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

Verbreitung des Lößes in Mitteleuropa.

Entworfen von R. Grahmann
Leipzig 1931
Loess Letter LL66 October 2011

Loess Letter LL is a newsletter for the INQUA Loess Focus Group, for the INQUA Loess & Dust Community, for anyone interested in loess. It is published from the Geography Department, Leicester University, and associated with the Leicester Quaternary Palaeoenvironments Research Group. (Editor Ian Smalley; ijs4@le.ac.uk in the Geography Department and ijsmalley@gmail.com in the LL office at the Tin Drum Community). INQUA is the International Union for Quaternary Research, dedicated to investigating the events and environments of the last 2.6 Myr (www.inqua.tcd.ie). A short history of INQUA was published as LL65.

From 35 to 65 LL was published from Nottingham Trent University and we owe a great debt of gratitude to that institution for support in production and postage. Some memorable issues were produced at NTU. Now we move back to Leicester. LL34 was a Leicester issue, devoted to fragipans in loess; for 66 we focus on the Bremen ADOM-MARUM Dust Workshop 2011.

LL66 is delayed slightly to allow us to publish material from the Bremen ADOM workshop. This was a relatively small meeting so it is useful to give the loess-related abstracts some wider circulation. The place to see all the abstracts is at www.marum.de/dust-workshop2011.html. -definitely worth a look; the latest word on loess and dust.

ED@80: Loess in China & Europe: a tribute to Edward Derbyshire- a conference to be held at the University of Novi Sad 27-30 September 2012. Participation invited; contact Slobodan.Markovic@dgt.uns.ac.rs for details.
Tracing dust provenance in paleoclimate records using mineralogical and isotopic fingerprints: additional clues from present-day studies

Dust records retrieved from ice and sediment cores represent some of our most valuable evidence for modifications of atmospheric circulation on various timescales over the last few million years. This information also contributes to the documentation of changes in continental palaeo-environments (e.g., changes in aridity), changes in iron inputs to the ocean, as well as changes in the hydrological cycle. Interpreting ice and sediment-core dust records, and using them for modelling purposes, requires firstly a good understanding of the dust provenance and its possible temporal variability. Specific intrinsic tracers such as clay mineralogy, major and trace elements, and radiogenic isotopes (strontium, neodymium, lead) have been used for this purpose, with variable effectiveness.

One difficulty lies in the fact that these measurements require significant amounts of material and can thus only be obtained at low temporal resolution, either because of the low dust concentration in ice cores or because of the low mass accumulation rates and bioturbation in marine sediments. As a result, dust samples extracted from ice and sediment cores for provenance investigation average long periods of time and may reflect mixtures from various source areas, complicating the interpretation of the data. Therefore, future trajectories (clay mineralogy and Sr-Nd isotopes in particular) may provide much of the discrimination of which continents provided most of the dust deposited in remote locations such as Greenland and Antarctica during the warm glacial stages. The locations of the contributing source areas, however, were not precisely identified. During the low-dust, interglacial periods, provenance has proven to be a more difficult task, even on broad (i.e., continental) geographic scales. In other aeolian deposits, such as Asian loess or marine sediments off West Africa, the provenance of the dust is still poorly constrained, despite the fact that these archives are located close to the highest dust-emission areas in the world.

Characterization of dust provenance (using mineralogical and isotopic fingerprints) at present, which can be achieved at much higher resolution and benefit from remote sensing data and well-constrained GCM outputs, may provide valuable clues for our understanding of dust provenance in paleoclimate records. We review some investigations carried out in Greenland and Antarctica over the last decade, and present new results from the West African margin. We discuss the extent to which these present-day time series may help us calibrating our paleo-dust provenance proxies, and improving our understanding of dust provenance in paleoclimate records.

With Shionoya, Bout-Roumazeilles, Grousset and Biscaye

Unraveling terrestrial and marine dust archives: towards a direct indicator record of wind strength

One of the outstanding problems of dust flux reconstruction from physicochemical properties of marine and terrestrial sediment records stems from the fact that most sediments are mixtures of sediment populations derived from different sources and transported by different mechanisms. We have formulated an approach to tackle the mixing problem which combines (i) grain size analysis of the silicate sediment fraction and (ii) decomposition of sets of grain-size distributions with the end-member modelling algorithm EMMMA [1] to characterise the different sediment transport processes and pathways. Here we report on several Late Quaternary dust records extracted from marine (e.g., Arabian Sea [2], Atlantic [3]) and terrestrial sedimentary archives (e.g., Chinese loess [4]) to indicate that a genetically meaningful decomposition of grain-size distributions can be accomplished with EMMMA.

The grain-size distributions of Chinese loess-paleosol sequences provide information on sediment provenance, transport pathways and East Asian monsoon variability. The warming role in conjunction with less accumulation rate estimates reveals that two contrasting dust supply patterns were active over the Loess Plateau during the last two glacial-interglacial cycles (5-7): (i) a background sedimentation pattern that was dominant during interglacial periods, especially the central and southern parts of the Loess Plateau, is reflected by the constant flux of the fine-grained loess component, (ii) the episodic, highly variable dust input pattern, that was dominant during glacial periods throughout the Loess Plateau and noticeable during interglacial periods mainly over the northern Loess Plateau and almost disappearing over the southern Loess Plateau, is reflected in the admixture of two coarse-grained loess components.

A genetic interpretation and the paleoclimatic significance of the mixing model for the Chinese loess-paleosol records is provided by comparison of the modelled components with modern dust samples in terms of their grain-size distribution and flux rates, and by the distribution patterns of the loess components across the Loess Plateau reconstructed for the last two glacial-interglacial cycles. The study shows that the main components represent the coarse dust fraction supplied by (modified) saltation and short-term suspension processes over the proximal part of the Loess Plateau during major dust outbreaks in spring. The loess component (eastern winter monsoon with westerly wind system) is the likely transporting agent for these dust events. A loess component represents the fine dust component supplied over the entire Loess Plateau by long-term suspension processes during major dust outbreaks and as part of a background supply system. The loess component in the glacial loess deposits is dominantly supplied during major dust outbreaks by the north-westerly winter monsoon, whereas the loess component in the interglacial paleosols is mainly supplied by non-dust-storm processes, possibly with a significant contribution by the high-latitude sub-tropical jet stream (westerly winds).

Characterisation of the coarse dust component – which is supplied by (modified) saltation and short-term suspension processes during major dust outbreaks in spring – allows for a reconstruction of winter monsoon variability. However, a prerequisite for an accurate reconstruction of wind-strength variability on the basis...
of loess grain-size distributions is that no significant changes in the location of the dust source area (determining the source-to-sink distance) has taken place through time. These conditions are met at a specific location, the Mangshan Plateau. The Mangshan Plateau is located on the south bank of the Huang He (Yellow River) just west of the city of Zhengzhou, well outside the Loess Plateau in central China. A mixing model of the grain-size data indicates that the loess deposits are mixtures of three loess components. Comparison of the mixing model with existing models established for a series of loess-paleosol sequences from the Loess Plateau [5-7] indicates that the Mangshan loess has been predominantly supplied from a proximal dust source, the Huang He floodplain, during major dust outbreaks [8]. The high accumulation rates, the composition of the loess components, and especially the high proportions of the sandy loess component support this. Owing to its specific geomorphologic setting and the exceptionally high accumulation rates, the Mangshan loess record provides a high-resolution archive of environmental and climate change [9] and specifically of East Asian Winter Monsoon variability. The Mangshan loess grain size derived wind strength record shows close similarities with the downwind Chinese speleothem 14C data records. The observations indicate that intensified winter monsoon conditions during glacial and stadial periods could account for these close similarities. And as a remarkable feature we infer that the fine-grained sediment, predominantly present during the interglacials and interstadials, actually represents the background input from the remote inner Asian deserts which function as dominant dust source areas of the deposits found at the Chinese Loess Plateau, and the dust that finally ends up in the Greenland Ice Sheet.

References:

With Kai C. Beets, Hongbo B. Zheng

Production of Asian dust: tectonic versus climate

Asian dust plays a major role in contributing to the world dust system, and in turn modulating global climate. Asian dust presumably originates from the deserts in Asian interior, yet the formation and evolution history of the deserts remain debated. In this paper we present sedimentological evidence from the southern margin of Tarim Basin (Taklimakan Desert) to determine the age of formation of the desert, and to envisage the mechanism in which dust is produced through a series of tectonic, fluvial, sedimentological and eolian processes.

Cenozoic sedimentary succession along the southern margin of the Tarim Basin, western China, reach up to 10 km in thickness. The two studied sections, the Yecheng and Aertashi, comprise ca. 4.5 km and ca. 7.0 km of clastic sediments respectively. The base of the Yecheng section is palaeomagnetically dated to be at about 8 Ma. Age control of the Aertashi section is based on 40Ar/39Ar measurements (for the basal marine bed), together with magnetostriatigraphy and regional stratigraphic correlation. The upper part of the sections is mainly composed of fine-grained mudstone and fine sandstone, which makes up the Wusuan Group (Miocene). The palaeoenvironment is low-energy, meandering and braided streams. The middle part is composed of red mudstone, sandstone with thin conglomerate beds, which makes up the Artux Formation (Pliocene). The palaeoenvironment is a delta to mid-fan environment. The uppermost part of the section, known as the Yiku Formation (Plio-Pleistocene), consists of cobble and boulder conglomerate intercalated with massive siltstone lenses, which formed as proximal alluvial fan and eolian deposits. Neogene red beds passing upward into upward-coarsening conglomerate and debris-flow deposits record the change in palaeoaltitude related to uplift of the northern margin of Tibetan Plateau.

The formation of loess dunes at ca. 8 Ma, and underlying playa lake deposits (as at Aertashi), may indicate an arid, enclosed basin in the southern Tarim after this time. Sedimentological characteristics, together with grain size distribution and geochemistry of siltstone bands in the Yiku and Artux Formations, point to an eolian origin. This indicates that the Taklimakan Desert and the regional climate regime may have been fully developed by the Early Pleocene, if not earlier. The onset of eolian sedimentation in the southern Tarim Basin coincided with uplift of the northern Tibetan Plateau, as inferred from the lithofacies change. Tibetan Plateau uplift resulted in the shift of sedimentary environments northwards into the southern Tarim Basin, and could have triggered the onset of full aridity in the Takhlimakan region as a whole.
One million years of dust dynamics recorded in Serbian loess-paleosol sequences
Loess deposits in the Vojvodina region, northern Serbia, are among the oldest and most complete loess-paleosol sequences in Europe. These thick sequences contain a detailed paleoclimatic record from the late Early Pleistocene. Based on the correlation of detailed magnetic susceptibility (MS) records from Vojvodina with the Chinese loess record and deep-sea isotope stratigraphy we here reconfirm and expand on a stratigraphic model of the Vojvodanian loess-paleosol chronostatigraphic sequence following the Chinese loess stratigraphic system.

Variations in MS, dust accumulation rates, and the intensity of pedogenesis demonstrate clear evidence for a Middle Pleistocene climatic and environmental transition. The onset of loess deposition in Vojvodina also indicates a direct link between dust generation in Europe and that in the interior of Eurasia since the Early Pleistocene. The youngest part of the Early Pleistocene and oldest part of the Middle Pleistocene is characterized by relatively uniform dust accumulation and soil formation rates as well as relatively high magnetic susceptibility values. In contrast, the last five interglacial-glacial cycles are characterized by sharp environmental differences between high dust accumulation rates during the glacial and low rates observed during soil development. The data presented in this study demonstrate the great potential of Vojvodina's loess archives for the reconstruction of continental Eurasian Pleistocene climatic and environmental evolution.

Loess-paleosol series preserved in northern Serbia are exceptionally complete and as such represent one of the most detailed European terrestrial climatic records available, made especially valuable by their spatial extent. The better preservation in Serbian loess in comparison to that in the north and west is most likely related to the continuous presence of much drier climatic conditions in this region and the persistence of stable 'plateaux' of accumulation. This relatively dry climate in Vojvodina may also further explain why the loess climate record there is similar to Chinese records. A direct correlation between Serbian and Chinese loess magnetic susceptibility (MS) records suggests the possibility of a link between long-term environmental change in Europe and Asia. A key similarity between Serbian and Chinese loess records is the remarkable trend to increased interglacial aridity over the course of the Middle Pleistocene. Furthermore, this trend is in sharp contrast to the globally integrated marine oxygen-isotope record, suggesting that this record does represent the true long-term environmental trends observed in continental mid latitude Eurasia over the Pleistocene. This observation is even more important because the consequences of future climate change need to be modelled for specific continental regions in order that the impact on humans can be predicted. Derived from the marine record appears not to characterise how the Eurasian continent.

With Ulrich Hombach, Thomas Stevens, Mladen Iovanović, Ken O’Hara-Dhind, Biliana Basarin, Huayu Lu, Zorica Suvčev, Ian Smalley, Tiwadar Gaudenji, Böhm Buggle, Michael Zach, Igor Obreht & Ludwig Zöller

Terrestrial dust record between tropical and extratropical circulation: the eastern Canary Islands
The position of the Eastern Canary Islands at the southernmost margin of the westley-influenced Mediterranean climate zone in the east of the north-hemispheric subtropical North Atlantic Ocean, 100 to 160 km off North Africa, allocates them a key role in studying present and past circulation patterns. Miocene-Pliocene volcanic (basaltic) masses are dissected by deep trough-shaped valleys, some of which were dammed by Lower to Middle Pleistocene lava flows and tephras to form closed pans locally called "vegas". These vegas have acted as sedimentary traps filled with aeolian, fluviolacustrine, and colluvial sediments reflecting direct or indirect input of Saharan dust. To a minor degree volcanic fallout has also filled the vegas. At present, the Canary Islands are influenced by three wind systems: trade winds of the Hadley circulation, Atlantic westerlies, and easterly Saharan winds. Saharan dust is brought to the Canary Islands either by lower-level easterly winds at the front end of Atlantic cyclones on a very southern track ("Calima"), or by the higher level "Saharan Air Layer", a branch of the Saharan Air Layer.

Due to an agricultural technique called "enarenado artificial" the vegas sediments are well exposed in several quarries. We investigated sediments from three vegas spanning the past ca. 180 ka to decipher a unique terrestrial archive in the area and to compare our results with those obtained from marine and from other terrestrial archives.

The chronology of our vegas sediments was established from OSL dating of allochthonous quartz grains back to ca. 125 ka. Beyond this, we used a correlation of kaolinite contents measured in the vegas sediments with those measured in nearby marine cores to adopt the marine chronot stratigraphy. Time resolution is, however, restricted to the scale of marine stages or substages, whereas shorter cycles such as D/O cycles could not be distinguished clearly.

We used frequency dependent magnetic susceptibility (kred) and grain size analysis (Malvern 2600C Laser Analyser) as proxies for past soil humidity and pedogenesis.
Our results indicate that the present aridity of Lanzarote Island (since ca. 8.5 ka) is the exception rather than the rule for the past ca. 180 ka. The period between ca. 75 and ca. 25 ka ago was generally wetter than the Holocene. Humid periods during the past 180 ka appear to be coeval with cold sea surface temperatures in the eastern North Atlantic, as well as with sapropel layers S1 to S6 in the Nile delta, except for S3.

Comparing our results with those from other archives and regarding positive or negative correlations, three scenarios can be discussed to explain the observed changes between more humid and more arid phases: I, higher (winter) precipitation due to more intensive North Atlantic
One million years of dust dynamics recorded in Serbian loess-paleosol sequences

Loess deposits in the Vojvodina region, northern Serbia, are among the oldest and most complete loess-paleosol sequences in Europe. These thick sequences contain a detailed paleoclimatic record from the late Early Pleistocene. Based on the correlation of detailed magnetic susceptibility (MS) records from Vojvodina with the Chinese loess record and deep-seated loess stratigraphy we here reconfirm and expand on a stratigraphic model of the Vojvodinian loess-paleosol chronostratigraphic sequence following the Chinese loess stratigraphic system.

Variations in MS, dust accumulation rates, and the intensity of pedogenesis demonstrate clear evidence for a Middle Pleistocene climatic and environmental transition. The onset of loess deposition in Vojvodina also indicates a direct link between dust generation in Europe and that in the interior of Eurasia since the Early Pleistocene. The youngest part of the Early Pleistocene and oldest part of the Middle Pleistocene is characterized by relatively uniform dust accumulation and soil formation rates as well as relatively high magnetic susceptibility values. In contrast, the last five interglacial-glacial cycles are characterized by sharp environmental differences between high dust accumulation rates during the glacial and low rates observed during soil development. The data presented in this study demonstrate the great potential of Vojvodina’s loess archives for the reconstruction of continental Eurasian Pleistocene climatic and environmental evolution.

Loess-paleosol series preserved in northern Serbia are exceptionally complete and as such represent one of the most detailed European terrestrial climatic records available, especially valuable by their spatial extent. The better preservation of Serbian loess in comparison to that to the north and west is most likely related to the continuous presence of much drier climatic conditions in this region and the persistence of stable ‘plateaux’ of accumulation. This relatively dry climate in Vojvodina may also further explain why the loess climate record there is similar to Chinese records. A direct correlation between Serbian and Chinese loess magnetic susceptibility (MS) records suggests the possibility of a link between long-term environmental change in Europe and Asia. A key similarity between Serbian and Chinese loess records is the remarkable trend to increased interglacial aridity over the course of the Middle Pleistocene. Furthermore, this trend is in sharp contrast to the globally integrated marine oxygen-isotope record, suggesting that this record does not reflect the true long-term environmental trends observed in continental mid-latitude Eurasia over the Pleistocene. This observation is even more important because the consequences of future climate change need to be modelled for specific continental regions in order that the impact on humans can be predicted. The information derived from the loess record may not to characterise what happens over the Eurasian continent.

With Ulrich Hornbach, Thomas Stevens, Mladen Jovanovic, Ken O’Hara-Dund, Biljana Basarin, Huang Lu, Zorica Stroev, Ian Smallay, Tivadar Gaudenly, Bjorn Buggle, Michael Zach, Igor Obreht & Ludwig Zoller

Terrestrial dust record between tropical and extratropical circulation: the eastern Canary Islands

The position of the Eastern Canary Islands at the southernmost margin of the westerly-influenced Mediterranean climate zone in the east of the north-hemispheric subtropical North Atlantic Ocean, 100 to 160 km off North Africa, allocates them a key role in studying present and past circulation patterns. Mi-Pliocene volcanic (basaltic) lavas are dissected by deep trench-shaped valleys, some of which were dammed by Lower to Middle Pliocene lava flows and tephra layers to form closed pans locally called "vegas". These vegas have acted as sedimentary traps filled with aeolian, fluvoaolian, and colluvial sediments reflecting direct or indirect input of Saharan dust. To a minor degree volcanic fallout has also filled the vegas. At present, the Canary Islands are influenced by three wind systems: trade winds of the Hadley circulation, Atlantic westerlies, and easterly Saharan winds. Saharan dust is brought to the Canary Islands either by lower-level easterly winds at the front end of Atlantic cyclones on a very southern track ("Calima"), or by the higher level "Saharan Air Layer", a branch of the Saharan Air Layer. Due to an agricultural technique called "enrañado artificial" the vegas sediments are well exposed in several quarries. We investigated sediments from three vegas spanning the past ca. 180 ka to decipher a unique terrestrial archive in the area and to compare our results with those obtained from marine and from other terrestrial archives.

The chronology of our vegas sediments was established from OSL dating of alluviochonous quartz grains back to ca. 125 ka. Beyond this, we used a correlation of kaolinite contents measured in the vegas sediments with those measured in nearby marine cores to adopt the marine chronostatigraphic. Time resolution is, however, restricted to the scale of marine stages or substages, whereas shorter cycles such as D/O cycles could not be distinguished clearly.

We used frequency dependent magnetic susceptibility (kappa) and grain size analysis (Malvern 2600C Laser Analyser) as proxies for past soil humidity and pedogenesis. Our results indicate that the present aridity of Lanzarote Island (since ca. 8.5 ka) is the exception rather than the rule for the past ca. 160 ka. The period between ca. 75 and ca. 25 ka ago was generally wetter than the Holocene. Humid periods during the past 160 ka appear to be coeval with cold sea surface temperatures in the eastern North Atlantic, as well as with soprox layers SI to 56 in the Nile delta, except for 53.

Comparing our results with those from other archives and regarding positive or negative scenarios, three scenarios can be discussed to explain the observed changes between more humid and more arid phases: i) higher (winter) precipitation due to more intensive North Atlantic

Ludwig Zoller
Bayreuth University
95440 Bayreuth, Germany
ludwig.zoller@uni-bayreuth.de
www.geomorph.uni-bayreuth.de
Long-term seasonality changes and short-term climate variability recorded in Eurasian loess: examples from Serbia, Romania, Kazakhstan, and China

Post-glacial dynamics associated with the Eurasian continent are well studied. However, the impact of intra-hemispheric-scale climate variability on the entire Eurasian landscape, as well as the self-generated effects of the continent on the global climate system, is still a matter of considerable debate. While western Atlantic polar and tropical air masses penetrate into the continent and are modified and 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 ocean processes and regulate teleconnection patterns of the Northern Hemisphere.

The distribution of Eurasian loess deposits allows interregional palaeoclimatic investigations along a west-east transect across the entire Eurasian loess belt of the Northern Hemisphere, offering the potential to reconstruct Pleistocene atmospheric circulation patterns and aeolian dust dynamics on a wide spatial scale.

This paper utilizes high resolution particle size data from several loess sequences across Eurasia (Serbia, Romania, Kazakhstan, and China) that provide a detailed signal of glacial-interglacial atmospheric dynamics and long term, semi-continuous trends in the aeolian dust record since marine isotope stage 10. In consideration of the modern synoptic atmospheric circulation patterns and aeolian dust transport across the Eurasian landscape, we propose that the observed data reflect oscillations superimposed on a long term signal of seasonality, triggered by changes in duration and permanency of the seasonal shift of the Eurasian polar front during the middle to late Pleistocene. As the activity of the polar front is intimately connected with the high level planetary frontal zone (HPFZ), the Eurasian loess archives may also serve as a recorder of intra-hemispheric climate connections in past atmospheric circulation.

Although there are large scale similarities in the dust transport record from numerous sites across Eurasia, the data reveal distinct differences in short-term climate variability along the studied transect from SE Europe over Central Asia to China. In Central and East Asia the observed dynamics in aeolian dust transport closely mirror 18O and fine dust variations seen 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, the presented data represent the first Central and East Asian aeolian dust records in which DO events are recorded, providing a means to verify hypothesized links between short-term climate variability recorded in Greenland and associated climate dynamics at Asian dust source areas. Ultimately, the data extend existing theories, 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 suborbital global climate changes and an initiator of abrupt climate oscillations in the Northern Hemisphere.


With: Hans van Sochockisz, Dominik Faust, Ulrich Hambach, Heidi Oberhonsli
European loess sequence, a record of atmospheric changes (ACTES ANR project)

The last climate cycle experienced millennial scale variations corresponding to massive discharges of icebergs in the North Atlantic Ocean and abrupt warmings observed in marine, ice and continental records. These changes are recorded in δ18O records in marine and ice-cores but the latter also yield other component of the climate system like mineral aerosols originated from Chinese northern deserts and transported mostly along a zonal dynamics. The ACTES project aims at investigating European loess sequences at 50°N latitude, and by performing model-data comparison to reconstruct how these sequences recorded the millennial scale climate changes by focusing on the emission, transport and deposition of dust which in the present case shows two main origin, local to regional for the coarse material and more distant one for the finest particles. The study shows that the loess sequences are a reliable indirect proxy of the past atmospheric circulation. The presentation illustrates that point through results obtained within the frame of the ACTES project.

With: Pierre Antoine (2), Christine Haté (3), France Lapoix (4), Adriana Sima (5), Masa Kageyama (3), Markus Fuchs (5), and the ACTES team members & ACTES fellow Team
(1) CNRS-ENS, Laboratoire de Météorologie Dynamique, 75231 Paris cedex 05, France
(2) Laboratoire de Géographie physique, UMR CNRS 8591, 1 place Aristide Briand, 92195 Meudon cedex, France.
(3) Laboratoire des Sciences du Climat et de l’Environnement, UMR 8212 CEA/ CNRS, Bât 12, Domaine du CNRS, Avenue de la Terrasse, 91198 Gif sur Yvette Cedex, France.
(4) Laboratoire de Physique du Globe, UMR CNRS 7154, Université Paris-Diderot, 4 place Jussieu, 75252 Paris, France.
(5) Department of Geography Geomorphology, Environmental Change and Natural Hazards Justus-Liebig-University Gießen, 35392 Gießen, Germany

Kay Beets
Vrije Universiteit Amsterdam
De Boelelaan 1085
1081 HV Amsterdam, the Netherlands
kay.beets@fakv.uu.nl
www.geo.uu.nl/~beets

Land snail shell records of East Asian monsoon δ18O seasonality

Chinese loess and stalagmites provide ample evidence that East Asian monsoon strength varied in tune with Northern Hemisphere insolation over the late Quaternary. But because of the limited resolution of these records, it remains elusive how the individual seasons were affected. Seasonal changes in atmospheric circulation, wind strength, temperature and precipitation amount, contribute to the variation in the oxygen isotope composition of atmospheric precipitation (Figs. 1 and 3).

The onset of the warm and wet summer monsoon over China produces a unique large decrease in rainwater oxygen isotope composition (Fig. 3), a potential marker for the change in atmospheric circulation and moisture provenance between April and July. This characteristic spring to summer isotopic contrast is documented (Fig. 2), remarkably well, in the growth increments of modern aragonitic land snail shells from the Mangshan loess plateaux on the south bank of the Yellow River. These isotope ranges compare favorably to the calculated equilibrium aragonite δ18O composition, which varies from a maximum of +1.5±1.2 % PDB for March, to a minimum of -10.6±1.2 % PDB for July (Fig. 1).

For comparison we also analyzed a Last Glacial Maximum (LGM) Cathaca pulveratix shell from the Mangshan loess sequence. This fossil specimen displays a much reduced isotopic range, between +3.8 and -4.5 % PDB (Fig. 2), and has a -4 % higher average than the modern shells.
Hence, the estimated LGM precipitation $\delta^18O$ varies between -1.5 and -4.6 $\%$ SMOW (Fig. 3), and lacks the light $\delta^18O$ signature of the contemporary East Asian summer monsoon rains.

This seasonal oxygen isotope pattern, therefore, suggests a modified atmospheric circulation and moisture provenance compared to the present day. Interestingly, the strong wind frequency over the Gobi desert shows a high covariance with the amount of precipitation and the precipitation $\delta^18O$ at Manghan-Zhengzhou for the March until October period. Applying this modern relationship to the reconstructed LGM precipitation $\delta^18O$ indicates a large decrease in monthly rainfall and an increase in strong wind frequency events (Fig. 3). The dominance of an intensified winter monsoon during the LGM could account for these observations, and would also explain the close similarity between the Manghan loess grain size derived wind strength record and the downwind Chinese speleothem $\delta^18O$ records.

With Simon R. Troelstra*, Maarten A. Prins*, Isla M. Kamering**, Frank D. Petzold*, Stefan Schouten*, Naiqin Wu*, and Hongbo Zhang†

1. Faculty of Earth and Life Sciences, VU University Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, NL
2. School of Geosciences, Geography and Environment, University of Aberdeen, United Kingdom
3. NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Organic Biogeochemistry, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands
4. Present address Geological Institute, ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland
5. Institute of Geology and Geophysics Chinese Academy of Sciences, Beijing, China
6. School of Earth Science and Engineering, Nanjing University, 22 Hankou Road, Nanjing, China

Fig. 1: View on the bluff of the Tiel Plateau at Duleto. The cliffs are formed by the ongoing erosion of the Tisa River. Peaks in the M5 record and the labels (V-Sx) indicate the positions of the palaeosol complexes.

Ulrich Hambach
Bayreuth University
95440 Bayreuth, Germany
ulrich.hambach@uni-bayreuth.de
www.geomorph.uni-bayreuth.de

The Tiel loess plateau: a unique palaeoclimatic record covering the last 600 kyrs
Loess deposits are considered to be some of the most detailed and long-term records of Pleistocene climate change. In Eurasia, a unique mid-latitude loess belt ranging from China to South-Eastern Europe provides insights into climate evolution since the Plenocene, at least. Whereas loess deposits in Western and Central Europe are temporarily and spatially discontinuous, in the Lower and Middle Danube Basin, at the western edge of the Eurasian loess belt, one can find true loess plateaus providing almost continuous archives of Pleistocene palaeoclimatic. These plateaus were presumably formed under similar environmental conditions like in the Chinese Loess Plateau (CLP) and in other Central Asian loess areas.
In the region called Vojvodina (North Serbia), we find loess deposits dating back at least to the younger Early-Pleistocene and reaching thicknesses of more than 50 m (Marković et al., 2009, 2011). A most remarkable morphological feature is the Titel Loess Plateau (TLP), situated in the interfluves of the Danube and Tisa rivers. Different phases of fluvial erosion have shaped the ellipsoid form of the plateau which is characterised by steep slopes on the margins. In the contrast of that, the plateau surface provides a more smooth morphology with low hypsometric differences. The TLP represents a loess island in the Danube and Tisa floodplains with maximal extension of c. 16 km (NW-SE) and a maximum width of c. 7 km. The loess sequences are comprised of multiple couplets of loess and palaeosol units totalling almost 50 m thickness of sediments (Fig. 1). 5 palaeosol complexes can be distinguished separated by several metres thick loess layers. The lower 2 palaeosol units are developed as strongly rubified forest soils with decreasing degree of pedogenesis from old to young. In contrary, the younger palaeosol units including the recent soil are developed as steppe soils.

Based on inter-profile correlation between three sites at the northern bluffs of the plateau (Veliški surdul, Feudvar and Dubočat) a synthetic TLP profile was built. A detailed magnetic susceptibility (MS) record in combination with palaeopedological observations forms the backbone of the relative stratigraphy. Results from optical dating (Bohland et al., 2009) prove the last glacial age of the uppermost loess unit and the thorough palaeopedological study by Branger (1976) corroborates our interpretations.

The pattern of MS variation and absence of any erosion sign in the profiles suggest a correlation of palaeosol complexes V-S5, V-S4, V-S3, V-S2 and V-S1 with the MIS 15-13, 11, 9, 7 and 5 (Fig. 2). The new stratigraphic model based on these correlations suggests serious re-interpretations of previous chronological concepts of the TLP loess series. The loess-paleosol sequences at the TLP and in Botanica (Vojvodina) deposited during the last five interglacial-glacial cycles are characterised by sharp environmental differences between high dust accumulation rates during the glaciads and reduced dust fluxes in the periods of palaeosol formation. The revised chronostratigraphic frame for the TLP loess-paleosol sequence provides an opportunity to examine the long term environmental dynamics within the context of regional, continental and global climate changes. Low values of MS and relative high accumulation rates derived from loess units V-L1, V-L2, V-L3, and V-L5 are in good agreement with the relative extent of ice sheets as estimates from marine isotope records (Lisiecki and Raymo, 2005).

The distinct and characteristic MS record of the TLP loess-paleosol sequences provides important and significant similarities to the environmental magnetic records observed in other Eurasian loess sections. This opens the possibility to extend the temporal and spatial correlation across the Eurasian loess belt from China via Central Asia to the Middle Danube Basin. Due to high accumulation rates, the Middle and Late Pleistocene loess-paleosol sequences of the TLP preserve a unique oceanic continental record of climate and environmental changes for the last c. 600 kyr.

---

**Fig. 2: Correlation of magnetic susceptibility records from Botanica (Marković et al., 2009) and the Titel Loess Plateau with the astronomically tuned magnetic susceptibility curve of the Chinese loess site Lingtai/Zhaojiaochuan (Sun et al., 2006) and with the marine isotope record (Lisiecki and Raymo, 2005).**
Frank Lehmkühl
Aachen University
Wüllenstraße 5b
52056 Aachen, Germany
lehmkuhl@geo.rwth-aachen.de
www.pgg.rwth-aachen.de/index.php?id=lehmkuhl

Distribution and timing of loess and loess-like sediments in mountains of Mongolia and Tibet

Research on aeolian sediments in Mongolia and Tibet shows two main cycles of aeolian sedimentation: first the accumulation of major sand fields neighbouring the eastern banks of rivers and lakes, and second the distribution of loess-like sediments on the mountain slopes. The first is resulting from strong westerly winds, being more strength especially during the glacial periods. The latter is resulting in the erosion and accumulation of silt in this region in more humid periods in interstadial stages and at the end of glacial periods. In addition, loessian sediments on the Tibetan Plateau are an important archive of palaeoclimatic information. For example, detailed analysis of aeolian sediments from the Dongqi Cona catchment on the north-eastern Tibetan Plateau show a complex pattern of long and short distance sediment transport. This depends on climatic changes as well as on the availability of sediments.

Based on the largest dataset of OSL datings (5) from a single catchment on the Tibetan Plateau, so far different periods of increased sediment transport have been reconstructed. Increased aeolian deposition in this high altitude environment started in the early Holocene with the accumulation of sands from around 12 to 7.5 kya. Loess sediments have been preserved from a period from 10.5 to 7.5 kya. Both archives are related to the strengthening of the Asian summer monsoon characterized by wetter and warmer climate. This change in climate led to the trapping of aeolian sediments. Under full monsoon conditions from around 10 kya onwards fluvial processes lead to the erosion of the aeolian archives and the formation of colluvial sediments until 6 kya. A dry and cooler climate resulted in the reactivation of dune sands from 13 kya to present, possibly in combination with stronger human influence. Aeolian sediments on the Tibetan Plateau therefore indicate two different climatic modes. During the early Holocene wetter conditions were favourable to retain aeolian sediments. The reactivation of sediment in the late Holocene due to small scale disturbances in the vegetation cover, points to a cooler and drier climate.

With Georg Rauch

Recent studies on loesses and loess-like sediments in the outermost east of the Pannonian Basin

As a part of geoarchaeological prospections in the Romanian Banat, numerous loess sections were studied in different geomorphological positions, from the Lowland to the foothills of the Banat Mountains. For the first time here, towards the eastern border of the Pannonian Basin, a series of improved methodology in grain size measurement and geochemical analysis offers opportunities to correlate these sections. Preliminary results show both, changes in the sedimentation and a change in the development and intensity of surface soils and palaeosols for that region. In general, the cover of loesses and loess-like sediments show larger distribution as expected. Following this catena to the west, a connection to adjacent Serbian and Hungarian loess sequences seems to be practicable.

With Holger Kiehl, Ulrich Hambach & Jens Potzel

1Department of Geography, RWTH Aachen University; 2Chair of Geomorphology, University of Bayreuth

Importance of biological loess crusts for loess formation in semi-arid environments

The essential components for loess deposition are: material (dust), atmospheric circulation (wind) and appropriate surface conditions for the trapping of aeolian material as well as the subsequent development of typical loess sedimentary structures. In spite of the world-wide distribution of loess deposits, knowledge of the processes of transformation from accumulated dust to mature loess sediment is still inadequate. Some recent studies highlight the potential importance of biologically crusts (BSC) in loess formation. BSC is highly specialized extremophile communities and generally play an important role in arid dust trapping and erosion prevention. Our initial results indicate that cyanobacterial strains isolated from loess exhibit some specific morphological and ecophysiological characteristics that play a key role in loess formation, warranting adoption of the new term biological loess crusts (BLC).

We suggest that loessification is heavily influenced by the metabolic activity of BLC microorganisms mainly through BLC polysaccharides (Fig 1). The sticky polysaccharide glue on the topographic surface, exuded mostly by cyanobacteria, can trap silty particles suspended in a dusty atmosphere (Fig 1B, D, F, BLC glue). This collection of airborne dust forming particles (ALFP) is part of the life strategy of crust organisms in so far as they provide the necessary minerals for further growth of the BLC, which in turn provides protection from desiccation during dry periods. Simultaneously, polysaccharides secreted by crust organisms bind particles inside the BLC zone, forming a cohesive crust that resists both wind and water erosion during dry periods (Fig 1A, C, E, BLC net). Metabolized particles (Fig 1MLFP), together with exuded metabolites (Fig 1IBM) and unused airborne particles (Fig 1ALFP) become the uppermost loess sediment covered with BLC (Fig 1C, E). During moist periods, accumulation of dust and loess forming particles is very active (Fig 1B, D, F). During the dry phases, the BLC becomes very stable and develops a resistant surface preventing wind and water erosion (Fig 1A, C, E). The drying period induces polysaccharide production by cyanobacteria, serving as protecting molecules from water stress. In the presence of water during a moist phase, polysaccharides produced in the transition from wet to dry phases and accumulated during dry phases become a new sticky layer for dust accumulation and initiate a new cycle of loessification (Fig 1B, D, F).

This model suggests that loess formation is intimately tied to BLC and cyanobacterial activity preferably combined with dry and wet environmental shifts. This scenario requires further detailed study in order to add it to the list of potential significant loess forming mechanisms that might describe not only particle generation, entainment, transport and deposition during loessification, but also might shed light on loess granulometry, thickness, permeability, geological zonality, adaption to the landscape and its changeability under human influence. Since BLC can be highly influenced by local changes of mineral and organic compounds, as well as moisture and temperature, this observation also raises questions about the importance of local environmental conditions for loess deposition.
Given that BLC is common on current loess surfaces that form the first stages of vegetation succession and also plays a key role in preventing wind and water erosion on disturbed soil, the proposed scenario about BLC dependent loessification should thus be seriously considered as one of the fundamental requirements for loess formation in semi-arid areas.

**Figure 1.** Possible model of the influence of BLC on loess formation: A. Initial dry season – BLC net prevents accumulation (solid line) and deflation (dashed line); B. Initial wet season – polysaccharide glue catches dust from air; C. and E. Next dry seasons – preservation of accumulated layers from previous wet seasons, i.e., no deflation; D. and F. Next wet seasons – formation of new polysaccharide glue associated with collecting of dust from air and transformation of older layers of accumulated dust to proto-loess deposits. BLC – biological loess crust; BLC glue – sticky polysaccharides produced by BLC organisms; ALFP – airborne loess forming particles; MLFP – metabolized loess forming particles; BLCM – metabolites, biomarkers.

With: Slobodan B. Marković, Thomas Stevens, Ian Smalley, Ulrich Hambach, Igor Obreht

1 Laboratory for paleoenvironmental reconstruction, Faculty of Sciences, University of Novi Sad, Trg D. Obradovića 2, 21000 Novi Sad, Serbia 2 Chair of Physical Geography, Faculty of Sciences, University of Novi Sad, Trg D. Obradovića 3, 21000 Novi Sad, Serbia 3 Centre for Quaternary Research, Department of Geography, Royal Holloway, University of London, Egham, Surrey, TW20 0EX, UK 4 Giotto Loess Research Group, Department of Geology, Leicester University, LE1 7RH, UK 5 Chair of Geomorphology, University of Bayreuth, D-95440, Germany

*ADOM-MARUM Dust workshop 2011 Abstracts short presentations & posters Page 55*