreatment. Many large loess deposits in eastern Europe are still supplying satisfactory bricks today, and many smaller deposits supplied the bricks for the great Victorian expansion of London.

Brickearth was defined by Arkell & Tomkeieff (1953) as "Loam used for making bricks. Especially in the Pleistocene of the Thames Valley. See EARTH." Under the heading EARTH is a quotation: 1667 Evelyn, Mem.ii.24, ORD, 'We went to search for brickearth.' Arkell & Tomkeieff, and probably John Evelyn, use brickearth in a suitably restricted sense, although further semantic restrictions will be useful. Tomkeieff (1983) defined loess as 'Homogeneous, unstratified, yellowish deposit of material of silt-size occurring in areas from north-central Europe to China as well as the United States.' This yellowish material deposited in southern Britain and concentrated in river valleys provided the raw material which could be fired to form early British bricks. Its depositional position is shown in Figure 1 (based on Gibbard 1985) which shows a typical valley in south eastern England. The widespread
aeolian loess is concentrated by fluvial action into the river valleys. In some places, e.g. Crayford, Sittingbourne and Faversham, considerable accumulations formed and many millions of bricks were subsequently manufactured there.

The way in which confusion has arisen, and precision been lost can be seen when the Tomkeieff (1983) definition of brick-earth is consulted: 'Naturally occurring clays which are used in the manufacture of bricks .... British brickearths are found in the Oxford Clay, the lower Lias and in the Wealden clays of Sussex, etc.' These three examples cited by Tomkeieff should not be included in the brick-earth definition, but the confusion will not be removed by attempting to restrict usage of the term: it would be better to add an adjective, so that 'loessic brick-earth' can refer to the silty-loamy deposits of south-eastern England which provided the raw material for early bricks and accounted, by their limited occurrence, for the constraints on the use of early bricks. Brick buildings in early Britain were constructed near to deposits of loessic brick-earth.

BRICKEARTH IN SOUTH EAST ENGLAND

The major deposits of loessic brick-earth in Britain are in the Middle and Lower Thames Valley but most of south eastern England would have received some loess material during the later Pleistocene period. Smith's (1985) map of brick-making in England in 1400-1450 shows brickyards near the river at Crockermend, Windsor, Slough, Petersham and Deptford. According to Smith, Deptford supplied most of the bricks for Henry VIII's manor house at Dartford in Kent, with smaller amounts obtained from Limehouse and from places much closer to Dartford itself. It seems likely that some of the bricks for Henry's house could have
come from the famous brick-earth at Crayford which was to be fully exploited in the nineteenth century (Kennard 1944).

The loessic brick-earth fires to a red brick (what were subsequently called 'Kentish Reds') but the greatest output from the Thames Valley brickyards was of the so-called Stock bricks in which the firing was augmented by the addition of combustible material, and these fired to a yellow colour. Stock brick production began at around 1700 and was at its peak between 1870 and 1890. The Sittingbourne-Faversham area was a major centre for the production of Stock bricks.

The manufacture of hand-made brick was a simple process and required no fixed equipment. The brickmakers were mobile and this allowed them to exploit quite small deposits of brick-earth. This is a major factor accounting for the removal of brick-earth from the Thames Valley sites - and most (possibly all) of what was removed and used in brick manufacture was the loessic brick-earth. Firman & Firman (1967), in their geological approach to the study of medieval brick, stated that the examination of the bricks themselves has shown that small superficial deposits of clay and brick-earth were normally, and perhaps exclusively, worked. All the evidence of plasticity, fossils and inclusions suggests that only superficial deposits were used.

Smith (1985, 4) stated that it is possible to regard eastern England in the fifteenth century as, in a sense, the westernmost extension of the European Brick Gothic region, but if this is done, the contrast must not be forgotten: in England brick occurs as the principal material in isolated, usually large-scale, buildings throughout the eastern counties, and one should hesitate before calling it, at this date, a characteristic material of these counties.

There are geological parallels: it is possible to regard eastern England as the westernmost extension of the European loess region. In England the loess occurs in isolated deposits rather than as the continuous cover found in western and central Europe. Initial brick-making operations in medieval England would tend to be located where geological factors had combined to produce fairly substantial deposits of brick-earth, and in fact this geological control operated on brick manufacture and use until developing technology provided access to deeper, harder clays and to an efficient transport network. Brick-earth may be a characteristic material of the eastern counties but it was not recognized as such by the geological mappers of the nineteenth century; it was necessary to wait for the soil-survey mappers of the 1950s before the widespread extent of loess in southern and eastern England was recognized. Significant amounts of brick-earth do occur as isolated deposits and these provided the raw material for English bricks up till about 1900. It seems possible that the Romans used loessic brick-earth to make their tegulae: they certainly have the characteristic red colour of a simple fired loess brick.

The classic brick-earth at Crayford has been described by Kennard (1944, essentially a geological treatise) and the downstream deposit at Sittingbourne and Faversham has been described by Twist (1984, from the point of view of brick manufacture). Twist gives a typical chemical analysis for a North Kent brick-earth:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica</td>
<td>76.76%</td>
</tr>
<tr>
<td>Alumina</td>
<td>10.89%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>1.06%</td>
</tr>
<tr>
<td>Lime</td>
<td>0.64%</td>
</tr>
<tr>
<td>Sulphuric Anhydride</td>
<td>0.03%</td>
</tr>
<tr>
<td>Ferric Oxide</td>
<td>4.43%</td>
</tr>
<tr>
<td>Sulphur as sulphide</td>
<td>0.01%</td>
</tr>
<tr>
<td>Alkalies</td>
<td>2.16%</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>2.16%</td>
</tr>
</tbody>
</table>
It seems feasible that most (perhaps all) of the alumina in such an analysis derived from the clay materials present in the brick earth. If the clay minerals were a mixture of kaolinite and illite (i.e. a mix of 1:1 and 2:1 minerals) then we might estimate the clay mineral content at around 25-30%. The rest of the mineralogy is dominated by quartz (usually of a typical size between 20 and 60 μm in particle diameter). The material looks like a typical clayey-loess. Analysing the clay mineral content is difficult; the most interesting analyses carried out on Thames Valley brick earths are probably the thermogravimetric determinations by Lill (1976). Besides giving valuable semiquantitative mineralogical data, the thermogravimetric method gives a picture of events occurring during the firing process, and in fact, starting with a raw brick earth sample, one ends up with a fired product.

**SMITH'S QUESTION**

Smith (1985, 6) puts the question 'Why did the wealthy men of State and Church not build in brick outside eastern England?' A simple answer is that the brick earth used by medieval brickmakers is not found in exploitable deposits outside eastern England. Smith (1985, 88) has proposed that building materials made from ubiquitous surface deposits present problems when attempts are made to determine provenance from physical or chemical tests; there is no doubt that the analytical signal from most earthy materials, such as those used to make bricks and tiles, is far from adequate for almost any purpose. However, it appears that the superficial brick-making materials were not as ubiquitous as they might appear at first sight. The lack of precision in the term brick earth has led to useful distinctions being obscured and a lack of appreciation of some of the factors affecting the making of bricks in England before, say, 1700.

The loessic brick earth used for early bricks had a high proportion of quartz silt and this tended to give the bricks dimensional stability i.e. the shrinkage problem was avoided. Of all superficial earthy materials which might be used to make bricks, it is probably only the loessic brick earths which give satisfactory bricks without pretreatment. The Romans could have been very familiar with such materials which are widespread in France, Germany and northern (but not in southern) Italy and when they came to southern Britain would have recognized the local brick earths.

Smith (1985, 85) quoted some observations by Blunden (1975) "Brick clays, like aggregates, are found in a very varied range of deposits of widespread occurrence in every region of Britain." In 1975 that was true, and remains true today, but in the context that it was cited this is a very misleading statement. Nineteenth and twentieth century technology gives us access to the Devonian clays in south Wales, the Triassic Keuper Marl of the English Midlands and the Jurassic Oxford clay which makes the Bedford and Peterborough Plettons, but none of these was accessible to early brickmakers. Roman and medieval brickmakers used recent surficial deposits which did not have widespread occurrence in every region of Britain; they were concentrated in the south and the east of England and this is where Roman and medieval bricks were made and used. As Smith (1985, 87) points out, bricks were never transported for long distances; 15-20 miles was exceptional, most movements being 0-5 miles. Bricks were made where the brick earth occurred and that was where the buildings were constructed.
CONCLUSIONS AND PROPOSALS

We have to be careful not to overstate the importance of loessic brick-earth in early brick manufacture in Britain. However, it seems reasonable to claim that it was the major source of material for early bricks and that its geographical distribution influenced the siting of the early brick industry and the location of early brick buildings. Other clay materials were used for brick manufacture; as Wight (1972, 76) stated 'Many different types of clay were used, not just one ideal brick-earth'. But the older clays were used in smaller amounts than the recent brick-earths, which are in fact close to an ideal brickmaking material. Battle Abbey in Kent used the Gault clay for its tilyer (Wight 1972, 37) but the Gault in Kent and Sussex, exposed by the unroofing of the Weald Anticline, has a relatively limited occurrence and it can be seen from the most general Wight distribution map (1972, 29, Figure 1) that there were few buildings of brick in the Wealden region by 1550. By contrast in Essex, the Thames Valley and East Anglia, there were many buildings.

We should try to distinguish between brick-earth and brick clay. This is a problem fraught with difficulties; usage varies with time, with geographical region, with the various groups of people involved (e.g. geologists and brickmakers) and precision will be difficult to achieve. It is worth striving for if it will make understanding easier and communication more efficient. As can be seen from the Tomkeieff (1983) piece already cited a wildly wrong definition can set the whole process back immeasurably. We must emphasize that brick-earth is a sedimentary deposit of recent origin, quite distinctive from the old clay 'rock' which is used to make modern bricks. The Arkell-Tomkeieff (1953) definition can be adapted and enlarged:

Brick-earth:
Loam used for making bricks. Especially in the Pleistocene of the Thames Valley and eastern England. A sedimentary deposit, related to the loess of western and central Europe, consisting largely of quartz \( (\text{SiO}_2) \) of a characteristic particle size range (20-60 \( \mu \text{m} \)) and perhaps up to 30\% by weight of clay minerals. Of recent age, usually less than 20,000 years old. Used as found to make medieval bricks; from about 1700 mixed with combustible material to make Stock bricks.

Brick clay:
Clay-rich material used for making bricks; a geological deposit composed primarily of clay minerals, often from some named formation, e.g. Oxford clay, Keuper Marl etc. Mineralogical analysis indicates a predominance of clay minerals and a high plasticity index.

A distinction should be made between the high plasticity clays used by potters and tile makers and the 'earth' materials, of lower plasticity and relatively low clay mineral content used by brick-makers. The Roman regularae possibly have more in common with pots than with Medieval bricks. Roman tiles/bricks appear to be largely fired in kilns (see McWhirr 1984) and Medieval bricks in clamps. It may be that the ancestor of the 1986 Fletton is the early Medieval brick, rather than the Roman regularae.
1) The Roman period: perhaps up to the 5th century A.D. (See McWhirr (1984) for an authoritative account of the production and distribution of brick and tile in Roman Britain.)

'Tegulae' made of surficial clay materials fired by external heat source.

2) The Medieval period: from 1400. (See Smith's important study of the period 1400-1450.)

Red bricks made of loessic brickearth, and used close to source. Small deposits of brickearth could be used by mobile brickmakers (very little equipment required). Firing style essentially as Roman.

3) Stock bricks: from about 1700. (See Twist (1984) for a good account of Stock brick manufacture from north Kent loessic brickearths.)

Red bricks continue to be made but Stock bricks, as made from a mixture of brickearth and combustible material, begin to appear. They normally fire to a yellow colour. External and internal heat sources.

4) Fletton bricks: from about 1900 (named after Fletton, near Peterborough).

Jurassic clays with a high content of combustible carbonaceous material. Firing processes are similar to Stock bricks.

REFERENCES


Lyell, C. 1835. Principles of Geology. (The section on loess from volume 4 has been reprinted (1986) as Loess Letter Supplement number 8, Lyell on Loess, with introduction by Ian Smalley.)


Search Results for "loess"

AS2.1
Air-Land Interactions (General Session) (co-sponsored by ILEAPS)
Convenor: Thomas Foken  |  Co-Conveners: Andreas Strom  
Orals / Wed, 10 Apr, 08:30-12:00 / 13:30-15:00 / Room B15
Posters / Attendance Wed, 10 Apr, 17:30-19:00 / Yellow Posters

270  EGU2013-1005
Surface Energy Budget Characteristics and Surface Energy Imbalance over Chinese Loess Plateau
Hongyu Li, Qing Zhang, Weidong Guo, Congbin Fu, and Jinshen Shi

293  EGU2013-9084
On the factors influencing surface-layer energy closure and their seasonal variability over the semi-arid Loess Plateau of Northwest China
Xia Xiao

BG1.1
Open session on Biogeoosciences (Posters only)
Convenor: Gerhard Reichert  |  Co-Conveners: Jürgen Reussmeier, Albert Bernsten, Andy Biggs, Tom J. Battin, Michael E. Böttcher, Stephan Glatzel, Emmanuel J. Savaux, Caroline P. Stock, and Thérèse Courteau
Posters / Attendance Thu, 11 Apr, 17:30-19:00 / Green Posters

G12  EGU2013-12901
n-Alkanes and short chain n-alkanes in loess: post-depositional or syn-depositional?
Michael Zeich, Sebastian Kreutzer, Tomasz Gostler, Sascha Mieszner, Tobias Krause, Dominik Faust, and Markus Fuchs

CL1.4
Climate response to orbital forcing (Including Millankovich Modal lecture)
Orals / Wed, 09 Apr, 10:30-12:00 / 13:30-17:00 / Room Y9
Posters / Attendance Tue, 09 Apr, 17:30-19:00 / Yellow Posters
Z190  EGU2013-2446
Modelling Study of Orbital-scale Precipitation Variations in Mid-latitude Asian Monsoon and Arid Areas over the Last Glacial-Interglacial Period
Xiaoyang Li and Xinhua Li

CL4.2/NS3.1/NS3.2
 Aeolian dust: Initiator, Player, and Recorder of Environmental Change (co-organized)
Convenor: Jan-Berend Stuart  |  Co-Conveners: Peter Knüppertz, Sue McLaren
Orals / Wed, 10 Apr, 13:30-17:00 / Room Y9
Posters / Attendance Wed, 10 Apr, 17:30-19:00 / Yellow Posters
Z346  EGU2013-22739
An erosional unconformity over whole Europe? - New insights into Late Pleistocene loess palaeosol sequences from Saxony (Germany)
Dominik Faust, Sascha Mieszner, Sebastian Kreutzer, and Markus Fuchs

EMFP3.5
The magnetic environment, and reliability of the signal in sediments
Convenor: Rainer Egg  |  Co-Conveners: Fabio Florindo, Andrew Roberts
Orals / Mon, 08 Apr, 08:30-10:00 / Room B3
Posters / Attendance Mon, 08 Apr, 17:30-19:00 / Blue Posters
B102  EGU2013-1462
The environmental magnetic fingerprint of periglacial loess in Eastern Germany
Philipp Baumgarten, Ulrich Hambach, Sascha Mieszner, and Dominik Faust
From archive to process: concepts and techniques in geomorphology/Quaternary sciences

Conveners: Michael Dietze Q | Co-Conveners: Hans von Sichselntzclt Q, Margret Fuchs Q, Ming Jin Q, Dominik Faust Q, Markus Fuchs Q, Pierre AntOnie Q

Oral | Wed, 10 Apr, 13:30-17:00 | Room G3
14:15-14:30 | EGU2013-11163
| Losses is the accumulation of dust, not evidence for aridity
Roland Zech

Posters | Attendance Wed, 10 Apr, 17:30-19:00 | Blue Posters

GM2.5 | SSS5.12
Landscape in the Anthropocene: state of the art and future directions (co-organized)

Conveners: Paolo Tarolli Q | Co-Conveners: Veeke Vanacker Q, Hans Middelkoop Q, Mark Macklin Q, Tony Brown Q

Oral | Thu, 11 Apr, 08:30-12:00 | Room G3
09:45-10:00 | EGU2013-5695
| The meandering Dijle River in the western European loss region: an anthropogenic landscape
Pietro Omodeo, Bert Verstraeten, Bastiaan Nolte, Cornelia Janssen, Jorg Schreer, and Jef Vandenberghe

Posters | Attendance Thu, 11 Apr, 17:30-19:00 | Blue Posters

GM6.2 | SSS5.11
Connectivity in landscape dynamics (co-organized)

Conveners: Anthony Parsons Q | Co-Conveners: Louise Bracken Q, David Dunkley Q, John Wainwright Q, Ronald Pohlig Q, Sasika Keesstra Q, Thomas Hoffman Q, Nikolaus J. Kuhn Q, Martin Fohrmann Q

Oral | Wed, 10 Apr, 08:30-12:00 | Room G2
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RS23 | EGU2013-11459
| Spatio-temporal organization of sediment dynamics at the hillslope scale in a loess landscape
Ulrike Schäfer, Erwin Zeh, Uwe Elbrecht, and Axel Kleidon

IOD/CUS | SSS5.2
L I sterile isotopes as a tool in paleo-climate studies in different environments and by multi-proximate approaches (co-organized)

Conveners: Niki Domény Q | Co-Conveners: Ralf Siegert Q, Ana-Voica Bojar Q, Olga Sidorova Q, Kerstin Tetrye Q, Aurel Pergal Q, Stanislaw Hales Q

Oral | Wed, 10 Apr, 08:30-12:00 | Room G13
PICO | Wed, 10 Apr, 13:30-15:00 | Room PICO Spot 4
14:27-14:30 | EGU2013-12771
| Aspects of loess development with impacts on understanding the paleo-environment
Gabriela Mara, Matthias Hellick, and Cornelia Holler

N9.0
Multi-hazard natural and technological risks: assessment and impacts

Conveners: Elena Petra Q, Kevin Flemming Q | Co-Conveners: Elisabeth Krauss Q, Alexander Garcia Q, Maria Nanopoulos Q

Oral | Wed, 10 Apr, 13:30-17:00 | Room G9
Posters | Attendance Wed, 10 Apr, 17:30-19:00 | Blue Posters

B445 | EGU2013-25631
| Natural and anthropogenic multi-type hazards for loess territoires
Nadine Maurya and Zulfiya Zakirova
Poster Summaries & Discussions: ES07-011, Wed, 10 Apr, 08:30-09:15, Room B4

SSP3.1
From the Mountain to the Sea: Significance of grain-size distributions in stratigraphy, sedimentology & pedo-paleoclimatology - Analysis, application, and interpretation (co-sponsored by IAS)  

Conveners: Bjorn Machalet Q | Co-Conveners: Inka Meyer Q, Nick Oches Q, P. Thompson Davis Q, Jan-Bernd Stuut Q

Oral | Tue, 09 Apr, 13:30-17:00 | Room B13
PICO | Tue, 09 Apr, 13:30-15:00 | Room PICO Spot 5
| Abrupt Climate Events Recorded in Chinese and Central Asian Loess Sequences
Johannes Machalett, Eric A. Oches, Eddie Haem, Zhengbing Liu, and Wilfred Endlicher

| High-resolution particle size analyses applied to late Quaternary loess deposits at Orkhodas, Uzbekistan, Western Tibet, and Nadir G. Mavlyanova, Bjorn Machalett, and Hirojii L. Rakhmatullin

SSP3.4 | A008.1/004.13/754.4
New horizons in provenance research (co-organized)

Conveners: Carita Augustsson Q | Co-Conveners: Udo Zimmermann Q, Sergio Ando Q

Oral | Fri, 12 Apr, 14:30-15:00 | Room B1

Posters | Attendance Fri, 12 Apr, 16:30-19:00 | Blue Posters

B716 | EGU2013-5681
| Origin of detrital rutiles in Austrian loess as reflected by their trace element compositions and U-Pb ages
Gabor Ujvari, Urs Hübner, Franz Kiraly, and Theodoros Retafos

SSS5.8
Spatial and Temporal Patterns in Soil Systems: Monitoring, Modeling and Characterisation of soil water contents and soil properties

Conveners: Gonzalo Martinez Q | Co-Conveners: Luca Brocca Q, Harry Vereecken Q, Karl Vanderlinden Q, Sonia Senereve Q

Oral | Mon, 08 Apr, 13:30-17:15 | Room B6
17:00-17:15 | EGU2013-1287
| Uplift of point soil moisture observations to spatial averages in a gully catchment of the loess plateau
Xiaodong Gao, Pute Wu, and Xining Zhao

Posters | Attendance Mon, 08 Apr, 17:30-19:00 | Blue Posters

SSS1.7 | C04.5.5/SSS4.3
Soil formation and weathering in time and space (co-organized)

Conveners: Markus Egg Q | Co-Conveners: Fabio Scardi Q, Elke Paquer Q

Oral | Tue, 09 Apr, 10:30-12:15 | Room B6
11:30-11:45 | EGU2013-2445
| A late Quaternary loss-paleos pedodocumented sequence at Monte Netto (northern Italy): loess sedimentation, soil formation and tectonics in the central Po Plain
Luca Tonolino, Andrea Zerbini, Franco Livio, Andrea Bertolucci, Alessandro M. Michetti, Christoph Spittel, and Helmut Redlich

Posters | Attendance Tue, 09 Apr, 17:30-19:00 | Blue Posters

SSS5.2
Land use change and land management Impacts on soil organic carbon: From process understanding to regional assessments

Conveners: Axel Don Q | Co-Conveners: Bas van Wesemael Q, Jens Leifeld Q, Robert Jandl Q

Oral | Tue, 09 Apr, 08:30-12:00 | Room B11
11:45-12:00 | EGU2013-1292
| Land rehabilitation, erosion and C sequestration in soils of the Chinese Loess Plateau
Yang Li, Kristof Van Oost, Tim Quine, and Gerard Govers

Posters | Attendance Tue, 09 Apr, 17:30-19:00 | Blue Posters

SSS5.9 | C04.8
Interactions between soils, organisms and hydrogeomorphological processes - understanding landscapes and ecosystems dynamics in response to disturbance regimes (including Amo Richter Award for Outstanding Young Scientists by Simon H. Mudd) (co-organized)

Conveners: Roum Lamesh Keshet Q | Co-Conveners: Rassama Campaleti Q, Reina van Brue Q, Div Corentin Q, Ws Turwadi Q, Markus Stoffers Q, Shart Lane Q, Stephen Rice Q, David Dunkley Q

Oral | Fri, 12 Apr, 08:30-12:00 | 13:30-15:30 | Room B6
11:00-11:15 | EGU2013-2419
| The effect of modification of pedon on distribution of soil moisture, plant growth and yield in loess plateau (E Poland)
Jerry repn

Posters | Attendance Fri, 12 Apr, 15:30-17:00 | Blue Posters

B559 | EGU2013-2509
| Soil organic carbon under different land uses and its storage in two typical watersheds of the Loess Plateau, China: Zhigong Xie, Shaoshan An, and Man Cheng
Upscaling of point soil moisture observations to spatial averages in a gully catchment of the Loess Plateau

Xiaodong Gao (1,2), Pute Wu (1,2), Xining Zhao (1,2)
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A gully catchment of the Chinese Loess Plateau geographically constitutes two components: hillslopes and gullies. The complex topography of gully catchments especially gullies leads to the difficulty of measuring in situ soil moisture content. Based on soil moisture datasets (0-20, 20-40, 40-60 and 60-80 cm) from 2010-2012 in the Yuanzegou catchment of the Loess Plateau, this study attempted to estimate spatial mean soil moisture of hillslopes, gullies and the whole catchment from one single hillslope location for each layer, by coupling time stability analysis with observation operators. The soil moisture datasets in 2010 and 2011 were used for time stability analysis and development of observation operators. The datasets in 2012 were used for validation. The results showed that soil moisture of hillslopes exhibited considerable time stability and the degree of time stability increased with depth. Topography (slope angle and position) was the main factor affecting time stability at surface layer (0-20 cm) while clay content was main factor at subsurface layers. The spatial averages of hillslopes were accurately estimated from that of the time-stable location for each depth. Furthermore, spatial averages of gullies and the whole catchment were accurately estimated from the same single hillslope location through the developed observation operators. The validation analysis indicated that the time-stable location and the developed observation operators were temporarily robust.

Soil organic carbon under different land uses and its storage in two typical watersheds of the Loess Plateau, China

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Soil organic carbon distribution and soil organic carbon storage were estimated in two classical small watersheds that based on 163 samples under different land uses and slope positions. Land use conversion would alter land cover, which results in carbon stock changes in biomass as well as in the soil. After the Grain for Green project initiated in 1999, most land of China’s loess plateau has been completed vegetation restoration as same as the comprehensive managed watershed (Shanghuang) which with spread vegetation-covered area and lower slope farmland. However, it is not clear how effective the newly initiated project will be. In this study, we found a reference area, original and untreated watershed (Sidigou). It is an area which has not any restore vegetation projects that kept primitive farming management. We found that there were significant differences between two study areas either soil organic carbon concentration or its distribution. The soil organic carbon content in the comprehensive managed watershed (Shanghuang) was higher than the untreated watershed’s (Sidigou). As the soil depth increases, the soil organic carbon content gradually decreases. Soil organic carbon concentration and distribution were significantly influenced by land uses and slope positions. More specifically, the soil organic carbon for the shrub land and natural grassland were significantly higher than for the other land uses. In different slope positions, valley’s soil organic carbon content was greater than that for the top of mound crests and mound slope. The total soil organic carbon storage of untreated watershed and comprehensively managed watershed were 20599.42 t and 46527.12 t, respectively. The area proportion of land uses is the significant reason for income gap of two study areas. Land use conversion from farmland to shrub land and manmade grassland in Shanghuang watershed played an important role in ecological restoration. It was found that vigorously developing Grain for Green project is of benefit for the Loess Plateau.
Surface Energy Budget Characteristics and Surface Energy Imbalance over Chinese Loess Plateau

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Abstract
Field observation of land-surface processes is a fundamental approach to quantitatively measure mass and energy exchanges between the land surface and the atmosphere. Chinese Loess Plateau, a unique landscape in the world, is known as a transitional zone both in terms of climate and ecosystem. Land-surface process measurement helps to better understand the aridity trend and the ecosystem change over Chinese Loess Plateau. Based on data collected at the Semi-Arid Climate and Environment Observatory of Lanzhou University (SACOL) from June 2008 to June 2010, we analyzed the characteristics of land surface radiation and energy budget in summer, as well as the surface energy imbalance issues over Chinese Loess Plateau. Main results are concluded as follows: (1) By studying impacts of different weather conditions on micrometeorological characteristics, the clouds and the precipitation contribute disturbances by about 25\% of P to each component of energy balance. Weakening impact of clouds and precipitation on surface energy budget is much stronger than that in desert and Gobi region. Furthermore, it shows that the mean climatic characteristics in summer relatively close to those of cloudy days. (2) To investigate the land surface energy imbalance over the Loess Plateau, we estimated the heat storage associated with change of air temperature and humidity as well as the energy stored in plants due to the photosynthesis, which determines the vertical water transport and soil temperature at the shadow soil layers. The peaks of averaged diurnal variation of energy storages by air and plant photosynthesis reach 1.5 and 2.0 W m$^{-2}$ respectively. In addition, the peak of diurnal variation of mean heat flux transferred by vertical water movement can reach nearly 8.0 W m$^{-2}$. The closure of energy balance is improved from 88.1\% to 89.6\% by adding the three additional energy terms mentioned above to the energy balance equation. We found that the special climate background and vegetation coverage over Chinese Loess Plateau essentially lead to the significant differences of energy storages between this region and other climatic districts.

The environmental magnetic fingerprint of periglacial loess in Eastern Germany

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In the framework of a comprehensive stratigraphic study of loess Eastern Germany, a detailed rock magnetic study was carried out of four last glacial/interglacial loess-paleosol sequences. Magnetic susceptibility and laboratory-induced remanences have been determined to compare individual sections and to identify the specific rock magnetic characteristics of the Saxonian Loess Province.

According to the model of pedogenic magnetic enhancement, an increasing neoformation of ferrimagnetic minerals in the course of pedogenesis was observed only in the uppermost Late Weichselian lithological units consisting of almost unweathered loesses and indicating dryer climatic conditions. In contrast, the rock magnetic characteristics of the lower Middle and Early Weichselian units exhibit a significant destruction of primary magnetic minerals caused by such secondary processes as climatically controlled waterlogging and reworking. The main observation, an increasing $X_{2s}$ with decreasing $y$ with stratigraphical depth, argues for a general magnetic depletion in conjunction with decreasing magnetic grain sizes caused by weathering of larger primary particles.

The magnetic fingerprint of the Saxsonian loesses is characterised by prevailing magnetic depletion processes, which effectively rules out the application of the wind vigour model. Moreover, the observed magnetic characteristics differ significantly from that of other loess regions. Therefore, we propose a new magnetic facies model for more humid (Central European) loess provinces dominated by typical periglacial conditions, including widespread permafrost, which control the intense reworking and waterlogging (gleyification) processes.
The effect of modification of pedon on distribution of soil moisture, plant growth and yield in loess plateau (E Poland)

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Long-term tillage and water erosion in loess areas resulted in modification of pedon structure and redistribution of soils within the fields. The changes are more significant in the areas of largely differentiated past micro-relief of relatively small differences in height. The effect of soil redistribution on soil moisture content, plant growth, and yield was studied within a small field (0.72 ha) located in the loess plateau (Lublin Upland, E Poland) in the years 2006-08. Structure of haplic Luvisol, soil properties, and yield of spring barley (Hordeum vulgare L.) were determined in a grid 10x10 m, and plant growth in sites located along the transect. Studies showed that after about 180 years of agricultural land use of the experimental site, small micro-relief forms as depressions and hills were partly or completely leveled by tillage and water erosion. In the effect of relief transformation, soils of eroded profiles represented 47.2, depositional soils 34.7 and non-eroded soils 18.1% of total number of studied pedons. Soil thickness, clay, silt and SOC were spatially correlated with a range of autocorrelation from 28 to 35 m. Soil redistribution affected the soil water content during vegetation season. Significantly higher water content at near soil surface was found on sites with depositional and non-eroded soils in April-May, while on eroded soils in June-July. As antecedent moisture conditions affect the water erosion process, various parts of field area could be responsible for quicker formation of runoff in different seasons of the year. Relation between crop and soil was complex and varied with precipitation during growing seasons. The more rainfall was close to the normal, the more significant positive correlations between the yield and soil thickness, silt and SOC, and negative with clay were found. The relations were reversed in a dry year, when yields were much lower. Results of the studies showed that loess plateau was significantly transformed during agricultural land use, and soil redistribution affects functioning of hydrological system, plant development and yields. Presence of Bt1 horizon in structure of haplic Luvisol could be regarded as a threshold for maintaining high productivity potential.

A late Quaternary loess-paleosol pedosedimentary sequence at Monte Netto (northern Italy): loess sedimentation, soil formation and tectonics in the central Po Plain.

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In the area of the Po Plain south of Brescia several isolated hills are present (Castenedolo hill, Cilivergher hill, and Monte Netto), corresponding to the top of Late Quaternary anticlines. The Castenedolo and Cilivergher area was widely explored in the last decades and thick sequences of pedosediments furnished detailed archives for the evolution of this part of the Po Plain. A new thick and complex loess-paleosol sequence, resting upon fluvial and fluvioglacial deposits exposed in a clay pit at the top of the Monte Netto hill is being studied in great detail. The Monte Netto is a large flat hill, gently undulated at its top, and the clay pit was opened close to the centre of the anticline, where fluval and fluvioglacial deposits are deformed. This succession, probably of middle Pleistocene age, is buried by a loess-paleosol sequence 2 to 7 m thick; the depth of the loess is related to its physiographic position, i.e. it becomes thicker going from the top of the anticline. Furthermore, the upper pedosediments are faulted by bending-moment structures, developed during fold amplification and allow to date some of the latest movements of the anticline. A pedological, sedimentological and micropedological investigation of the whole extension of the quarry shows a distinctive difference between the loess-paleosol sequence at the top of the anticline and the one placed at its southern fringe (150 m away). On the top of the anticline a deeply weathered red paleosols developed in loess underneath a weakly weathered loess. In this soil also a small lithic assemblage dating to the Middle Piacenzian was found.

The pedosedimentary sequence at the southern fringe of the anticline consists of several loess layers showing different degrees of weathering. According to OSL dating, the upper part of the sequence was formed in the Upper Pleistocene, when most of the loess at the margins of the Po Plain was deposited. A tentative model of the exposed profiles involves the burial of the anticline by loess layers since the Middle Pleistocene and their successive weathering (and probably truncation) during subsequent interglacials and interstadials. These events probably correspond to the number of loess-paleosol couples identified in the outer part of the anticline. In this sense light weathered horizons could represent buried paleosols. Furthermore, the highly rubified paleosols at the top of the anticline should be regarded as a polygenetic soil or as a vetosol, developed near the surface for a long time since the Middle Pleistocene. The on-going geopedological, geochronological and seismic analyses will permit to define the time and steps of development of the Monte Netto hill and help to clarify the climatic and tectonic context during which these sediments were deposited, deformed, and weathered.
Modeling Study of Orbital-scale Precipitation Variations in Mid-latitude Asian Monsoon and Arid Areas over the Last Glacial-interglacial Period

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Based on a 150-ka transient numerical simulation with the Community Climate System Model version 3 (CCSM3) of the National Center for Atmospheric Research (NCAR) and the orbital acceleration technique, comparative analyses are made to reveal orbital-scale precipitation variations induced by changes in insolation related to Earth's orbital parameters in humid monsoon areas and arid inland regions of mid-latitude Asia during the last glacial interglacial period. The results show that there are significant quasi-20ka precession cycles for the annual precipitation in both East Asian monsoon region and Central Asia arid zone during the past 150 ka, in phase with the summer insolation of Northern Hemisphere (NH). However, the rainy season appears in summer and winter for East Asia and Central Asia, respectively. And thus, the annual precipitation mainly depends on summer rainfall brought by the summer monsoon over East Asia, while the annual precipitation is mostly decided by the winter-controlled winter precipitation. Composite analyses of seven precession cycles show that the precession-induced reverse changes in the boreal summer and winter insolation control precipitation variations of rainy season over East Asia and Central Asia, respectively. When the NH summer insolation is intensified by the effect of precession, the warming over Asian continent is more significant than that near the ocean, resulting in increased land-sea thermal contrast, significantly enhanced and northward shifted East Asian summer monsoon, finally causing in creased precipitation in East Asian monsoon region. Meanwhile, during the period of weakened winter insolation corresponding to the period of enhanced summer insolation in the NH due to the precession cycle, the tropospheric temperature is generally lower in the NH middle and low latitudes, causing a decrease of temperature gradient between the polar and equatorial regions, resulting in weakened and southward moved mid-latitude westerly circulation, forming an abnormal moisture conveyor belt from southern Europe to Central Asia, ultimately bringing more precipitation in the arid region of Central Asia. Therefore, simultaneous responses of the monsoon and westerly circulation systems determining the rainy season precipitation to the precession-induced summer and winter insolation changes are the main reason for the in-phase variations of the orbital-scale annual precipitation in the East Asian monsoon region and Central Asia arid area.

Fig. 6.—Abrasion scale for cubes. Losses determined by weight
Homage to Kuenen

Natural and anthropogenic multi-type hazards for loess territories

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Central Asia (CA) is an extremely large region of varied geography from plains to high, rugged mountains (the region belongs to the Tien-Shan and Pamirs mountain system), vast deserts (Kara Kum, Kyzyl Kum, Taklimakan). The area of the CA region is including the territories of following countries: of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. CA is particularly exposed to natural hazards like earthquakes, landslides, rockfalls, avalanches, mudflows, flooding, high mountains lakes, lake flooding, and debris flow. This region is one of the most seismically active in the world. In XX century almost in each of five countries have occurred strong earthquakes with magnitude more than 7, led to human victims.

Loess soils are widespread in this region in foothills, foothill plains and intermountain depressions. Loess can cause a number of engineering problems because loess undergoes structural collapse and subsidence due to saturation when both the initial dry density and initial water content are low. By comparison of the map of seismic zoning to a map of distribution of loess soils it is easy to be convinced that the territory of the majority of seismic areas are covering by collapsible loess soils with significant thickness (50-150 m). The natural hazards leads to a disaster, if it develops in an urbanized or industrial areas and directly affects people and economic objects. In this case, risk takes place with all its consequences especially on loess soil.

In the past a formation of natural hazards was connected generally with two main groups of factors: geological structure and climatic conditions. Now to them the third factor – of human made influence was added. Intensive influence of human activity to the loess territories in CA for last 60 years is destruction of nature balance and changing in environment of loess land in zone with high seismic hazard. This processes primarily associated with following: 1) irrigation of new lands; 2) the developing of mining manufactures and their waste located in the foothill areas with high seismic risk and where manifested of dangerous-geological processes as landslide, collapse, mud stream, rock falls and toxic contamination; 3) development of urbanization with manifestation of difference engineering geological processes in loess soil on the based of constructions in cities (collapse, liquefaction).

That example of cascade effects when natural and anthropogenic multi type hazards in loess was the Gis sar earthquake (1989) in Tajikistan when the earthquake of rather moderate intensity (M=5.2; H=5-7 km; I=7 - MSK scale) was triggered several landslides and mudslides connected with liquefaction of wetted loess and can cause a large number of human victims. In the pre 20 years steady irrigation of the slope area occurred for cotton field. This moistening has increase and the water content of the soil to wet 24-28%, up to a depth of 20-30 m that increased the vulnerability of this territory.

The interactions between different natural hazards, include triggered, especially earthquakes, landslides, collapses, liquefaction in loess soil with taking account of anthropogenic hazard influence was investigate.
Origin of detrital rutiles in Austrian loess as reflected by their trace element compositions and U-Pb ages

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Previous studies on detrital rutiles in sandstones demonstrated that rutile trace element geochemistry (especially Cr and Nb contents) and Zr-in-rutile thermometry may yield diagnostic data on the lithology and metamorphic facies of possible source rocks. U-Pb geochronology of detrital rutiles is as yet rare in spite of its potential to date metamorphic events, thereby yielding useful information for provenance analysis. In this study we provide the first trace element and U-Pb data from 89 detrital rutiles separated from loess in Austria and analyzed by EPMA and LA-ICP-MS. Cr and Nb data indicate that the majority (70-75%) of the rutiles are likely to originate from metapelitic sources, ca. 9-14% from metamafic rocks, while the rest cannot be unambiguously attributed to any of these sources. Rutiles in loess sampled close to the Alps (Wels section) generally displayed lower metamorphic temperatures (580-650 °C) compared to those found in proximity to the Bohemian Massif (700-800 °C; Krems Stratting profiles). The rutile U-Pb ages from loess at Krems cluster around 345-370 Ma. These ages and the calculated metamorphic temperatures reveal that these rutiles record the last high-T overprint of rocks making up the Varied series and Grüns units, thereby strongly favoring Bohemian Massif granulitic sources for many of the grains in loess of the region. At the same time, the lower temperatures found for rutiles in loess at Wels imply that these rutiles were derived from Alpine amphibolite-grade metamorphic rocks.

The meandering Diijle River in the western European loess region: an anthropogenic landscape

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Floodplain deposition rates have increased markedly under influence of human impact throughout the Late Holocene in many Western and Central European catchments. These variations in sedimentation rates have changed the geomorphology and ecology of many floodplains. In this study we discuss the human impact and its influence on floodplain geology during the Middle and Late Holocene for the Diijle catchment (760 km²), located in the Belgian part of the western European loess belt. Based on sedimentological and palynological data, the geology of the floodplain and the regional vegetation was reconstructed at 6 locations. Age-depth models for each of the studied sequences were obtained through 60 radiocarbon dates. Human impact in the catchment was quantified based on statistical analysis of the pollen data (cluster analysis and correspondence analysis). Our data show that until ca. 2500 cal BP, human impact was either absent or limited to local disturbances yielding no clear influence on the floodplain geology. The river environment was in a stable phase and consisted of a marshy environment with organic material could accumulate, which is in contrast to the natural state of the floodplain. From ca. 2500 BP onwards, human impact gradually increased. However, only when human impact in the catchment crossed a threshold, the floodplain geology changed with clearing of the Alder carr forest, the dominance of minerogenic overbank sedimentation and the emergence of a single channel meandering river. Spatial and temporal variability in the coupling between increasing human impact and changes in floodplain geology can be attributed to differences in hillslope-fluvial system connectivity and local differences in human impact. Overall, this study sheds new light on the indirect effect of anthropogenic forces on floodplain geology. It also shows that the contemporary morphology of the Diijle River floodplain contrasts widely with that of the Middle Holocene, which was dominated by peat formation in marshes and gyttja deposition in floodplain lakes. These changes in floodplain geology are the result of human disturbances in the catchment.
On the factors influencing surface-layer energy closure and their seasonal variability over the semi-arid Loess Plateau of Northwest China

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The energy observed in the surface layer, when using eddy-covariance techniques to measure turbulent fluxes, is not balanced. Important progress has been made in recent years in identifying potential reasons for this lack of closure in the energy balance, but the problem is not yet resolved. In this paper, long-term data that include output of tower, radiation, surface turbulence flux and soil measurement collected from September 2006 to August 2010 in the Semi-Arid Climate Change and Environment Observatory, Lanzhou University, in the semi-arid Loess Plateau of Northwest China, were analysed, focusing on the seasonal characteristics of the surface energy and the factors that have impact on the energy balance closure (EBC). The analysis shows that (1) the long-term observation is successful; the interaction between the land and the atmosphere in semi-arid climates can be represented by the turbulent transport of energy. In addition, even though the residual is obvious, this suggests that the factors that impact the EBC are stable, and their seasonal variations are identical. The analysis also shows that (2) four factors have obvious impact on the EBC: the diverse schemes for surface soil heat flux, the flux contributo from the target source area, the low-frequency part of the turbulence spectra, and the strength of atmospheric turbulence motion. The impact of these four factors on the EBC are similar in all seasons. Lastly, the result indicate that (3) atmospheric turbulence intensity is a very important factor in terms of its impact on the EBC. The relative turbulence intensity, RIw, characterises the strength of atmospheric turbulence motion, and is found to exert a noticeable impact on the EBC; in all seasons, the EBC is increased when the relative turbulence intensity is enlarged.

Loess is the accumulation of dust, not evidence for aridity

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Loess-paleosol sequences (LPS) are valuable terrestrial archives for Quaternary climate and environmental changes. The famous sections on the Chinese Loess Plateau, for example, document the alternation of warm and humid interglacials (paleosols) and cold and more arid glacial periods (loess). This, at least partly, reflects the weakening of the monsoon circulation during glacial times and has led to the notion that loess in general documents more arid conditions. Paleosols, on the other hand, are often interpreted to document more humid conditions. We studied the LPS Črvenka in the Carpathian Basin, southeast Europe, which spans the full last glacial cycle, and obtained results that do not fit the above concept: (i) The analysis of plant-derived long-chain n-alkanes indicates the presence of deciduous trees and shrubs during glacial times, i.e., sufficient precipitation for tree growth, whereas tree-less grass steppes seem to have prevailed during the Eemian, the last interglacial. (ii) Compound-specific deuterium analyses on the alkanes show only little changes on glacial-interglacial timescale. When compared with the isotopic enrichment of the Mediterranean Sea during the last glacial, this likely documents a combination of increased rainfall, reduced evapo-transpiration and reduced temperatures. (iii) Novel lipid biomarkers derived from soil bacteria (GDGTs, glycerol dialkyl glycerol tetraethers) also indicate humid glacial (BIT index close to 1) and more arid interglacials (BIT<0.8).

Our results are in good agreement with modelling studies suggesting a southward shift of the westerlies during glacial times, and aridization in the Mediterranean area in response to man-made global warming. More importantly, they remind us of an important fact: Loess is the accumulation of dust, but not (necessarily) evidence for aridity. Pedogenetic processes may simply not have been able to keep pace with high glacial dust accumulation rates related to intense glacial, periglacial and fluvial activity. Proxies independent of accumulation rates should be further developed and applied in LPS.
Spatio-temporal organization of sediment dynamics at the hillslope scale in a loess landscape

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In hilly landscapes, where erosion rates do not exceed the weathering rates of bedrock material, the shape of hillslopes is typically convex near the hilltop and becomes increasingly planar further downslope with the steepest descent in the middle of the slope and a concave shaped hillfoot. This convex-concave shape is the result of long term erosion and sediment redistribution processes driven by climatic forcing. We hypothesize that this typical shape is related to optimized sediment transport dynamics when examined in a thermodynamic perspective.

We used the process based model CATFLOW-SED to analyze the spatio-temporal organization of sediment dynamics at the hillslope scale. The model simulates overland flow using the diffusion wave equation. Soil detachment is a threshold process and depends on the attacking forces of rainfall and overland flow and the model parameter erosion resistance, which is characterized by soil properties, land use and management practice. Transport capacity and deposition are modeled for different grain size fractions. For the hillslope studies, data of the Weihersbach catchment was used, which is located in an intensively cultivated loess region in southwestern Germany. We designed convex and convex-concave shaped slopes similar to the hillslopes in the Weihersbach catchment, with identical gradients, slope lengths, soil properties and vegetation but varying curvatures. Then we modeled sediment dynamics using observed rainfall and climate data and quantified the power generated by water and sediment flux for the different slopes.

We found a minimum of the power generated by sediment flux for the convex-concave shaped hillslope which represent the hypsometric curve of the Weihersbach catchment. The typically shaped hillslopes are thus in a state of minimum work performed on the hillslope, resulting in a steady hillslope shape and minimum sediment export. This tendency for a hillslope to develop towards an 'optimal' shape and sediment export rate should be generally applicable; a thermodynamically formulated principle of minimum work performed on hillslopes in steady state could hence serve as a constraint when estimating sediment export rates in similar landscapes.

Land rehabilitation, erosion and C sequestration in soils of the Chinese Loess Plateau

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Once the cradle of Chinese civilization, the Chinese loess plateau is now one of the most degraded ecosystems in the world and a wide range of ecological rehabilitation programs have been implemented since the 1950s that aim at facilitating synergies between soil conservation, food production and socio-economic welfare. More recently, the scope of vegetation restoration programs has been extended to include sequestration of C by soils and the reconservation of 4.8 million ha of cropland to forest and grassland has re-sequestered a substantial amount of C in soils between 2000 and 2008. Although this appears to represent a significant win-win, these estimates are associated with considerable uncertainty both due to the extrapolation and, significantly, because of the assumptions made about the pre-restoration state.

Here, we argue that a full assessment of the C sequestration benefit of land rehabilitation programs requires quantification not only of the C uptake in vegetation and plants under the new land use regime (as has been undertaken), but also of the soil atmosphere C exchange associated with the elevated erosion rates that typify the pre-restoration state. We present the results of an intensive measurement campaign to characterize the erosional control on vertical carbon fluxes from degraded land, typical of the pre-restoration state. We report year-round soil respiration (in the absence of vegetation) measurements with high temporal resolution along an erosion gradient on cultivated sloping land in the Chinese Loess Plateau. At 14 sites along an eroding cultivated slope, we quantified the temporal dynamics of soil CO2 fluxes using an Automated Soil CO2 Flux System. This resulted in 1396 respiration measurements between April 2007 and September 2008. We investigate the factors controlling in-situ soil respiration, including soil temperature, moisture, soil erosion and SOC stock and quality. Soil and, by inference, C erosion and deposition since 1954 were quantified for 53 soil profiles using the artificial fallout radionuclide 137Cs. Our results indicate that the existing approaches ignore the erosion-induced reduction of in-situ soil CO2 emission from agriculturally eroding sites, and may therefore significantly overestimate the potential of reforestation in enhancing carbon sequestration. When the elimination of the erosion-induced sink term is accounted for, and for a range of protection levels of buried SOC in the fluvial system, we estimate that the C sequestration potential of re-vegetation may be overestimated by 25% to 50% for a period of 100 years.
Aspects of loess doll development with impacts on understanding the paleoenvironment

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Loess dolls are carbonate concretions in loess-paleosol sequences which cause associations due to their various morphologies. They can either be found dispersed in loess deposits or right under paleosols. Their formation is connected with leaching and reprecipitation processes. For the redistribution of carbonates infiltrating solutions play a major role. The formation of loess dolls occur in cavity systems of biogenic or abiogenic origin, which are well exposed to air and therefore have lower partial CO₂ pressure. Carbonates also precipitate around condensation nuclei, e.g. certain secondary carbonate types. With knowledge on morphological and structural properties of loess dolls specific hypotheses can be drawn on multiphase development history.

We collected five loess doll samples from the Paks sequence in Hungary and cut them into two parts for the following subsequent investigations: A) visualization of pore network and pore development by using high resolution micro-CT analysis, B) measurement of stable oxygen and carbon isotope compositions through high resolution sampling by hand drill, and C) a thin section preparation in order to recognize recrystallization effects.

First results indicate that the loess dolls with prominent cavities allow to distinguish between different developmental phases. Their structural units are characterized by distinct stable oxygen isotope clusters. More compensated oxygen isotope compositions are characteristic for loess dolls that either lie in a more homogeneous build-up or have dispersely scattered pores.

We discuss if stable isotope signals of these loess dolls are useful as paleoenvironmental proxies or if the signals are just suitable to differentiate between the development of structural phases. Eventually this work helps to clarify between the applicability versus doubts of a possible paleoenvironmental reconstruction based on loess dolls research.

An erosional unconformity over whole Europe? - New insights into Late Pleistocene loess paleosol sequences from Saxony (Germany)

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The Saxonian loess region is located in the transition zone between the Central German Uplands (here Erzgebirge and the Northern European Lowland. A loess layer on average of 6 m thickness sediments mainly the Weichselian glaciation causes a characteristic smooth landscape of gently rolling hills. Since 2008 this area is focused for paleoenvironmental research on loess paleosol sequences (Meszner et al.; and Meszner et al. 2012) to aim to establish a new, high resolved stratigraphical stack of all units in the Weichselian loess sequences. The authors substitute this new standard profile in five units. Unit IV is as represent pre-Eemian and Early Weichselian sediments with intercalated Eemian soil complex. The following III is build of several redepotised week interstadial Cambio-like and trunda gley soils of a period form 30/5 to 28 ka. Above, unit II composed of barren and pure Upper Pleniglacial loess follows and reaches a maxis thickness of 7 m (at site Gleina). It is subdivided by several tundra gley soils and shows a stratified loess facies in the lower and non-stratified loess facies in the upper part. The surface near the margin (max 2.5 m thick bleached material within the Holocene Late Pleistocene interglacial soil is classified as unit I).

A conspicuous complex of a reddish-brown substrate from top of unit IV and its overlaid bright gray Gleysoy (lowest part of unit III is called Gleina Complex. Lieberoth (1963) defined it as in important interstadial development of younger Middle Weichselian and called it 'Gleina soil development'. New luminescence age estimations indicate a hiatus inside of this complex. Between the brown substrate (top), with an OSL-age estimation of app. 60 ka and the upper part (strong Gleysoy), with an age estimation of app. 30-35 ka, an unconformity spanning app. 30 ka is identified. This hiatus, roughly spanning MIS 3, or found in all investigated loess sequences in Saxony!

Furthermore, it seems that this complex is not a regional phenomenon only. Also in the central German region close to the Saale river, in Lower Silesia, and region retrone to Wroclaw (Poland) and in Sandomierz the region (Poland) this complex could also be found.

First of all, on the base of our results we suppose that the preservation of MIS 3 loess and paleosols in central Europe is very rare. The processes forming this hiatus are discussed recently. One possibility is that there was not enough dust sedimentation for profile growing. However, in this case there might be even one with a weak sedimentation which accounts the preservation. But there is no site including a sequence spanning this timeframe yet. Another possibility is that during a period of strong reworking, all sediments of MIS 3 were eroded. This seems to be more likely due to the fact that the hiatus is clearly visible. This abrupt step of OSL-a follows the clear boundary between the described layers.

Generally, the recent study clearly illustrates the inhomogeneity of preservation in loess paleosol sequences in loess, as a terrestrial archive for landscape evolution, there are sequences of high resolution (e.g. Up Pleniglacial) close to huge hiatuses at the same site.
n-Alkane lipid biomarkers in loess: post-sedimentary or syn-sedimentary?

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There is an ongoing discussion whether n-alkane biomarkers – and organic matter (OM) from loesses in general – reflect a syn-sedimentary paleoenvironmental and paleoclimate signal or whether they are significantly a post-sedimentary feature contaminated by root-derived OM (Zech et al., 2012, 2013; Wiesenberg and Gocke, 2013). We present first radiocarbon data for the n-alkane fraction of lipid extracts and for the first time luminescence ages for the Middle to Late Weichselian loess-paleosol sequence of Gleina in Saxony, Germany. Comparison of these biomarker ages with sedimentation ages as assessed by optically stimulated luminescence (OSL) dating shows that one n-alkane sample features a syn-sedimentary age (14C: 29.2 ± 1.4 kyr calBP versus OSL: 27.3 ± 3.0 kyr). By contrast, the 14C ages derived from the other n-alkane samples are clearly younger (20.3 ± 0.7 kyr calBP, 22.1 ± 0.7 kyr calBP and 29.8 ± 1.4 kyr calBP) than the corresponding OSL ages (26.6 ± 3.1 kyr, 32.0 ± 3.5 kyr and 45.6 ± 5.3 kyr). This finding suggests that a post-sedimentary n-alkane contamination presumably by roots has occurred. In order to estimate the post-sedimentary n-alkane contamination more quantitatively, we applied a 14C mass balance calculation based on the measured pMC (percent modern carbon) values, the calculated syn-sedimentary pMC values and pMC values suspected to reflect likely times of post-sedimentary contamination (modern last decades, 3 kyr, 6 kyr and 9 kyr). Accordingly, modern and last decadal root-contamination would account for up to 7%, a 3 kyr old root-contamination for up to 10%, and an Early and Middle Holocene root-contamination for up to 20% of the total sedimentary n-alkane pool. We acknowledge and encourage that these first radiocarbon results need further confirmation both from other loess-paleosol sequences and for different biomarkers, e.g. carboxylic acids or alcohols as further lipid biomarkers.


Abrupt Climate Events Recorded in Chinese and Central Asian Loess Sequences

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Past climate dynamics associated with the Eurasian continent have been extensively studied. However, the impact of intra-hemispheric-scale climate variability on the entire Eurasian landmass, as well as the self-generated effects of the continent on the global climate system, is still a matter of investigation. While western Atlantic and tropical air masses penetrate into the continent and are transformed as they cross Eurasia, the interior regions of Eurasia strongly influence Earth’s climate system. Significant cooling and heating of Central and High Asia drive interactions between atmospheric and oceanic processes and regulate teleconnection patterns across the Northern Hemisphere.

This paper utilizes high resolution particle size data from the Central Asian loess sequence at Remisowka, Kazakhstan, and the long studied, monsoon-influenced Chinese loess sequence at Xifeng, to reconstruct past atmospheric circulation and aeolian dust dynamics within interior Eurasia since the last interglacial period. The observed dynamics in aeolian dust transport closely mirror d18O and fine dust variations measured in Greenland ice cores, suggesting a correlation with short-term climate oscillations (DO events) recorded therein. An Asian origin of fine aeolian dust preserved in Greenland ice cores has been discussed previously, and recent papers reveal a close link between Asian aeolian dust dynamics and DO events recorded in Greenland ice cores.

In this context, data presented here represent the first Central and East Asian aeolian dust records in which DO events are recorded, providing a means to test hypothesized links between short-term climate variability recorded in Greenland and associated climate dynamics at Asian dust source areas. Ultimately, the data extend existing hypotheses, suggesting that the Central and High Asian mountains are a crucial element within the sensitive glacier-desert-dust response system in interior Eurasia and may be considered a pacemaker of subtropical global climate changes and an initiator of abrupt climate oscillations in the Northern Hemisphere.
High-resolution particle size analyses applied to late Quaternary loess deposits at Orkutsay, Uzbekistan, Western Tien-Shan

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The loess deposits in the proximity of Tashkent (Uzbekistan) are one of the most promising widespread terrestrial climate and environmental archives of the Pleistocene in Central Asia, in addition to the loess of southern Tajikistan and the loess in the region of Almaly (Kazakhstan).

In this paper we present high resolution particle-size data from the upper part of the long-studied loess record at Orkutsay (Uzbekistan). During the fieldwork samples for grain size and magnetic susceptibility were taken at 2 cm and 5 cm intervals from the loess. Particle size measurements of all samples were made on a Beckman Coulter LS 13320 PIDS laser sizer with auto-prep station to provide a dynamic range that spans from 0.04 to 2000 μm and ensure accuracy and reproducibility.

The granulometric results show a maximum in the fine and middle silt fraction and allow a clear distinction between cold and dry, and warm cycles. They show an important coherence between the type of dust sedimentation and the prevailing climate. Loess layers, which are associated with cold climate conditions, are dominated by the deposition of coarser dust particles. In contrast, finer airborne material has been deposited within the pedocomplexes that represent temperate intertidal or interglacial environments.

Our results demonstrate the potential of the aeolian dust record at Orkutsay to decipher impacts of past climatic changes on terrestrial ecosystems and to understand climate feedback processes in continental interiors such as Central Asia.

The nature and formation of aeolian mineral dust material

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Aeolian dust affects climate and records past climates. It has become a much studied material but there has been a certain lack of emphasis on the actual nature of the dust, and an even greater neglect of actual production mechanisms for dust particles. Huge amounts of dust may be raised from the Bodele depression and other parts of North Africa, and much of it may be carried across the North Atlantic to aid in soil formation in Brazil. But what does it consist of? We know that much of the Bodele dust is diatoms from old Lake Chad, but what of the lithological inorganic mineral content?

A very crude division of aeolian dust into large dust (say around 20-50 μm) and small dust (2-5 μm) has been proposed. Much of the study of loess has been confused by the failure to make this distinction, and similar problems may arise in the study of the finer fractions of aeolian dust. Much aeolian material is clay-mineral based-from clay mineral aggregates (CMA), from lake bottom sediments. This can form large dust particles, as in para in Australia, but also contributes largely to small long travel aeolian dust.

Another major contributor is the quartz fragment. The large dust for classic loess deposits is mostly quartz silt and there is considerable discussion about the controls that affect quartz silt. There are some interesting modalities in the world of quartz particle sedimentology which need to be examined. Quartz sand (say 200-500 μm) has been studied more extensively.

Small quartz dust is difficult to produce. The high-low stress works again in the surface regions of sand dunes; a combination of impact stresses and internal stresses yields small dust sized particles. But this stress combination only yields small dust. Large dune areas may produce a considerable amount of small quartz dust, but at a negligible amount of large dust. Mineral particles generated by hot deserts and going to make desert clouds can be expected to contain small quartz dust and small CMA dust. Outline mechanisms for the production of these two particle types can now be proposed, and the size controls delineated.

To quote Morales from Saharan Dust 1979: he proposed that we need "comprehensive studies to understand the production of fine particulate material by weathering and disintegration processes as a first and important step in dust production." These are still needed.
Thermokarst processes in west-European loess series: new evidences for rapid climatic warming events during the Last Glacial

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For a long time, the imprint of millennial climatic cycles (D/O cycles) in the Last Glacial loess sequences has been related to the alternation of loess layers and arctic brown soil horizons, especially between about 60 and 30 ka BP (± MIS 3). Nevertheless, owing to erosion gaps and strong reductions in the sedimentation rate, there are always less individual soil horizons than D/O cycles during the same period, which makes correlations very difficult. The discovery in the Nussloch loess sequence (Germany) of a thermokarst structure including well preserved vegetal remains, mollusc shells, and relicts of former ice wedge casts, provides new evidences for a rapid climatic warming at the origin of a major erosion event during the Middle Pleniglacial (±MIS 3). This elongated thermokarst erosion gully incised the underlying deposits. The presence of deformed ice-wedge relicts along its very sharp and irregular lower boundary indicates a formation by thermal erosion linked to a rapid melting of the permafrost ice. The analysis of the biological data (vegetal remains and mollusc shells) allows to evidence interstadial conditions strongly contrasting with the over- and underlying loess environments. Radiocarbon dates from wood remains (average 32.26 14C / ± 37.7 cal. BP) allow the correlation of the main thermokarst formation and infilling with GIS-8 from the GRIP ice core, following H4 event. Similar structures have been evidenced in other west-European loess sequences, most of them at the base of the Middle Pleniglacial formations. On the basis of a comparison with present day analogues from Alaska and Siberia permafrost areas, past "thermokarst events" are related to thermal erosion processes and proposed as markers for rapid warming periods in Last Glacial European loess sequences.