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LOESS LETTER 52

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.

The Nottingham Trent University

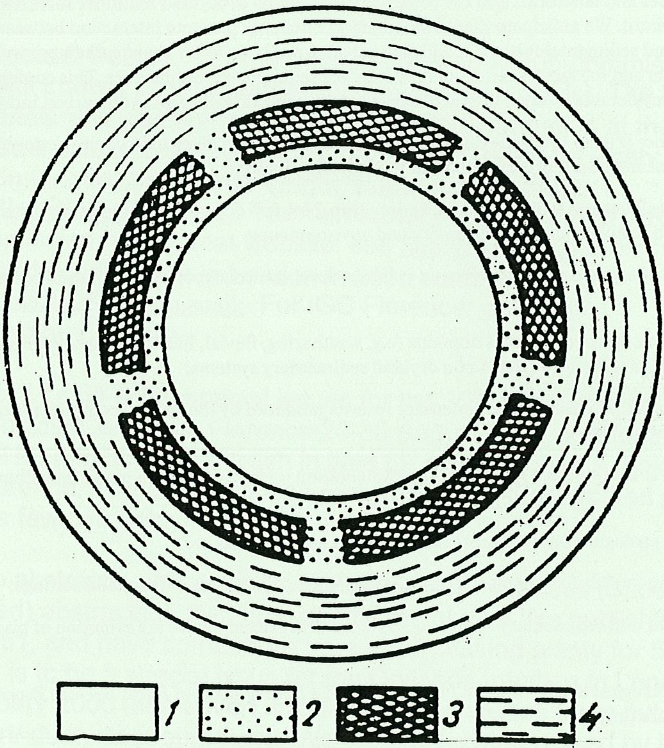


Рис. XII.9. Схема строения глобулярного агрегата — основного структурного элемента лёссового грунта (по Н. Н. Комиссаровой): *1* — кварц; *2* — гель аморфной SiO_2; *3* — $CaCO_3$; *4* — глинистые частицы $+ Fe_2O_3 +$ $+$ аморфная $SiO_2 + CaCO_3 +$ $+$ кварц

Notice of a Joint BGRG/BSRG International Conference

Drylands: Linking Landscape Processes to Sedimentary Environments

2nd - 4th February 2005, Geological Society, London

The overall aim of this joint BGRG/BSRG international conference is to bring together researchers working in modern and ancient dryland environments, in order to improve our understanding of arid zone processes and landforms and the preservation potential of dryland sediment successions in the geological record. We anticipate that the meeting will not only promote interaction between geomorphologists and sedimentologists, but will also enhance our knowledge about contemporary dryland environments and the factors influencing subsurface sedimentary architecture. This conference will also be of considerable interest to practitioners working in the water and hydrocarbon industries.

The conference is open to a wide range of researchers and practitioners. However, we specifically wish to attract oral and poster presentations on the following themes:

- Factors influencing sediment mobilisation, transport and deposition in the range of earth surface process domains operating within dryland environments;
- Impacts of external tectonic, climatic and base-level controls upon sedimentation patterns in drylands;
- Interactions between process domains (e.g. weathering, fluvial, hillslope, playa lake and aeolian processes) and their impacts upon dryland sedimentary systems;
- Preservation potential and sedimentary records produced by the various components of dryland landscapes;
- Impacts of near-surface geochemical sedimentation upon preservation potential within dryland systems;
- Modern analogues for dryland sediments in the geological record;
- Predictive models for spatial and temporal lithofacies distribution in dryland settings;
- Behaviour and sedimentary records of drylands that existed before the evolution of plant life on land.

An edited Geological Society Special Publication and a Special Issue of *Earth Surface Processes & Landforms* are proposed.

For further information contact the Convenors: Dr David Nash (University of Brighton), Dr Joanna Bullard (Loughborough University) and Dr Colin North (University of Aberdeen).

Website: http://www.bton.ac.uk/environment/drylands/ Email: drylands.2005@lboro.ac.uk

LL52. Loess Letter is an INQUA newsletter. INQUA is the International Union for Quaternary Research (originally INternationale QUArtarvereinigung). Details of INQUA at www.inqua.tcd.ie. The work of INQUA (looking at the last 2 million years) is carried out by five Commissions.Loess studies are concentrated into two: the Stratigraphy & Chronology Commission (sub-commission on Loess Stratigraphy & Palaeopedology) and the Terrestrial Processes, Deposits and History Commission (working group on Loess Materials).

Contacts & People. For the Loess Stratigraphy sub-commission contact Ludwig Zoeller (ludwig.zoeller@uni-bayreuth.de). The Loess Materials WG was constituted at the PASSED meeting at the Hanse Institute (HWK) in April. Chair/Pres. Grant McTainsh; VP Martin Iriondo; Sec. Janet Wright; Editor Ian Smalley (smalley@loessletter.com). The Terrestrial Processes (TERPRO) Commission has a great website: see http://inqua.nlh.no. For the Drylands conference in London in 2005 contact: drylands.2005@lboro.ac.uk. For IGC Florence; details at http://www.32igc.org.

LL52. LLs 51 & 52: special issues for the 32nd International Geological Congress, Florence 20-30 August 2004. We follow the usual LL practice and publish in time for distribution at a major conference. The 50 distribution programme at Reno worked well; and a few 51s were PASSED out.

Reno abstracts. We estimate that there were 66 loess (& loess related) abstracts in the Reno abstracts volume. We published 22 in LL51, and have some more here in 52, leaving plenty for 53. LL53 is to be a special issue for the Drylands meeting in London in February 2005 (see advert. inside cover) so we will try to put dry/ desert/ dusty abstracts there. We remain very impressed by the Reno abstracts volume- not since LoessFest'99 has there been such a grand gathering of loess papers. They deserve the double exposure which LL offers.

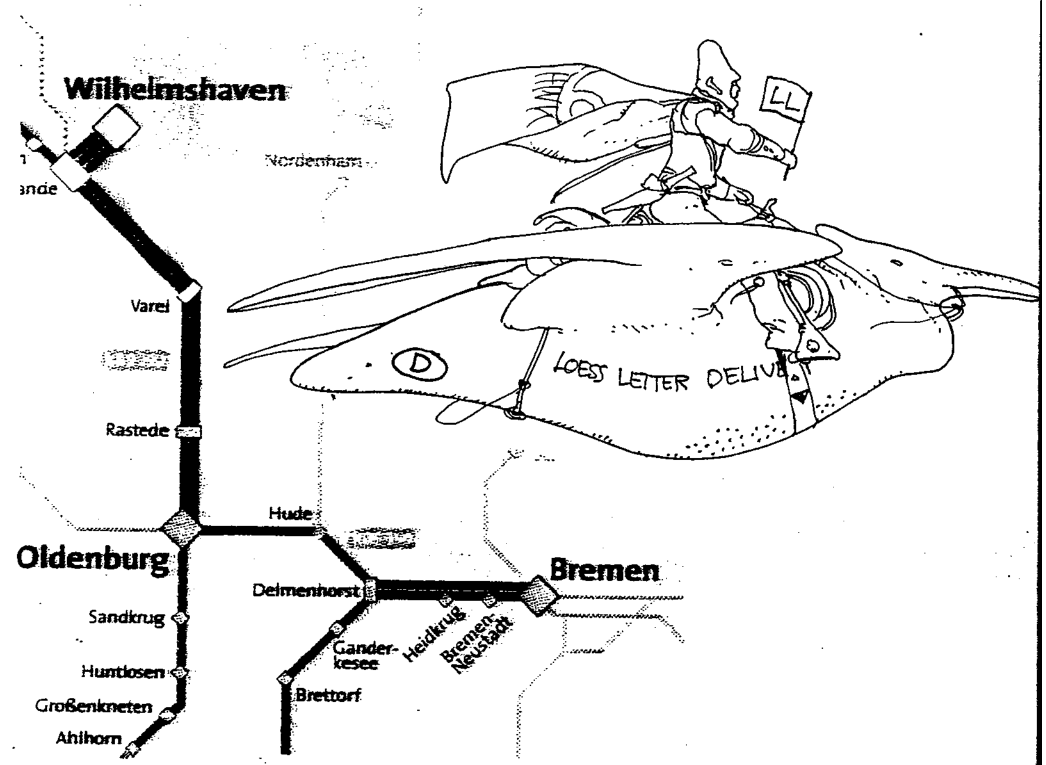
Quotations for dust people. "I ain't a scholar in much, Rokesmith, but I'm a pretty fair scholar in dust", who said that, and where? (answers in 53 if we remember). "Dust smells of a sun-ray…" Who? A clue- not originally in English, or German.

"From Particle Size to Sediment Dynamics". The PASSED conference was held at the Hanse Wissenschaftskolleg (HWK) in Delmenhorst 15-18 April 2004. We reproduce a few snippets. If you want a proper look at the extended abstracts go to: www. pangaea.de/Projects/PASSED/abstractlist.html. A great conference, making a substantial contribution to loess/ dust studies. It enclosed the set-up meeting of the INQUA Loess Materials WG. The WG is devoted to the study of loess as a material- a sediment, a soil; particle nature, particle size, particle behaviour. Participation is invited; contact via LL. Major LMWG concerns are: Loess in Australia, Argentina & Uzbekistan, hydrocollapse in loess, particle formation, the loess/ dust connection, the loess/ chernozem connection (the Black Earth project), and (high priority) loess studies in the Russian literature.

Covers & Pictures. On the front cover the complex loess particle as envisaged by N.N.Komissarova; inside the classic diagram of loess collapse by N.Ya.Denisov, and the map of collapsing loess in the Russian regions by V.T.Trofimov. Some cartoon figures by Moebius; a few other loess related cartoons. The back cover for 32 IGC. Thanks to NordWestBahn for the Delmenhorst map (& a great ride through beautiful flat country).

Loess Letter. LL is published by the Midlands Loess Group at the College of Environmental Studies, Nottingham Trent University, Nottingham NG1 4BU, UK. The editors are Ian Smalley and Ian Jefferson (ian.jefferson@ntu.ac.uk). LL comes out twice a year, nominally in April and October but publication times fluctuate wildly to accommodate major conferences. The members of the Midlands Loess Group are the Universities of Leicester, Loughborough, Birmingham and Nottingham Trent, and the British Geological Survey at Keyworth.

INQUA 2007. Looking some way ahead; the 17th INQUA Congress will be in Cairns, Queensland in 2007. Plan to attend, there will be some interesting discussions on Australian and New Zealand loess. It is proposed that there should be field excursions to NZ- in part to see the NZ loess. We might get to see the NZ loess at Timaru- where John Hardcastle invented loess stratigraphy in 1890.



From Particle Size to Sediment Dynamics

Contributions to an International Workshop held at the Hanse Institute for Advanced Study Delmenhorst (Germany), 15 – 18 April 2004

Editors:

B. W. Flemming, D. Hartmann & M. T. Delafontaine

Hanse Wissenschaftskolleg

senckenberg
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NEW" TYPES OF LOESS, NOT RELATED TO GLACIATION

I. Iriondo & D. Kröhling

I. Iriondo (✉), CONICET, C.C. 487, 3100 Paraná, Argentina (e-mail: rniriond@ceride.gov.ar)
ı. Kröhling, CONICET, Universidad Nacional del Litoral, C.C. 217, 3000 Santa Fe, Argentina

ıtroduction

oess is an aeolian sediment dominantly formed by silt or ilty loam, which normally generates rich soils. Consequently, is an object of permanent interest in sedimentology and soil cience.

he world's major loess deposits have correctly been linked) glacial processes (North America and North Europe loess) r to cold weathering processes (Chinese and Central Asian)ess). Such a particular pattern influenced the theory so trongly that today specialists assume some kind of relation 'ith ice. The fact that such an assumption is frequently nplicit is not less negative for the development of the nowledge on this issue. Deposits clearly disconnected of a old system are "a priori" disregarded by most loess specia-sts. Sometimes non-sedimentological theories are used, uch as rock alteration, mass movements, etc.

he real fact is that transport of silt and clay in suspension by 'ind is a universal process. Observations and measurements f the general movement of atmospheric dust and studies ıade on Quaternary fine sediments elsewhere suggest that ıe loess question is more ubiquitous, and it also occurs in on-glacial-related systems.

he general movement of dust by wind occurs under all limates, mainly in tropical deserts and sub-desert regions. Ioreover, measurements of sediment transport indicate that etween 90 and 95% of the total load of the world's rivers is omposed of silt and clay. Such a statistic is a sound ıdicator of the present continental dynamics. A somewhat ırger time span of sedimentation can be covered if one onsiders the surficial deposits of the ocean basins, which epresent a period of a few thousand years. Muds and "clays" re in fact silt-sized particles and aggregates under natural onditions.

urther, if one looks at the whole Phanerozoic Eon in a imple way, the dominance of silt always persists. Between 0 and 83% of the computed sedimentary rocks are "lutites", ersus 5-14% of sandstones; the remainder corresponds to mestones (Pettijohn et al. 1973). Mean values of thickness f sediments and sedimentary rocks are 3 km in the oceans nd 1.5 km on the continents, composed of 75% silt and clay Kuenen 1941).

)n the other hand, glaciations were scarce and represented hort episodes, occurring on Earth at intervals of about 00 million years. Glaciations are not really global; such vents cover only specific regions. Three glaciations have ccurred in geological times since the Precambrian. Glaciation thus represents about 5% of geologic time, overing minor portions of the continental masses, and can ot be the unique origin of all the windblown particles.

he present contribution proposes a more comprehensive ationale including the scattered available information about lternative origins in the general concept of loess. Some nportant loess deposits recently identified in South America an not be explained by the commonly accepted "strict rthodox" theory. A few cases are discussed in this ontribution.

Processes

In order to develop a correct rationale of loess, a sequence of necessary processes must be considered (Iriondo 1999). These processes are as follows.

Generation of silt particles

Several natural mechanisms can produce massive volumes of silt-sized particles. The most spectacular one is explosive volcanism, which can eject almost instantaneously millions of cubic meters of particles into the atmosphere. Physical weathering also accounts for the silt production. The most significant physical process appears to be crystal growth (frost and salt weathering). Crystallization of salt, with development of important tensile stresses, occurs in brines and sediments in hot deserts. Insolation weathering in tropical deserts and abrasion during transport by water or wind can also produce sizable amounts of silt particles.

The processes of soil lixiviation or elluviation under humid climates (chemical weathering) provide large amounts of loose silt to deflation during subsequent arid periods. Another quantitatively noteworthy process is the agglomeration of clay and colloid particles by flocculation during desiccation of water bodies, among others.

Incorporation of such particles by wind

Wind picks up silt particles from the surface when local humidity of the air is low and its velocity is above the shear velocity (20-40 cm/s). Dry seasons in all climates and even beaches or low-level wetlands in humid climates are favourable places for deflation. A definitely arid climate is not absolutely necessary for this process.

Transport of dust

Transport of dust by wind is a universal phenomenon with clear peaks around the tropical desert belts of the world.

Subaerial sedimentation

The accumulation of silt particles in subaerial surfaces is a necessary condition by definition. It occurs where efficient sediment traps are available in the environment. The best of these appears to be herbaceous vegetation.

Weak epigenetic alteration

A weak epigenesis is a key mechanism for transforming a simple deposit of silt into loess. It consists in a profound lixiviation of solutes which slightly precipitate in the whole sediment body. The classical composition of this salt is calcium carbonate, but it can be any cement, such as iron or manganese oxides, silica, even gypsum. No loess definition prohibits these conditions.

This process incorporates the field diagnostic characteristic of loess: vertical disjunction, friability, vertical slopes in outcrops, subfusion, and others.

Some cases in South America

The following non-classical types of loess are consistent with accepted loess definitions and share the most important field characteristics.

Tropical loess

Aeolian fine-grained sediments, dark red in colour and limited at the base by erosive discordances, cover as a mantle the landscape of large areas in tropical South America (north-eastern Argentina, south-eastern Brazil, eastern Paraguay and the lowlands of Bolivia). Such sediments were defined as "tropical loess" by Iriondo and Kröhling (1997, 2001).

The field characteristics of the tropical loess are loam to silty loam, powderish, porous and friable, organized in weak prisms with vertical dominance. It forms steep slopes in gullies.

The mobilization of iron was dominant throughout the profile. Iron and manganese sesqui-oxides concretions are frequent. Mineralogy indicates that the immediate sediment source was the alluvial plains of large rivers (Paraná and Uruguay) during dry seasons in the Last Glacial Maximum (Iriondo et al. 1997). After accumulation, a savannah enviro-nment developed in the region, provoking the percolation of iron.

Trade-wind loess

The global importance of this case lays on the permanent action of the North Hemisphere trade winds in a wide front and by the oscilation of the ITCZ in the tropical belt as factors of loess generation.

Trade winds permanently blow into the Orinoco Llanos (Colombia and Venezuela) during dry seasons. They enter in the region by crossing the Atlantic coast from east to west with strong force.

Alluvial sediments of the Orinoco River are exposed to wind action during dry periods, forming dune fields and silt deposits at the lee side and along the laterals of the system (Iriondo 1997). Such a deposit was considered as loess by Goosens (1971) and covers as a mantle 50,000 km^2 in the Colombian Llanos.

The loess is composed of an association of quartz and kaolinite, indicating an origin of the material in the Guayana shield. Geochemical composition suggests that the sediment originated at the Atlantic coast besides the shield, but not in the glaciated Andean Cordillera.

The dominant grain size is loamy silt to silty loam, yellow ochre in colour; it is powderish, friable and structured in steep walls. The main epigenetic agent was iron hydroxides. The loess was generated during the Last Glacial Maximum.

Another observed case produced by the action of the South trade winds occurs in north-eastern Brazil, where some loess deposits were studied by Iriondo and Molinas (2000).

Volcanic loess

Large, explosive volcanism under a mountain climate produced a different type of loess named "cangahua" in Ecuador. Persistently field geologists working in the area compare this deposit, or simply define it, as loess (Sauer 1965; Clapperton 1993).

The cangahua is a loose ash deposit reworked by wind fixed under a humid prairie climate, covering as a m 20,000 km^2 of the Interandean Corridor and adjacent sl in northern Ecuador and in southern Colombia (Iriondo 1 The sediment is formed by silt and very fine sand clas andesitic petrographic composition. It forms vertical slop gullies, shows scarce resistance to deep linear erosion undergoes subfusion processes. The colour is grey to o and it shows a weak degree of cohesion produced by s precipitate. Sauer (1965) identified three canga formations in the upper Quaternary.

There are probably other cases of this type of loess in S America. Specifically in the Central Valley of Chile, intergrades from volcanic ash, through re-transported ash to non-volcanic sediments form the valley infill (Iriondo 19

Our preliminary observations in the Volcanic Belt of Me resulted in the finding of frequent loess-like profiles in ver gullies, intercalated with particular, cemented horizons lo named "tepetates".

Loess generated by anticyclones

A mantle of aeolian silt, 20-80 cm thick, occurs at the surf in the Pampa Plain of Argentina and in the Chaco Plai Bolivia, Paraguay and Argentina and surrounding region Brazil and Uruguay. It covers homogeneously the local fo of the landscape. It is composed of coarse and medium with minor proportions of clay and very fine sand. The dep is loose, friable and porous, grey in colour. The epigen agent is silica. According to mineralogical indicators, sediment basically originated from local sources.

There are scattered sand fields of the same age develope that large region. Such sand fields are formed by parab dunes, which provide robust indicators of palaeowind di tions. The geographic pattern of such palaeowinds marks anti-cyclonic circulation (600-800 km radii), typical anticyclones in the Southern Hemisphere. This clim structure was dominant during a dry period which occurre the late Holocene (Iriondo 1990).

A European case

The lack of siliciclastic rocks and the dominance of gypsu northern Spain and the action of the above-mentioned loe forming factors produced a fine aeolian sediment, which all requirements of the definition of loess. Such a loess composed of silt-sized particles of anhydrite and gypsum appears in the Ebro basin, which forms a wide aeol corridor linking the North Atlantic Ocean with Mediterranean Sea.

The sediment is silty loam, yellow brown in colour, massi friable. The loess has a typical thickness of 6 m, outcrops steep profiles with vertical disjunction and conspicuo subfusion holes. The segregated epigenetic mineral gypsum, together with calcium carbonate. The mineralogi results indicate that the source of the clasts are the Terti gypsiferous formations, which are dominant in the area.

The particularity here is the process of generation of silt-siz particles of gypsum by arid physical weathering. The rest the sequential processes are "normal": a dominant nor westerly wind under a dry climate in an aeolian corridor, a fixation of the particles by sparse vegetation. According to datings, the loess is late Pleistocene-early Holocene (Irion and Krohling 2004).

PARTICLE-SIZE CHARACTERISTICS OF AEOLIAN DUSTS USING SEDIMENT POPULATION ANALYSIS

Grant McTainsh & John Leys

G. McTainsh (✉), Faculty of Environmental Sciences, Griffith University, Brisbane, Qld 4111, Australia (e-mail: g.mctainsh@griffith.edu.au)
J. Leys, Centre for Natural Resources, Department of Infrastructure, Planning and Resources, Gunnedah, NSW 2380, Australia

Introduction

Statistical analysis of particle-size data has been a challenge to earth scientists since the early 1900s, when Udden (1914) and Wentworth (1922) were among the first to conclude that particle-size distributions (PSDs) are log-normal. Folk and Ward (1957) used graphical statistical measures of mean, median, standard deviation (sorting), skewness and kurtosis to quantify PSDs. Later, Folk (1971) took the quite different conceptual standpoint of describing particle-size distributions in terms of mixtures of discrete log-normal sediment populations, or quanta.

It is only recently that statistical software has emerged which allow these mixtures of sediment populations to be quantified. A size-frequency curve-fitting program called MIX 3.1, developed by Macdonald and Green (1988) for ecological population studies, is used here to perform these sediment population analyses.

An experiment was set up to demonstrate the capacity of MIX to accurately quantify the component populations within multi-modal PSDs. The outcome of this experiment is reported here, along with three examples of research applications of this technology.

Methods

Particle-size analyses were by Coulter Multisizer, which produces high-resolution PSDs (256 size classes) on very small samples (<0.1g; McTainsh et al. 1997). The MIX 3.1 software can fit up to 15 component populations to frequency data grouped into a maximum of 80 class intervals. The theory behind the model is described by Macdonald and Green (1988).

For each MIX analysis, the operator must first estimate the mean, proportion and standard deviation of each component population within a PSD and enter them as input parameters. MIX may be directed to use these parameters as either estimated starting values (i.e. Floating Parameter Option), or as known constant values (i.e. Fixed Parameter Option). A Chi-Squared (χ^2) statistic is used to test the statistical significance of the overall fit to the original distribution if based upon count data. As percentage frequency data are used here, χ^2 can be viewed only as an informal indicator of goodness-of-fit.

Graphical output is in the form of a particle-size relative frequency histogram with best-fit normal frequency curves for each population within the total PSD. Figure 1 shows a soil PSD (Fig. 1, top) and a MIX plot (Fig. 1, bottom). Although unlabelled, the MIX plot X- and Y-axes represent a set of size classes (expressed in $\log_{10}$ microns) and the proportional frequencies within these classes respectively. The mode (or mean) of each population is indicated by a solid triangle on the X-axis and the proportion (%) of each population is listed. The best visual evidence of goodness-of-fit is the extent to which the frequency curve overlays the frequency histogram.

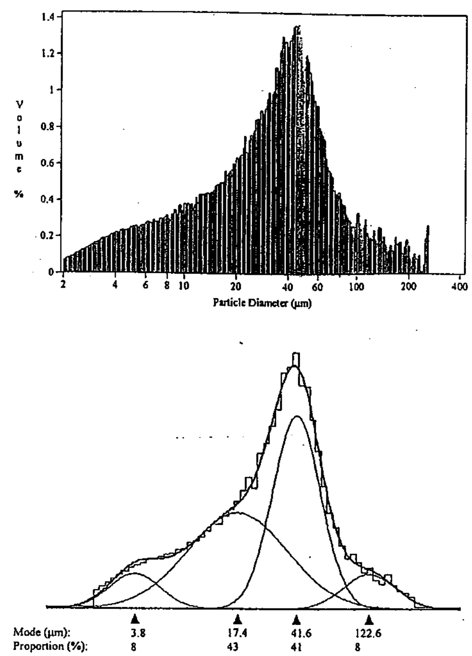


Fig. 1. *Top* Particle-size distribution, by Coulter Multisizer analysis, of a suspected loess soil in central NSW. *Bottom* MIX analysis output, showing a particle-size frequency histogram reduced to 80 size classes from the original 256 size-class Multisizer output, an overlay line plot which provides visual measure of the goodness-of-fit of the MIX analysis, and information on population modes (or means) and proportions

Results and discussion

Testing MIX

Two sediment samples with different particle-size modes were chosen. Sample A (Fig. 2, top left) is a dust with a mode of ~60 µm, and sample B (Fig. 2, top right) is a sandy soil with a mode of ~260 µm. These samples were particle-size analysed by Coulter Multisizer, then analysed with MIX to quantify the component population means, standard deviations and relative proportions. A synthetic PSD was then created by combining the data from the two samples in equal proportions using a spreadsheet. This synthetic PSD was then re-analysed with MIX and its characteristics compared with those of samples A and B. If the known sample component populations can be deconstructed from the synthetic

PALAEOCLIMATE SIGNALS IN LOESS SIZE DISTRIBUTIONS

Maarten A. Prins, Jef Vandenberghe & Gert Jan Weltje

M. A. Prins (✉) & J. Vandenberghe, Faculty of Earth and Life Sciences, Vrije Universiteit, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands (e-mail: maarten.prins@falw.vu.nl)
G. Jan Weltje, Department of Applied Earth Sciences, Delft University of Technology, P.O. Box 5028, 2600 GA Delft The Netherlands

Introduction

The formation, transport and deposition of aeolian dust is intimately coupled to and indicative of changes in climate. Several physico-chemical properties of dust can be used to trace the source area and to characterise the mode of transport. This means that, in principle, it is possible to quantify variables such as transport distance, wind direction and wind strength. Relations between these variables and the dust properties can be tested and validated on the basis of field observations and experiments.

Conventional approaches to palaeoclimate reconstruction from wind-blown sediments, including loess deposits, often ignore the common fact that sediments are mixtures of sediment populations derived from different sources and transported to the site of deposition by different mechanisms. Most studies fail therefore to recognise the true significance of variations in sediment properties.

Weltje (1997) has formulated a numerical-statistical inversion technique (end-member modelling) which turned out to be particularly well suited to the unmixing of grain-size distributions. End-member models of grain-size distributions have been used to distinguish aeolian from fluvial/hemipelagic and turbiditic sediments in the Arabian Sea (Prins and Weltje 1999; Prins et al. 2000a, 2002b), and other marine settings (Moreno et al. 2002; Stuut et al. 2002; Arz et al. 2003; Weltje and Prins 2003). End-member modelling has also been used to distinguish current-sorted silts from ice-rafted detritus in the North Atlantic (e.g. Prins et al. 2002; Weltje and Prins 2003).

The present contribution provides a synthesis of the grain-size measurements of Late Quaternary loess records extending across the Chinese Loess Plateau. The aim is to formulate an approach which enables the distinction and quantification of unweathered and weathered loess components.

Material and methods

At the Vrije Universiteit we have an extensive grain-size dataset of a series of Late Quaternary loess sections extending across the Chinese Loess Plateau (Fig. 1). Description of the loess sections and major results have been published by Nugteren (2003).

A Fritsch A22 Laser Particle Sizer was used to analyse the grain-size distribution (0.15-1682 µm). Prior to the grain-size analysis, organic carbon and carbonate were removed by treatment with excess H_2O_2 and HCl, and $Na_4P_2O_7.10H_2O$ was added to ensure complete suspension of the sediment sample. Details on the laser-particle sizer and method used are given in Konert and Vandenberghe (1997).

For each loess section, the grain-size dataset has been unmixed with the inversion algorithm for end-member modelling of compositional data (Weltje 1997) to construct mixing models which express the observations as mixtures of a limited number of end members.

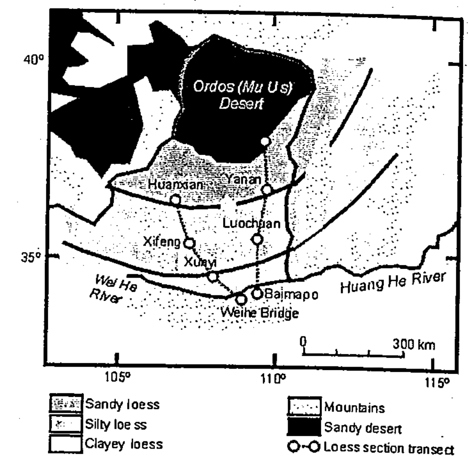


Fig. 1. The Central Loess Plateau in China with current deposition of sandy, silty and clayey loess, and the location of analysed loess sections along a western and an eastern transect

Results and interpretation

The modelling results indicate that the loess-palaeosol records are adequately described as mixtures of three (occasionally four) end members, explaining on average 73 to 89% of the variance. As an example, the grain-size distributions of the three modelled end members of the Luochuan section are shown in Fig. 2A. Down-wind variations in end-member compositions (not shown here) along the two north to south transects clearly reflect the transition from sandy loess to silty loess to clayey loess across the Central Loess Plateau (Fig. 1). In each loess section, the major lithological loess (e.g. L1, L2) and palaeosol (e.g. S0, S1, S2) units are clearly characterised by variations in the proportional contributions of the end members to the sediment record (Fig. 3). The loess units which are deposited during the glacial periods are dominated by silty and sandy loess end members (EM-1 and EM-2). By contrast, the paleosol units deposited during the interglacial periods are dominated by clayey loess end members (EM-3). These results indicate that the method is highly suitable for the characterisation of loess grain-size records.

The most interesting aspect of the end-member modelling approach is that it (potentially) enables the quantitative distinction of weathered and unweathered loess components, as explained below. Mathematical fitting experiments indicate that the coarse-grained, unimodal loess end members (EM-1 and EM-2) closely resemble rather simple, so-called Weibull distribution functions (Fig. 2B). The clayey end members (EM-3), which are strongly bimodal (Figs. 2A and 4A), are well described as mixtures of a silty component following a

ALIBRATION OF MIXING PATTERNS IN GRAIN-SIZE DISTRIBUTION DATA

lirjam Vriend & Maarten A. Prins

l. Vriend (✉) & M. A. Prins, Faculty of Earth and Life Sciences, Vrije Universiteit, De Boelelaan 1085, 1081 HV Amsterdam, he Netherlands (e-mail: mirjam.vriend@falw.vu.nl)

ıtroduction

aser-diffraction techniques have been widely applied to eep-sea and terrestrial sediments with the aim of alaeoclimate reconstructions from grain-size properties. lowever, several applications indicated that the alaeoclimatic significance of grain-size variations in a basin ll can only be fully appreciated when a distinction is made etween provenance- and dispersal-related variations in rain-size distributions (e.g. Weltje and Prins 2003). In other rords, it is of utmost importance that the grain-size technique sed has the ability to reflect mixing patterns in geological rain-size distribution data accurately.

ìeveral mixing experiments indicated that laser-diffraction ize analysers are indeed suitable for the tracing of ubpopulations in natural sediments by decomposition of their rain-size distributions (Prins and Stuut 1999; Stuut and Prins :001). However, these experiments also indicated that, due o, for instance, the inescapable particle-shape effects on aser-diffraction size analysis, variations in the proportional ;ontributions of subpopulations are only indicative of relative not absolute) changes in composition. Prins and Weltje 1999) therefore stated that if one is interested in the absolute veight proportions of the different sediment subpopulations, or instance, for determination of flux records, one should extract the appropriate sediment fractions from the sediment samples similar to the subpopulations. Mixing experiments vith these sediment fractions would allow one to calibrate the modelled) mixing structure.

Ve designed an experiment which allows calibration of the nixing pattern established for a grain-size dataset of the Tuxiangdao loess-palaeosol succession from the north-eastern Tibetan Plateau. The high loess accumulation rates at this locality enables (in theory) a detailed investigation of the palaeoclimate of the last glacial cycle, as the ~33 m long Tuxiangdao succession covers the last ~90 ka, corresponding to marine oxygen-isotope stages 1 to 5a. End-member modelling of the grain-size dataset shows that the loess size distributions are adequately described as mixtures of three end members (Vriend, unpublished data).

Material and methods

A large number of sediment samples obtained from the Tuxiangdao loess-palaeosol succession in the north-eastern part of the Tibetan Plateau have been mixed to produce the 'source material' for the mixing experiment. Carbonate and organic matter have been removed from the loess material according to standard procedures described in detail by Konert and Vandenberghe (1997).

Three size fractions have been extracted by selective settling within a settling tube. Settling times were chosen such that the procedure resulted in three standards, which closely resemble the modelled end-member grain-size distributions of the Tuxiangdao record as close as possible. The three loess standards are referred to as A, B and C. Two- and three-component mixtures were prepared and analysed by mixing standards A, B and C according to the following procedure.

- Sediment standards (A, B, C) with known grain-size distributions were selected as end members of a mixing series;
- the standards were mixed in stepwise-changing proportions p ($0 < p < 1$; increments ~0.10);
- sediment mixtures were analysed with a Fritsch A22 Laser Particle Sizer (size range: 0.15-1682 µm);
- approximation of the analysed grain-size distributions as mixtures of the sediment standards by means of the least-squares method provide the best-fit estimate of the mixing coefficient q;
- calibration of the grain-size measurements is provided by the comparison of the weight proportions p and mixing coefficients q.

Results

The three modelled end members of the Tuxiangdao loess record and the standards A, B and C are shown in Fig. 1.

For the two- and three-component mixtures the best-fit mixing proportions q are compared with the actual weight proportions p. Near-linear relations are observed between the actual and best-fit mixing proportions p and q for all three standards which in all cases deviate slightly from the line $p=q$ (not shown here).

However, on average the coarse-grained standard A appears to be slightly underestimated (and standards B and C slightly overestimated) by the Fritsch laser-diffraction size analyser.

This is illustrated when the sample compositions are plotted in a ternary diagram (Fig. 2). Important to notice here is that, because the laser-diffraction size analysers expresses sediment 'mass' in units of volume, the best-fit mixing proportions q are expressed in volume percentages. By contrast, the actual mixing proportions p are expressed in weight percentages, as the sediment standards were mixed by weight.

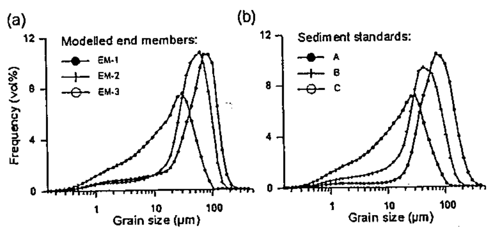


Fig. 1. a Modelled end-member distributions of the Tuxiangdao loess-paleosol succession from the north-eastern Tibetan Plateau. b Size distributions of sediment standards used in the mixing experiment

THE ROLE OF WEATHERING IN THE PRODUCTION OF QUARTZ SILT

Janet S. Wright

J. S. Wright (✉), Department of Geography, Staffordshire University, Stoke-on-Trent, Staffs ST4 2DE, UK (e-mail: j.s.wright@staffs.ac.uk)

Introduction

Quartz silt is a widespread detrital sediment. Large aeolian (loess) and alluvial silt deposits form important components of many contemporary landscapes (Assallay et al. 1998), and ocean sediments contain substantial quantities of terrigenous quartz silt (Sarnthein and Koopman 1980). The greater uncertainties associated with the formation of loess deposits compared with alluvial silt deposits has prompted much research within the field of loess studies into mechanisms of quartz silt particle generation, and this bias towards loess studies will be reflected in this paper. Although quartz silt is simply the debris resulting from the comminution of coarser quartz particles, the issue of quartz silt generation has stimulated considerable debate (e.g. Iriondi 1999; Wright et al. 1998; Wright 2001) because quartz is a mechanically and chemically resistant mineral which tends to occur with a mean size of 700 µm within crystalline source rocks (Livingstone and Warren 1996). Consequently, the key question is what geomorphic mechanisms are sufficiently energetic to bring about the comminution of quartz sand grains into silt grains or to release quartz silt directly from bedrock?

Mechanisms of silt generation

Although research indicates that a range of opportunities exist for the comminution of quartz into silt particles within a wide variety of geomorphic environments (e.g. glacial grinding, fluvial comminution, aeolian abrasion, frost weathering, salt weathering, insolation weathering and deep weathering; see Pye 1987; Assallay et al. 1998; Smith et al. 2002 for summaries), the 'glacial-aeolian' hypothesis has traditionally been favoured as the most likely explanation for loess formation (Boulton 1978; Smalley and Krinsley 1978), as the Quaternary was a particularly silt-rich period (Blatt 1987). Thus, loess is seen as primarily a Quaternary phenomenon, "and we see the entire process [of loess formation] being completed in Quaternary times" (Smalley 1995, p. 645). As a consequence, there has been a tendency to underestimate sediment inputs into loess systems by geomorphological processes operating within pre-Quaternary environments. In particular, earth scientists may have considerably underestimated the role of weathering in global silt generation. Thus, the aim of this paper is to explore the contention made by Nahon and Trompette (1982, p. 25) that "Glacial grinding would generate only a little silt. A large part of the material of Quaternary loess may be derived from glacially reworked weathering profiles".

Weathering as a generator of silt

Experimental studies of both salt weathering and frost weathering of quartz sandstones have produced debris which contains silt-sized fragments (Smith and McAlister 1986; Smith et al. 1987; Wright 2000). The experimental salt weathering of unconstrained dune and grus sand grains has also produced silt-rich fragments of quartz (Goudie et al. 1979; Pye and Sperling 1983). It is envisaged that the production of these silt fragments may occur in one of three ways: (1) the exploitation of pre-existing cracks and flaws within the sand grains, (2) multiple point loading of grains and the development of microfracture chains in constrained masses, and (3) the fracturing and collapse of qua overgrowths as salts expand or water freezes in adjace pores. It is also recognised that etching by saline solutio may play a role in grain fragmentation. Field observations rock disintegration in the Namib Desert (Goudie et al. 199 and of particle characteristics in regolithic material fro Mount Kenya (St. Arnaud and Whiteside 1963) and B Arkle, Scotland (Pye and Paine 1984) confirm these lab ratory observations on the efficacy of both salt weatheri and frost weathering as mechanisms of quartz silt generatio

Silt in the weathering profile

Due to the complexity of the weathering system, consideration of the characteristics of weathering profiles as whole, rather than attempting to assess the contribution fro individual weathering mechanisms, should allow a great appreciation of the role of weathering in the generation quartz silt. Research into the characteristics of weatheri profiles and residual deposits has tended to concentrate o the chemico-mineralogical changes which occur duri weathering (e.g. Gerrard 1994; Power and Smith 199 Taboada and Garcia 1999). However, less is known abo the actual physical breakage of the parent rock and th resulting size characteristics. In relation to the weathering plutonic rocks such as granitoids, it is usually accepted that terms of particle size characteristics two different kinds weathering profiles can develop. Arenaceous or sand weathering profiles are common in temperate environmen (e.g. Lundqvist 1985; Hall 1985, 1986), and argillaceous clayey weathering profiles are associated with humid tropic environments (e.g. Eswaran and Bin 1978). In both case granitoid weathering profiles are often considered to b deficient in silt-sized material.

Arenaceous weathering profiles are viewed as the product the mechanical fracturing of the quartz and orthocla component of granitoids, and thus they simply represe quartz-rich sands. On the other hand, argillaceous weatherin profiles result from the chemical transformation of th feldspar component of the parent rock into clay mineral while the quartz component remains as largely unaltere sand-sized particles. This has the effect of imparting bimodal distribution to many argillaceous weathering profile providing them with a high clay and sand content and low si content, as was observed by Taylor and Howard (1999) fo the weathering profiles which have developed o quartzofeldspathic gneiss in Uganda.

This bimodal size distribution is believed to develop withi granitoid weathering profiles formed under extreme chemica weathering conditions because quartz is a hard, resistan mineral which, once shaped during the crystallisation o igneous rock, tends to resist further change (both physica and chemical) for longer than other rock-forming mineral Therefore, it is assumed that a quartz sand grain release from a granitic rock during weathering tends to retain it identity as a sand grain. Assallay et al. (1998) use assertions such as ... a significant silt-size component is ofte absent in soils associated with tropical environments ... Afric is lacking in fertile soils because of a low silt content ... t reinforce this idea of the inability of humid tropical weatherin to generate silt in significant quantities.

THE DESERT LOESS RECORD OF CLIMATE AND HUMAN IMPACT - EXAMPLES FROM SINAI PENINSULA AND LANZAROTE (CANARY ISLANDS)

ZOELLER, Ludwig R., Geomorphology Chair, Univ of Bayreuth, Bayreuth 95440 Germany, ludwig.zoeller@uni-bayreuth.de.

Desert loess or loess-like silt in desert environments is increasingly recognised as a record of paleoecology and paleoclimate in lower latitudes. Dating of these deposits has so far been rare mainly due to the lack of datable organic material.

Luminescence (TL, IRSL) dating has been applied to thick sequences of silt-paleosol sequences in the Wadi Feiran (Sinai Peninsula) and Lanzarote (Canary Islands). In both areas past shifts to slightly more humid conditions are witnessed by paleosols and mineralogical and geochemical data. In the Wadi Feiran, the sedimentation of up to 55 m thick silt took place during MIS 2, and intercalated paleosols are only weakly developed humic horizons. In Lanzarote both, very weakly and very intensively developed paleosols are found. The sequences dated so far range between ca. 200 and ca. 5 ka. Intensive soil formation occurred during MIS 3 and, apparently, during MIS 7. Weaker cambic soils developed during the lower and middle Holocene and apparently during MIS 5. Periods of stronger desert loess accumulation apparently started shortly after the maximum of an interglacial, but the strongest desert loess input coincides with the "Erg Ogolien" arid phase (late MIS 2) in North Africa.

The arrival of man to Lanzarote during a lower or middle Holocene moister period between 10 and 5 ka is deduced from numerous finds of ovicaprid bones. The first human occupation occurred thus much earlier than proved from the archaeological record so far. It resulted in disastrous soil erosion and land degradation long before the colonial age. The early onset of soil erosion affecting a very sensitive semi-arid ecosystem could have been enhanced by more arid conditions since ca. 5 ka. More closely spaced luminescence dating will improve our understanding of the paleoecology and man-environment interaction.

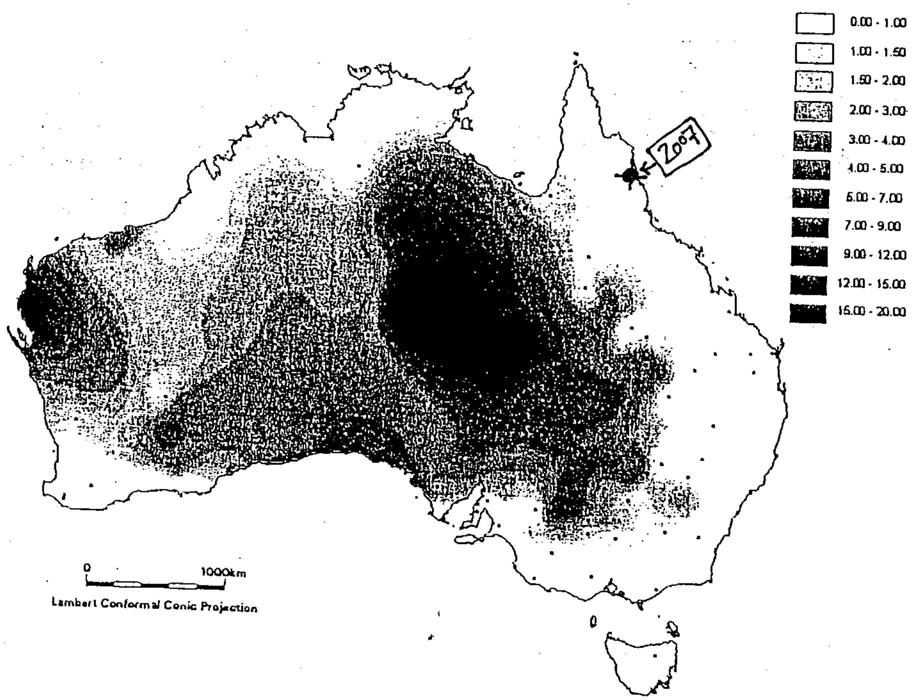


Fig. 2. Spatial pattern of dust entrainment in Australia (1960–1999) using the Dust Storm Index of McTainsh (1998).

MAGNETOSTATIGRAPHY OF AN EARLY-MIDDLE MIOCENE LOESS-SOIL SEQUENCE IN THE WESTERN LOESS PLATEAU OF CHINA

HAO, Qingzhen[1], GUO, Zhengtang[2], GUO, Zhengtang[1], QIAO, Yansong[1], PENG, Shuzhen[1], WEI, Jianjing[1], and ZHANG, Zhongshi[1], (1) Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing, 100029, China, haoqz@163.net, (2) Institute of Earth Environ, Chinese Academy of Sciences, Xian, 710075, China, ztguo@95777.com

Earlier studies on two parallel sections (QA-I and QA-II) in the Qinan region from the western Loess Plateau demonstrated that loess deposition in northern China started by 22 Ma ago, indicating the onset of Asian desertification and winter monsoon circulation by the early Miocene time. A third section, 218.2 m thick, about 30 km east of the previously studied sections, is geomagnetically dated in this study. The upper portion (0-166.5 m) of this section consists of alternating typical loess and soil units while the lower part (166.5 m-218.2 m) is water-reworked, but the material was derived from loess deposits.

Thermal demagnetization was performed on 853 samples at an average interval of 25 cm. Samples were demagnetized in a MMTD-600 Thermal Demagnetiser and measured using a 2G three-axis cryogenic magnetometer, both installed in field-free space. Most of the samples yield a stable characteristic remanent magnetization (ChRM) above 350 degree and 91% of the samples gave reliable characteristic remanence directions.

The obtained magnetic polarity zonation is well correlative with the portion from the Chron C6Ar to Chron C5r.3r of the GPTS without any significant hiatus. Extrapolation based on sedimentation rate indicates a time span of the sequence from 21.4 Ma to 11.6 Ma BP. The boundary between the typical loess-soil sequence and water-reworked lower portion is dated for 19.6 Ma.

Lithostratigraphy and magnetic susceptibility of the sequence are consistent with the geomagnetic results. They show high similarity and correlativity with those of the QA-I and QA-II sections. These results firstly confirm our earlier studies that loess deposition started in northern China by the early Miocene, and secondly demonstrates that the stratigraphy of the Miocene loess-soil sequences is spatially correlative, having therefore great potential for the study of regional/global climate changes during the Miocene time. The Miocene loess-soil sequences, combined with the well-known Quaternary loess-soil sequence and the Late Miocene-Pliocene Hipparion Red-Earth formation, provides a unique continuous eolian record of paleoclimates since the early Neogene.

RETRIEVING PALEOENVIRONMENTAL INFORMATION FROM LOESS DEPOSITS IN CHINA WITH A MULTIPROXY APPROACH

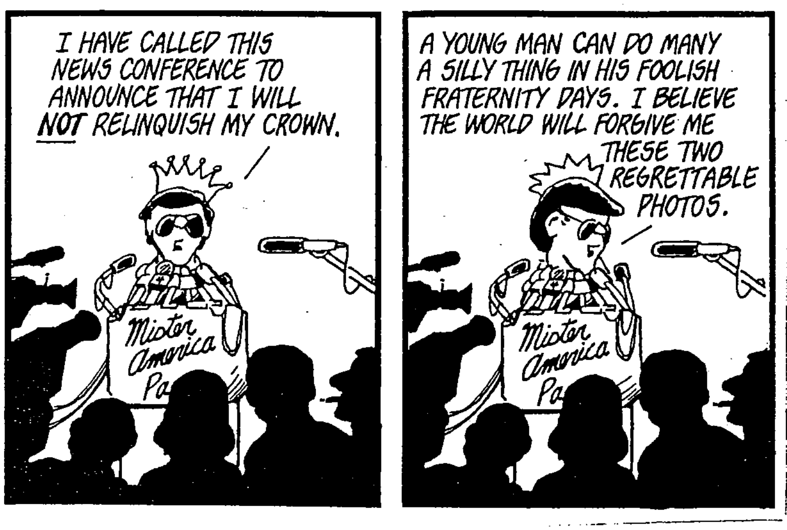
ZHOU, Liping[1], SHEN, Z X[1], ZHU, Y M[1], LI, X[1], and CHEN, F[2], (1) College of Environmental Sciences, Peking Univ, Beijing, Beijing, 100871, China, lpzhou@pku.edu.cn, (2) Department of Geography, Univ of North Carolina, Chapel Hill, NC27599-3220

Succession of loess deposits is one of the most complete geological archives which contain rich information on terrestrial environmental changes for the last several million years. Reconstruction of the regional paleoenvironment can be achieved by the use of physical, chemical or biological proxies obtained from the loess deposits. However, the retrieval and interpretation of the paleosignals which have clear association with regional environmental changes are not straightforward. The inferred climate variability is sometimes found to display inconsistency depending on the proxies used. This is particularly true when the amplitude of the climate change is considered. Here we present a multiproxy study on loess deposits from different parts of the Loess Plateau in China. Downcore variations of magnetic, sedimentological and mineralogical measurements are compared and implications of the results based on individual proxies are discussed.

CARBON ISOTOPE RECORDS FROM THE LOESS-PALEOSOL SEQUENCES FOR C3/C4 PLANT VARIATIONS IN THE LOESS PLATEAU DURING THE LAST 150 KA BP: IMPLICATION OF VEGETATION RESPONSE TO CLIMATIC CHANGES

GU, Zhaoyan[1], LIU, Qiang[1], XU, Bing[1], HAN, Jiamao[1], DING, Zhongli[1], LIU, Tungsheng[1], and LAL, Devendra[2], (1) Institute of Geology and Geophysics, Chinese Academy of Sciences, P O Box 9825, Beijing, 100029, China, zgu@95777.com, (2) Geological Research Division, A-0224, Scripps Institution of Oceanography, La Jolla, CA 92037

: is important to understand which is the major factor to drive ecological changes on a regional cale since our atmospheric CO2 level is increasing because human activities. In this presentaon, the analyses of carbon isotope of organic matter, grain size, carbonate, and magnetic suseptibility have been carried out on the samples from the loess-paleosol sequences at different ites in Chinese Loess Plateau for the histories of C3/C4 plant abundance and climate since the ıst interglacial. The following conclusions emerge from the analytic data. First, the fact that the ɔra are characterized by a mixture of C3/C4 grasses during relative warm periods except for the st interglacial (equivalent to Eemian in Europe), and by a C3 grass domain during relative cold əriods of the last 150 ka BP indicates that temperature is the major factor to induce changes in 3/C4 abundance. This conclusion is also supported by an increasing trend of C4 plant abunance for a given period from the cold northwest to the warmest southeast of the Loess Plateau. əcond, the C4 plant abundance during warm periods increase with seasonal intensity of precipition and/or dryness, implying that the East Asian monsoons play an important role in the plant otosynthetic type when the temperature is high enough to grow C4 plants. Finally, a great conəst in the C3/C4 plant abundance is presented between Holocene and the Eemian, when mospheric CO2 level was high for both of the periods. The Holocene flora is a mixture of C3/C4 asses in the plateau. However, the Eemian flora become into a C3 plant domain only in the utheastern plateau. Since the Eamian climate is the warmest in the last 150 ka BP, it can be duced that forest had fully covered on the southeastern plateau due to reducing of the seasonty of precipitation during that period.



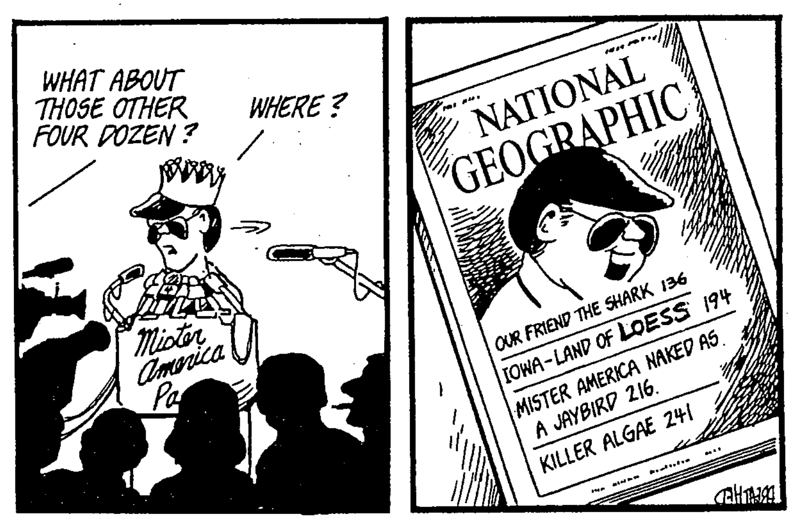
LIKHVIN (HOLSTEINIAN) INTERGLACIAL SOIL COVER RECONSTRUCTION BY PALEOPEDOLOGICAL DATA FOR THE EAST EUROPEAN PLAIN, RUSSIA

DLUSSKY, Konstantin G., Earth & Atmospheric Sciences, Univ of Alberta, 126, Earth Sciences Building, Edmonton, AB T6G 2E3, Canada, kdlussky@ualberta.ca and MOROZOVA, Tatiana D., Laboratory of Evolutionary Geography, Institute of Geography, Russian Academy of Sciences, Staromonetny line, 29, Moscow, 109017, Russia

The aim of this study is to elucidate long-term climatic change over the East European Plain du ing the Middle Pleistocene. For this purpose, we investigated about 40 loess/paleosol sections. We reconstruct the genesis and secondary transformations of the oldest Middle Pleistocene int glacial paleosol (the Inzhavino paleosol) in the Oka, Don and Dnieper River basins (48-56° N, 3 44° E). The Inzhavino paleosol corresponds locally to the Likhvin interglacial and regionally to t Holsteinian interglacial of Western Europe.

Micromorphology indicates that the Inzhavino paleosol is polygenetic and implies that borea sub-boreal conditions prevailed during the stage of most pronounced soil formation, corresponding to the thermal optimum of the Likhvin Interglacial. There are clear indications of distinct pre optimal and post-optimal stages of soil formation. The soil of the optimal stage has a zonal struc ture. In the northern part of the region, it is distinguished by a conspicuous textural differentiatio through the profile (Ah-Ae-Btf-Bg). South of 52° N, the eluvial horizon is usually not pronounced morphologically, instead in situ weathering signs are more evident (Ah-(Aej)-Btgj). South of 51° in the Don River basin and south of 50° N in the Dnieper River basin, the Inzhavino paleosol ha a chernozem-like profile with a thick Ah horizon, carbonate accumulations and numerous krotov inas. The boundaries of the soil zones are aligned from WSW to ENE, probably because of the influence of the Atlantic Ocean. In some sections, for the pre-optimal stage of soil formation, the is micromorphological evidence of an earlier generation of lessivage and humus illuviation. Thes features are more pronounced in the NE part of the region where they are accompanied by iron illuviation. There, we identify two Bt sub-horizons. South of 52° N, especially in the middle Dniep River basin, we observe a Btj horizon at the bottom of the optimal stage chernozem-like solum.

Humus accumulation is the most pronounced process for the post-optimal stage. It is also distinguished by two Ah sub-horizons and a very low position of the Ae horizon. Finally, there are two generations of small-polygon cryogenic deformations at the top of the Inzhavino paleosol.



SEDIMENTARY RECORD OF PREHISTORIC AND HISTORIC HUMAN IMPACT, SUB-SUDETIC LOESS PLATEAU, POLAND

KLIMEK, Kazimierz, Earth Scienses Faculty, Univ of Silesia, Bedzinska 60, Sosnowiec 41-200 Poland, klimek@ultra.cto.us.edu.pl.

Located within the temperate climatic zone of Central Europe, the northern foreland of the Sudetes is covered by Quaternary deposits related to the Scandinavian glaciations which are in turn covered by loess several meters thick deposited during the last (Wurm/Vistulian) Pleistocene cool period. Rivers flowing northward from the Sudetes often cause large floods, the loess plateau receive up to 700 mm annual precipitation, and the local stream pattern is dense. The first farmers, migrating northward from the Danube Basin, crossed the line of Sudetes-Carpathians about 7000 years ago and settled on the loess Glubczyce Plateau. The farming and breeding tribes of the Early Bronze Age created the compact settlement structure of the Lusitian culture in this area about 1600-1300 years BC, leading to extensive deforestation of the populated areas. The first forest clearance began at this time. Following depopulation of the settled area in the Migration period, a new stage of agricultural colonization started in the region between the 8th and 10th centuries AD. Colluvial deposits found in the small dry valleys and alluvial fan deposits at the mouth of these valleys are sediments dating back to the periods in question. Fine grained overbank deposits infilling palaeomeanders in the vicinity of present-day channels indicate that the fossilization of organic material that filled these palaeochannels started in Early Medieval times, due to more frequent flood waves and an increased rate of overbank sedimentation. Analysis of heavy metal concentration indicates that these alluvia derived by transfer of sediments from the deforested loess Plateau.

ALLUVIATION IN SMALL VALLEYS AS AN INDICATOR OF LAND USE CHANGES DURING THE LAST MILLENIUM, SUBCARPATHIAN LOESS PLATEAU, POLAND

KLIMEK, Kazimierz[1], LANCZONT, Maria[2], and NOGAJ-CHACHAJ, Jolanta[2], (1) Earth Sciences Faculty, Univ of Silesia, Bedzinska 60, Sosnowiec, 41-200, Poland, klimek@ultra.cto.us.edu.pl, (2) Curie-Sklodowska Univ, Lublin, 20-031, Poland

The undulating Kanczuga Loess Plateau, 250-270 m a. s. l., is located in the temperate climatic zone of Central Europe, within the northern foreland of the Carpathians. It is dissected by a network of valleys from 30 to 60 m deep, filled by a several meters thick layer of mineral and organic deposits, which started to accumulate in the early Holocene. In one such valley, traces of human-induced environmental transformation from the Neolithic period have been found. Around 3500 years BP, however, conditions conducive to the accretion of organic matter prevailed, suggesting renaturalisation of the environment. Accretion of organic matter was interrupted by the deposition of organic silts. Transfer of eroded soils started first in the small tributary valley mouth areas as early as in the late Roman period – around 280 BC - 30 AD. In the upper reach of the main valley, which was the last area penetrated by people, traces of soil erosion have been recorded as a thin (10 cm) layer of silts with pollen of synanthropic plants, covering the peat younger than 1260±70 years BP (680-870 AD). Radiocarbon dating indicates that the process of alluviation of the small valleys dissecting the sides of the largest ones began only in the 11th century. Processes of soil erosion and sediment transfer during this period were caused by agricultural activity in the drainage basin and by valley side clearance and subsequently intensified in the 14th century, linked to the increase of cultivated area and the associated clearance. It is very probable that changes in the precipitation regime at the beginning of the Little Ice Age accelerated the soil erosion and sediment transfer processes initiated by human activity. This sequence of events was broadly similar to those found in the temperate climatic zone located further to the west, within the foreland of the Eastern Sudetes Mountain and in the Rhine Catchment.

RESPONSE OF SOIL EROSION TO ENVIRONMENTAL CHANGES AND HUMAN ACTIVITIES DURING QUATERNARY, LOESS PLATEAU, CHINA

HE, Xiubin, Soil Science, Chengdu Institute of Mountain Hazards and Environ, CAS, No. 9 Block 4, South Renmin Road, Chengdu, 610041, China, hexiubin@yahoo.com and TANG, Keli, Soil Science, Insittute of Soil and Water Conservation, CAS, 26 Xinong Road, Yangling, 712100, China

In evaluating modern soil erosion and foretelling soil erosion characteristic of the future under the background of global changes, we are facing a great number of questions that can only be answered through a better knowledge of the past. This paper analyzed structures and characteristics of soil erosion systems on the Loess Plateau during Quaternary. Based on stratigraphyical, archaeological evidence, written historical records and previous works, the history of soil erosion in Quaternary was reconstructed. The soil erosion in the transitional period between dry-cool periods and wet-warm periods was more intensive than that in the dry-cool period or the wet-warm period. A chronological analysis of soil erosion on the loess plateau during Quaternary is presented. The intensive soil erosion occurred at 2.4M.a.B.P., 1.48M.a.B.P., 0.56M.a.B.P., 0.25M.a.B.P., 0.14M.a.B.P.and 0.01M.a.B.P.; and during the Holocene, the periods of intensive soil erosion were 7500a.B.P.-7000a.B.P.; 200BC-0AD; 1000AD-1600AD; and the 30's, 50's and the later 60's of this century. Under the background of paleoenvironmental reconstruction, it shows that the influence of geo-ecological environmental changes on soil erosion was obvious, especially during the transitional periods. The soil erosion, however, was not serious during geological periods due to the self-control mechanism of the system. The serious accelerated soil erosion has occurred in recent 2500 years because of the man-made devastation of vegetation and other human disturbance to geo-ecological environment.

NATURAL ONGOING DESERTIFICATION IN THE ARID AND SEMI-ARID REGIONS OF THE MIDDLE EAST

AVNI, Yoav, Geological Survey of Israel, Malkhe Yisrael 30, Jerusalem 95501 Israel, yavni@mail.gsi.gov.il.

In the arid and semiarid regions of the Middle East, gully incision erodes alluvial sediments and loess soils deposited during the Upper Pleistocene along the valleys. This phenomenon becomes critical in the arid region of the Negev Highlands of southern Israel where the land carrying most of the natural biomass and which has agricultural value is limited to narrow valleys. These fields, cultivated during the Iron Age (3000 years BP) and the Roman-Byzantine Age (1800-1400 BP), were irrigated by runoff harvesting techniques. The semi-nomadic population in the region continues to cultivate parts of these fields today. During flood events, the runoff penetrates the alluvial cover of the valleys, forming vertical headcuts, which gradually retreat up the valleys. The formation of deep and narrow gullies within the valleys concentrates the runoff into narrow channels, preventing the floodwater from irrigating the whole width of the valleys. The sharp change in irrigation efficiency is reflected in a sharp drop in biomass, up to 80%. This phenomenon continues downstream along the gullies, almost without recovery. The annual migration rate of the headcuts in the study area exceeds several meters up to 100 m. The ongoing stripping of the valleys floor has severely reduced the agricultural potential of the region and the vegetative biomass available for pastoral herds and other grazing animals. This phenomenon causes ongoing degradation of soil and biomass, leading to the increasing desertification of the region. OSL dating of alluvial units, as well as the position of archeological sites relative to the gullies, indicates that gully incisions initiated during the Early Holocene. It is concluded that desertification, caused by gully incision and headcut migration, is an ongoing process, which has been active in the Negev Highlands for the last few millenniums. The loess sediments, deposited during the late Pleistocene within the drainage basins, are being eroded and removed during the Holocene. This process is related to the long-term re-adjacent of the geomorphologic system to the Holocene climate. Similar processes of gully incision and ongoing desertification are active in wide regions of the Middle East, as well as in other semiarid and arid regions worldwide, such as southern Africa, central Asia and northern China.

RECORDING PALAEO-EVENTS IN THE CENTRAL ASIAN DRYLANDS- THE PERIMONTANE AND PERIDESERT LOESS REGIONS INTERACT

SMALLEY, Ian J., School of Property & Construction, Nottingham Trent Univ, Nottingham, NG1 4BU, smalley@loessletter.com and MAVLYANOVA, Nadira, G.A.Mavlyanov Institute of Seismology, Uzbek Academy of Sciences, Tashkent, Uzbekistan

The thick loess in Uzbekistan could one day rival the deposits in north China as an accessible store of environmental proxy archives. Thick loess deposits contain many palaeosols and other indicators of Quaternary climate change, but it is useful if the sedimentological setting is both simple and fairly well understood. The nature of a loess deposit does have some influence on its use as a 'climate register'. While Central Asia was part of the USSR there were many opinions in favour of the eluvial/ in-situ/ soil formation theory of loess development(the famous Berg theory) and this top-down approach is impossible to reconcile with 100m thick deposits and multiple palaeosols (and observed hydrocollapse). Many Central Asian investigators, particularly in Uzbekistan, retained the loess ideas of A.P.Pavlov(c.1900) which essentially divided loess into deluvial (slope) loess and proluvial (plains) loess. Direct deposition from water was required, and there are deposits, e.g. associated with the Chirchik river, that appear to be water-laid. Obruchev, by 1952, had reconciled aeolian deposition with the Pavlov scheme- but more progress in this direction is required. The PTD scheme allows loess particles to originate in the Tien Shan and eventually form airfall deposits. It is possible that the D1 deposits in the current scheme are what Pavlov would call 'deluvial' loess, and that the D2 deposits are 'proluvial' loess. A good case can be made for the D3 deposits being aeolian, and the D4 deposits the result of wind erosion. Once the true nature of the thick deposits has been determined, valuable palaeoclimatic data can be obtained. The 'desert' loess problem is very visible here because the desert edge is very close to the Tien Shan; there are important Quaternary processes still to be investigated in the overlap region.

SEDIMENT MAGNETIC SIGNATURE OF CLIMATE IN MODERN LOESSIC SOILS FROM THE GREAT PLAINS

GEISS, Christoph E., Physics, Trinity College, McCook Hall 105, 300 Summit St, Hartford, CT 06106, christoph.geiss@trincoll.edu, ZANNER, C. William, School of Natural Resource Sciences, Univ of Nebraska, 133 Keim Hall, Lincoln, NE 68583-0915, and BISBEE, James H., Trinity College, 300 Summit St, Hartford, CT 06106

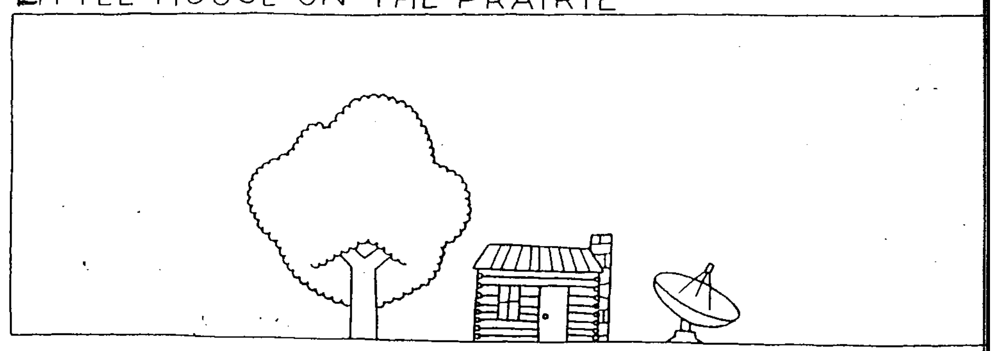
We sampled 17 modern soils along a SW-NE trending transect through Nebraska and western Iowa for pedologic and sediment magnetic analyses. Selecting soils developed in loess on stable upland summits allowed us to isolate modern climate as the main influence on soil properties. These sites were complemented by four soils developed in sandy material and seven soils developed in strongly dissected terrain in order to test the sensitivity of our approach to non-climatic influences. All loessic sites contain magnetically enhanced A-horizons, characterized by higher values of magnetic susceptibility, anhysteretic remanent magnetization (ARM) and isothermal remanent magnetization (IRM) as compared to the unaltered parent material. For sites developed in stable upland positions the correlation between magnetic enhancement and modern precipitation is best when using grain-size dependent parameters such as ARM (r^2=0.7) or ARM/IRM (r^2=0.8) to describe changes in magnetic properties. Enhancement in magnetic susceptibility, which has been used successfully in Chinese loess-paleosol sequences to reconstruct changes in paleoprecipitation, follows the modern precipitation gradient to a lesser degree (r^2=0.3). The better performance of ARM or ARM/IRM as a predictor of modern precipitation is due to the high sensitivity of these parameters to small (d=0.01 - 0.1 im), single domain (SD) grains of pedogenic origin. Soils from erosion prone locations show a lower degree of magnetic enhancement due to the continuous loss of magnetically enhanced A-horizon material, while sandy soils show generally very little enhancement regardless of landscape position.

THE COLUMBIA PLATEAU DUST ENGINE DURING THE LAST GLACIAL MAXIMUM: TROUBLE WITH COLD STARTS

SWEENEY, Mark R., Dept. of Geology, Washington State Univ, Pullman, WA 99164-2812, sweeney@wsunix.wsu.edu, BUSACCA, Alan J., Dept. of Crop and Soil Sciences, Washington State Univ, Pullman, WA 99164-6420, RICHARDSON, Catherine A., School o Geography, Univ of Manchester, Mansfield Cooper Building, Oxford Road, Manchester, M13 9PL, England, BLINNIKOV, Mikhail, Dept. of Geography, St. Cloud State Univ, 345 Stewart Hall, 720 Fourth Avenue South, St. Cloud, MN 56301-4498, and MCDONALD, Eric V., Division of Earth and Ecosystem Sciences, Desert Rsch Institute, 2215 Raggio Parkway, Reno, NV 89512

Global circulation models are used as tools in characterizing Quaternary climate change, but are occasionally contradicted when compared to eolian records. Simulations show that the large ice sheets of North America created high pressure from which a glacial anticyclone was generated. Anticyclonic winds coming off the ice sheet were apparently from the east, different from the winds that generated expansive dune and loess deposits during the last glacial maximum (LGM). Severa studies have noted the mismatch between models and geologic data and have either dismissed the anticyclone or minimized its influence. Loess accumulations that span the LGM on the Columbia Plateau, Washington, record a hiatus or slowing in dust deposition rates that was likely due to anticyclonic winds. The Palouse loess, which covers approximately 10,000 sq km as thick as 75 m, has grain-size and thickness trends suggesting dominant dust-transporting winds were persistently from the southwest as far back as 75 ka. Luminescence ages of loess that span the LGM and beyond (18-40 ka) show a sharp decrease in deposition rates proximal to dust-producin basins, and a hiatus at loess sections closest to the ice sheet. This decrease in dust deposition occurs at a time when world-wide dust deposition was increasing. Paleoclimate proxies including paleosol features and opal phytolith assemblages confirm cold and dry conditions from 18 to 40 ka, represented by a well-developed calcium carbonate horizon and sagebrush steppe dominatin the Columbia Plateau. Exhaustion of the sedimentary supply is an unlikely cause of the hiatus because loess was still accumulating at proximal sites. The most likely explanation for the hiatus relates to easterly winds generated by the anticyclone that squelched prevailing southwesterly winds, shutting down dust deposition near the ice sheet. The influence of easterly winds, however may have been seasonal, and were not strong enough to result in reorganization of the eolian system. The luminescence ages combined with paleoecologic data suggest anticyclonic winds may have influenced the Columbia Plateau as far back as 40 ka, when ice volumes were increasing. This evidence potentially implicates the anticyclone as more than just a LGM phenomenon.

LITTLE HOUSE ON THE PRAIRIE



CLIMATE-DRIVEN GLACIAL/INTERGLACIAL VEGETATION CHANGES ON THE CHINESE LOESS PLATEAU

VIDIC, Natasa J., Biotechnical Faculty, Agronomy Department, Univ of Ljubljana, Jamnikarjeva 101, Ljubljana, 1111, Slovenia, njvidic@ucdavis.edu and MONTANEZ, Isabel P., Dept. of Geology, Univ of California, Davis, CA 95616

We employ isotope compositions of organic matter and pedogenic carbonate nodules preserved in several loess/palaeosol couplets (S0, S1, S5, S15-S19) from the Jiaodao section, Shaanxi Province, to reconstruct past variations in floral composition at the site. Carbon isotope values of soil organic matter (SOM) consistently increase from minimum values in loess (-24 to -22 ‰ VPDB) to maximum values in paleosols (-19 to -21 ‰ VPDB). These data are interpreted to record repeated shifts in the ratio of C3 to C4 vegetation at the site during glacial/interglacial cycles. The proportion of C4 vegetation was consistently higher (up to 60%) during warm and wet interglacial periods than during dry and cold glacial periods (30% or less). Carbon isotope values of SOM correlate well with magnetic susceptibility values suggesting that the two proxies responded to the same climatic forcing. Pedogenic carbonate nodules at the bases of the studied paleosols were both microsampled and analyzed in bulk. Carbon isotope values of pedogenic carbonate nodules vary between -4 and -7 ‰ VPDB and suggest that the nodules formed in the presence of an elevated percentage of C4 vegetation. Oxygen isotope values of microsamples vary between -8.5 and -10.5 ‰ VPDB and correlate negatively to the corresponding carbon isotope values suggesting that peak C4 vegetation occurred during periods of intensified precipitation (peak interglacials). Bulk nodule isotope compositions ($\delta^{13}C$=-5.1 to -6.5 , $\delta^{18}O$=-8.9 to -10.0 ‰ VPDB) do record long-term conditions at the site, but they mask smaller-scale temporal environmental variations.

AEOLIAN LOESS AND PALEOENVIRONMENTAL CHANGES

ZHENG, Xiangmin, Department of Geography, East China Normal Univ, Shanghai, 200062, China, zhengxm8@yahoo.com.cn and ENDO, Kunihiko, Department of geosystem Sciences, Nihon Univ, Tokyo, 156, Japan, endo@chs.nihon-u.ac.jp

A typical aeolian loess stratum is found on the Shengshan islandsin East China Sea at first. This island is located at about 122∞‹40' E,30∞‹55'N in East China Sea. The loess strata of 3-8 M in thickness distribute on the top and slop of the rock mountain of this island with the elevation about from 80 to 100 meters. The similar loess strata have also been found in the other small islands of the Zhoushan archipelago. Being continuous deposition of the loess strata, it contains a lot of information of the paleoenvironmental change and studying on the loess in the islands have important geological significance in recognizing the Quaternary loess distribution in China and East Asia, depositing process and the evolution of paleoenvironment of the East China Sea . Through a series of analysis on the loess strata in the Island and comparing to the Xiashu loess strata in the western hilly of the Yangtze River Delta, the following conclusions can be made: 1.The analysis results on the loess (e.g. grain size, heavy mineral, phytolith analysis, pollens and spores, magnetic susceptibility, geochemical composition , surfical features of quartz grains, IRSL dating and so on) show that the loess in the Shengshan Island is aeolian in origin deposited under the cold-dry climatic condition. The sediment features are similar to the Xiashu loess in the western hilly of the Yangtze River Delta. 2.In according to the IRSL dating and strata comparison with the loess strata in the western hilly of the Yangtze River Delta, the loess in the Shengshan Island is mainly deposited during the last glacial period. 3. The material resources of the loess in the islands came from the Northwest China and Central China transported by west-wind during the late Glacial Period. 4.During the last glacial period, the aeolian dust may have been widely deposited in the East China plain, the Yellow Sea and East China Sea, and even on the Korea Peninsula, Japanses Islands and the neighboring sea areas. Therefore, the eastern limit of the loess deposits in late Pleistocene in China is farther eastward than that had been recognized. 5. The diagram of curve of grain size, and magnetic susceptibility show that there areseveral climatic fluctuations with several different dust materials during the aeolian deposition period.

Alan Turing, David Hilbert, the Entscheidungsproblem, and the future of loess research

Ian Smalley

School of Property & Construction, Nottingham Trent University, Nottingham NG1 4BU, UK (ian.smalley@ntu.ac.uk)

I took for my reading on the long journeys to and from Reno INQUA the biography of Alan Turing (mathematician, computer pioneer and code-breaker) by Andrew Hodges and it occurred to me (as my mind slid into travel mode) that it may be possible to make a very tentative connection between Turing solving the Entscheidungsproblem and the much more ordinary and down-to-earth problems of loess ground and loess soils; a connection (maybe) between the problems of higher mathematics and those of the superficial earth sciences. The 1937 paper Turing paper on 'Computable Numbers' put in place one of the philosophical foundations of the modern computer world; it was one of the great intellectual achievements of the 20th Century; its full title is 'On computable numbers, with an application to the Entscheidungsproblem' (Proc.London Math.Soc. 2, 42, 1937) and it changed the way we think about the nature of mathematics.

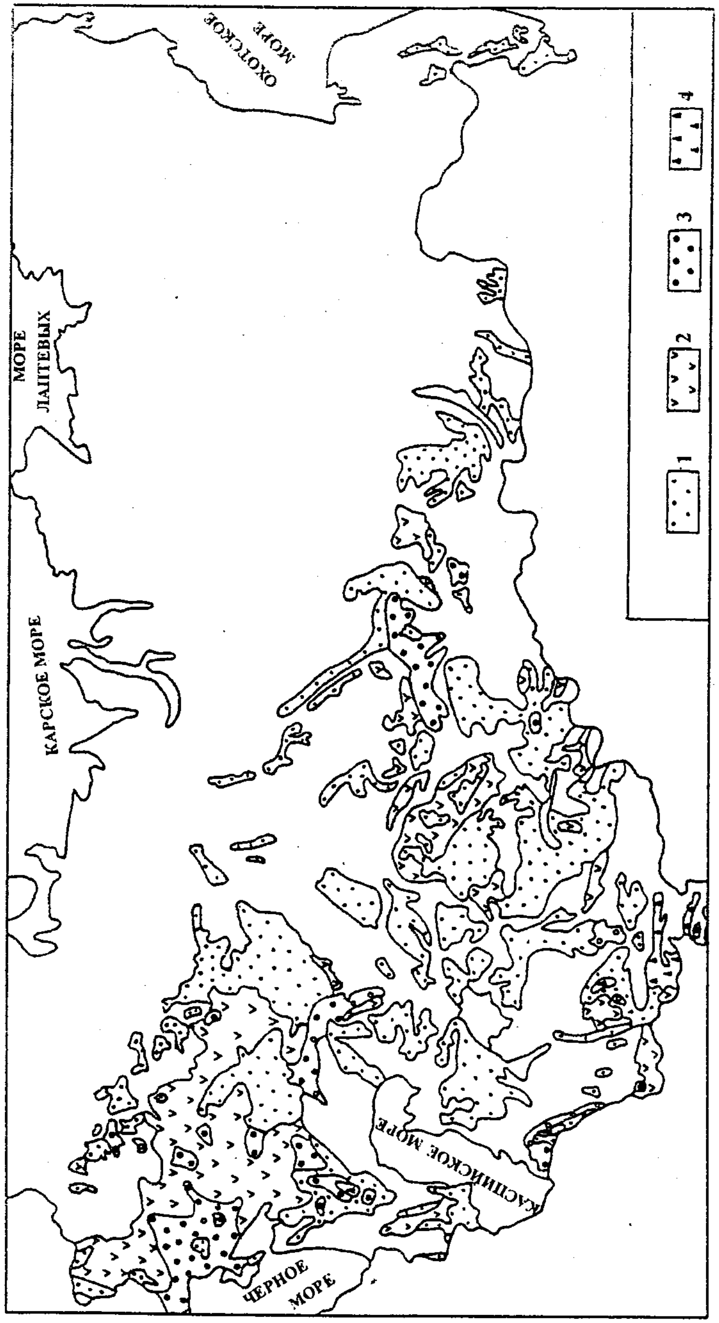


Рис. 5. Схема распределения преобладающих величин мощностей просадочной толщи лессовых пород при нагрузке 0,3 МПа (или природной + 0,3 МПа). Составлена А.В. Ершовой и В.Т. Трофимовым на основе Карты прогноза просадочности территории распространения лессовых пород СССР, масштаб 1:2500000.
1 – до 5 м; 2 – до 10 м; 3 – до 20 м; 4 – более 20 м

The Entscheidungsproblem belongs to David Hilbert, the most famous mathematician of recent times. At the 1928 International Mathematical Congress Hilbert raised a series of questions. First: was mathematics *complete*, in the technical sense that every statement (such as 'every integer is the sum of four squares') could be either proved or disproved. Second: was mathematics *consistent*, in the sense that the statement '2 + 2 = 5' could never be arrived at by a sequence of valid steps of proof. And thirdly: was mathematics *decidable*. By this he meant, did there exist a definable method which could, in principle, be applied to any assertion, and which was guaranteed to produce a correct decision as to whether that assertion was true.

It was this third problem that Alan Turing solved—by inventing the Turing machine; by inventing a *new way* of solving mathematical problems. The machine did not exist; it was an imaginary machine; a conceptual machine. By imagining this machine one of the basic problems of mathematics was solved, and Turing triumphed. But of course Turing did not triumph in a vacuum, for Turing to generate a solution, Hilbert had to pose a problem. Hilbert's problem was a precondition for Turing's solution, and it is this duality that strikes one—this balance between question and answer. Hilbert's genius allows the question to be posed; Turing's genius allows it to be solved.

But what has all this to do with the Soil/Earth sciences, and with loess in particular? Well it might be a good idea (as the 21st Century gains momentum, and the Loess Commission becomes two Sub-commissions) if we gave more thought

to the idea of setting ourselves a few broad, but specific problems, a few targets, outlining a few study areas. We operate and control the solution part of the scientific process quite well but we have not grasped as thoroughly as we might the questioning (Hilbertian) part of the process. Perhaps we should have a 'programme'—actually although Hilbert understood the need for programmes the most famous mathematical programme was the 'Erlangen' programme, set out by Felix Klein when he took up the chair at the University of Erlangen in 1872. But of course mathematics is a much more man-made discipline than, say, geology; i.e. man sets most of the constraints and boundaries while in geology and soil science these are set by the planet we investigate. Perhaps mathematicians like Hilbert and Klein are more disposed to list making; even so we know enough about the world machine for us each to be questioning how our separate parts of the earth sciences fit together to form the whole. I think INQUA may have been groping towards this point as the basis for the new structure and the re-organisation of the commissions.

If one can come up with a brilliant question will it provoke a brilliant answer? Earth scientists have found some brilliant answers in the past—but occasionally before the questions were posed. The idea of continental drift was a great answer which was around for a long time before anyone would accept the question. The nature of geology and of all the earth sciences is such that we tend to find answers before questions.

After Reno INQUA and the intellectual stimulus thereby provided, and to mark the re-shaping of the loess world, and to celebrate part of INQUA 2007 heading for New Zealand, it seems reasonable to offer a few basic questions in the field of loess research; so here are ten questions for the first part of the 21st Century; the Reno programme of loess research. Some of them hopefully show where loess studies can be tied to other parts of the earth/soil sciences programme; the big picture.

1. Is loess definable? The old Smalley & Vita-Finzi definition of 1968 has worked well for nearly 40 years but there is still a problem of reconciling the descriptive and mechanistic approaches to the task of defining the material/deposit. Should we define loess material and loess deposits? Is loess a soil? Is loess a rock? How valid is the engineers' idea of loess ground?
2. What is the status of the quartz in the source igneous rocks?—and in other types of source rock? How does the nature of the quartz in the source rock influence the formation and nature of the eventual modal loess particle? Are there internal controls on the size and nature of the modal quartz particles?
3. What particle formation actions are there, and which are the most effective? This seems to be a very important question—how are the modal quartz particles made by natural processes? This is a fairly recent question, it was not seriously asked before 1966, and although some resolution has occurred since then still lacks a totally

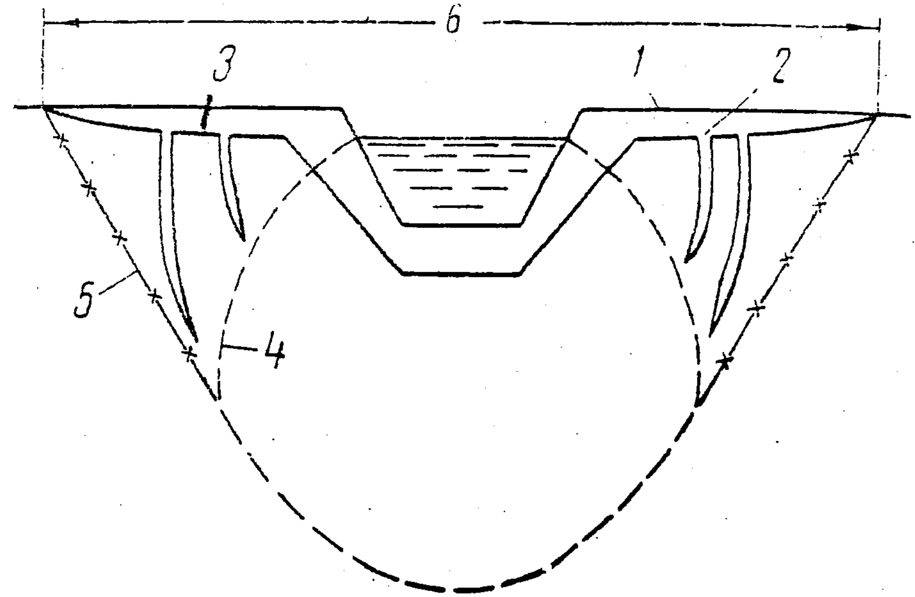


Рис. 32. Схема просадок у котлована

1 — поверхность земли до просадок; *2* — трещины; *3* — поверхность земли после просадок; *4* — граница распространения инфильтрационного потока; *5* — граница влияния деформаций, вызываемых уплотнением пород в пределах зоны распространения инфильтрационного потока; *6* — ширина зоны просадок

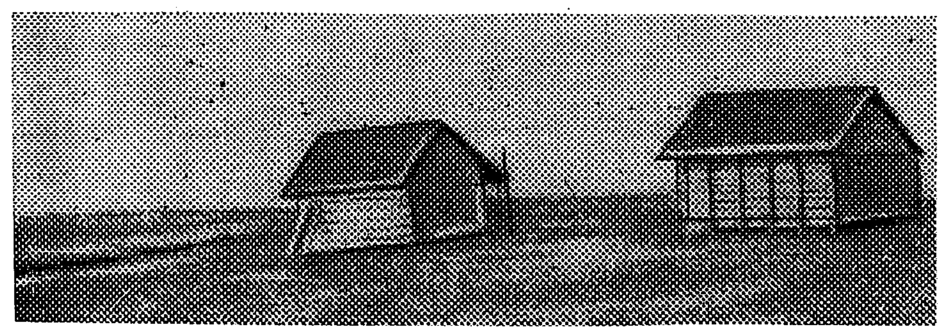
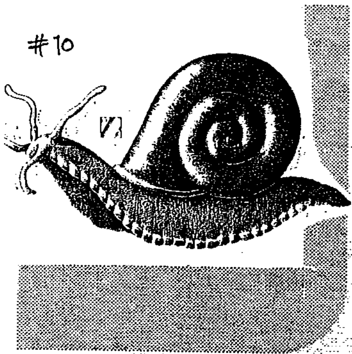


Рис. 7. Опускание поверхности земли у канала

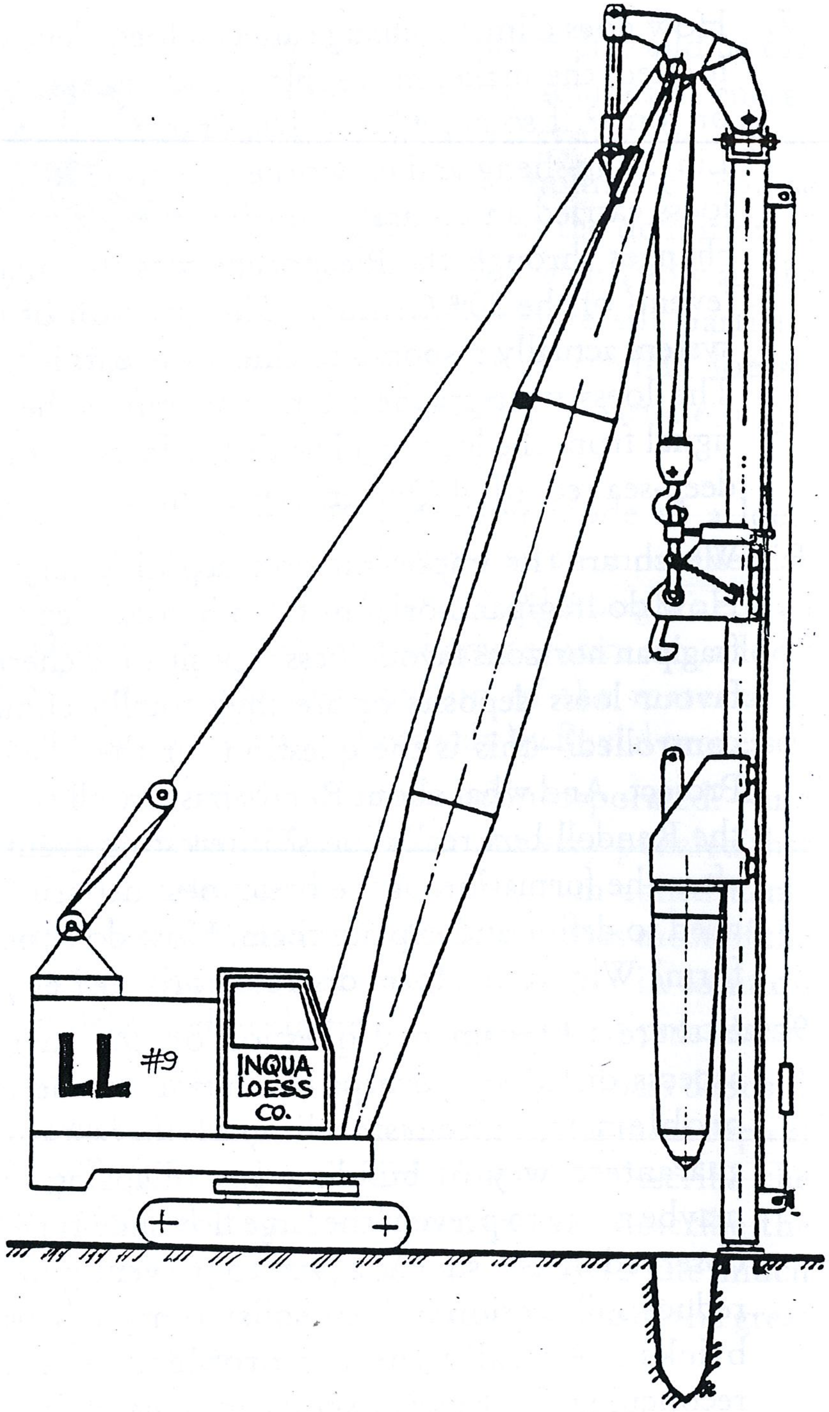
#10



satisfactory solution. It could be cast in the form: what sources of energy are there in natural systems which can generate large amounts of coarse quartz silt? And, as the definition of loess moves and develops, how are the fine clay agglomerate silt particles which form the Australian loessic deposits formed? The particle origin question is a key, basic question.

4. What is the initial transportation mode of a loess particle? Which transportation modes are most effective in distributing loess material? Although aeolian processes confer the chief characteristics on a loess deposit the actual distribution of the material is probably achieved more effectively by fluvial processes.
5. At what stage is carbonate material incorporated?—and clay minerals? In 1920 Keilhack was very puzzled that quartz and carbonate could be the main constituents of loess—Das Ratsel der Lossbildung. Does most of the carbonate come in with the groundwater in solution or is it delivered in clastic form by aeolian processes?
6. Can we describe the packing texture in a loess deposit? The open structure is characteristic of the most typical loess; will it ever be possible for us to describe the packing in real terms, and perhaps also describe the collapse process. This problem relates to the much wider one of describing soil structure—one of the great insoluble problems.

7. How does climatic change affect a loess deposit? Does it affect the make, move, place and change events- all or some? If some, which? The dramatic discovery by Liu Tung-sheng and co-workers in the 1950s that the loess carried an accurate imprint of multiple climatic changes through the Pleistocene was the major loess 'event' of the 20th Century. The question of how the system actually responds to climatic events is still open. The loess stratigraphers strive to refine the climatic signal from the loess, and to tie the loess record to the deep-sea record of Quaternary events.
8. Which are the important post-depositionary events? How do fragipan horizons form in loess deposits? Do fragipan horizons favour loess deposits? Do chernozems favour loess deposits or are they totally climatically controlled?—this is the question for the Black Earth Project. And what about Rendzinas- are all the soils in the Rendoll box really loess? Interesting events occur after the formation of the basic loess deposit, we still need to define and explain them. How do concretions form? Why to the form discrete horizons? etc.
9. Is there a fundamental question on the engineering aspects of loess?—perhaps a solution to the collapse problem (an understanding of metastabilty); a guaranteed way of building on collapsing loess; or maybe a way to prevent the large flowslide-type failures observed in Gansu. Or a way to prevent gullying; to reduce soil erosion in loess soils; to make better loess bricks... Actually the big problem here may be reconciling the Russian speaking researchers and the English-speaking workers; there is a great divide.



10. Fauna. The long loess sections in China have a rich fossil fauna; can we equate loess and horse? The Chinese loess stands on the Hipparion clay, should we think of loess time as horse time—and is there a connection?

What evolutionary opportunities does loess offer? How precise can malacological stratigraphy become? What about those mammoths in Ukraine?

[11. Not a serious entry. When will all that good data on the Wairarapa loess be published? How can that famous NZ tradition of not publishing results be turned around?]

The questions are important; we should search constantly for new ways of looking at our subject, there may be levels of complexity we have never dreamed of—who would have imagined that a thick loess deposit could suggest 40 climatic cycles in the Quaternary. David Hilbert, right at the beginning of 'Foundations of Geometry' quoted Kant: 'All human knowledge begins with intuitions, thence passes to concepts and ends with ideas'. Karl Caesar von Leonhard had an intuition, in Heidelberg, early in the 19th Century, that the yellowish material he observed on the Neckar banks at Haarlass was important, was sufficiently different from the rest of the earth surface materials to deserve a name, an identity. Then: how was it formed? What does it tell us...? John Hardcastle, standing on the beach at Timaru, looking up at the Dashing Rocks section, had the thought that the loess recorded the climate...

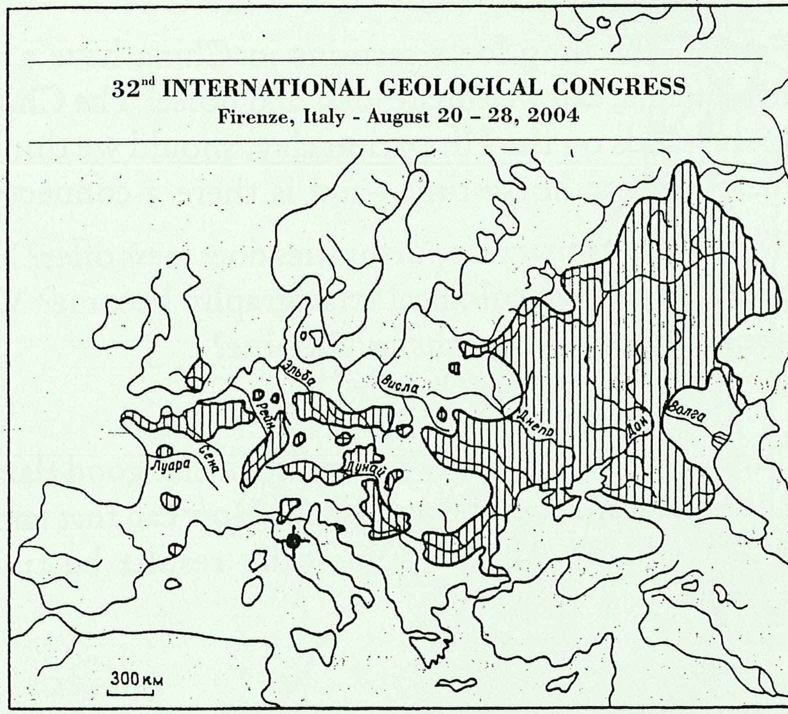


Рис. 5. Основные ареалы распространения лёссовых пород Европы (заштриховано). Составлена по материалам монографии “Лёссовые породы СССР” (*1966, 1986*), *А.А. Величко и Т.А. Халчевой* (*1981*), *П. Лебре и Ж.-П. Лотриду* (*1991*).

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