LOESS LETTER 39

April 1998 ISSN 0110-7658

The Nottingham Trent University

ICAR-4

GLOBAL CHANGE
LOESS SOIL
DUST AEROSOLS

Call for Papers

DUST AEROSOLS, LOESS & GLOBAL CHANGE: An Interdisciplinary Conference and Field Tour on Dust in Ancient Environments and Contemporary Environmental Management

Our next speaker is Dr Leroy Fehd who will discuss his hypothesis that widespread airfall loess deposits are composed of spent fuel from alien spacecraft..

LOESS LETTER 39 April 1998 ISSN 0110-7658

Communique

What are all those French people doing on the cover of LL? They are spelling out in semaphore the word"Communique". We wanted them to say Loess Letter or at least La Lettre du Loess but they insisted that"Communique" was the most suitable word for LL39(adequately bilingual). How do we know that these are French people? By their stripey shirts, by their berets, and by their Tricoleurs. Vive la France! They all live in Normandie, on the loess; they all work for CNRS. They are in fact the CNRS semaphore team.

Important events:take note of these-

1. The International Joint Field Meeting on'Loess in Argentina: Temperate & Tropical'- organised by Martin Iriondo. Parana Argentina 15-21 May 1998 miriond@arcride.edu.ar.

2. ICAR4- The 4th International Conference on Aeolian Research; to be held in Oxford 6-10 July 1998. Contact Ian Livingstone(ian.livingstone@nene.ac.uk)at Nene College, Northampton for details.

3. Loess Commission at Seattle:'Dust Aerosols, Loess & Global Change' Field Tour 8-11 October 1998, Conference 11-13 October 1998, at Battelle Conference Center, Seattle WA. Organiser Alan Busacca(busacca@wsu.edu). Send a message by Mayday if possible- see detailed announcement in this LL.

4. IBG/RGS at Leicester January 1999.'Geographies of the Future'- the annual meeting of the Institute of British Geographers and the Royal Geographical Society at Leicester University in January 1999 will include a symposium on'Loess in Britain'. Contributions are invited, contact Ian Smalley (ijs4@le.ac.uk). This symposium is supported by the British Geological Survey and will provide an opportunity to discuss their new project assessing the collapsing soils of the UK. Also we shall celebrate 20 years of LL. General inquiries to rgs-ibg@le.ac.uk.

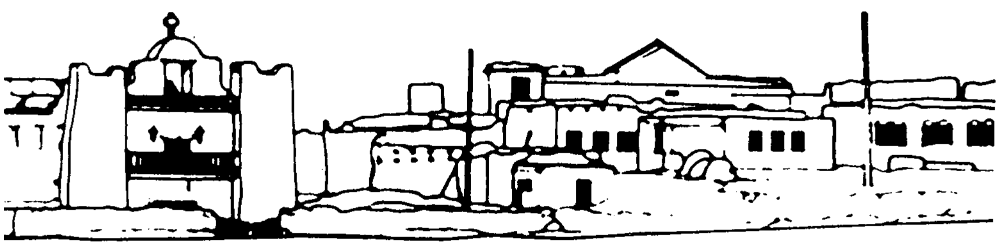
5. LoessFest at Bonn & Heideleberg: early 1999. To celebrate 175 years since Karl Caesar von Leonhard launched the European loess into the scholarly world. Contact Ludwig Zoeller(zoeller@goanna.mpi-hd.mpg.de)for details.

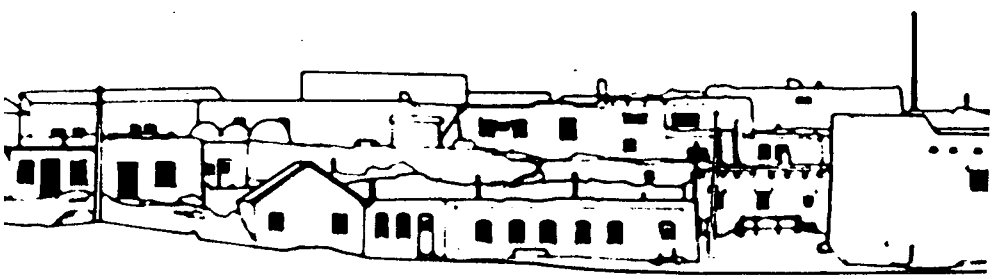
6. Full-scale INQUA at Durban 3-12 August 1999. Two Loess Commission symposia are proposed 'Fluctuations of loess tracers to indicate atmospheric circulation variations on global and regional scales' and 'Quaternary collapsing soils'. Contact An Zhi-sheng or Nick Fedoroff for details of the first, and Ian Jefferson or Ian Smalley for information on the second. Contributions are invited. Remember also that a total replacement of the Loess Commission officers is required at the Durban meeting(INQUA constitution requires this)- so be ready to volunteer(yourself or somebody else).

LL39 features the history of soil science, loess in the USA and the new dam on the Yellow River. Drs Yaalon & Berkowicz have produced an excellent history of soil science in 22 chapters, with many authors; no 29 in the Advances in Geoecology series. We reproduce the essential details and a piece about L.S.Berg and'loess as a product of weathering and soil formation'. We owe a great debt to Berg(and to R.J.Russell) for making us think. Russell is fully discussed by Leon Follmer in his paper in Eng.Geol. We can only reproduce part(read the whole thing) but we particularly wanted to include the maps of loess distribution. Especially with the Loess Commission meeting coming up in Seattle in October.

The Yellow River dam is not getting as much attention as the Three Gorges dam on the Yangtse, but obviously from our point of view it is probably more important. The paper reproduced comes from the New Civil Engineer. It may be that silt will prove more important to the Three Gorges dam than has been anticipated. The Yangtse may not be a silt-shifter on the scale of the Yellow River but there are downstream loess deposits. Silt does travel down the Great River.

LL40 should be out in time for the Seattle meeting; we hope to include an article on the repair and restoration of the loess bluffs at Natchez. The Loess Bluffs are a national landmark- they must be preserved and cherished. Charles Lyell admired them, and our successors should have the chance to do likewise.





DUST AEROSOLS

DUST AEROSOLS, LOESS & GLOBAL CHANGE: An Interdisciplinary Conference and Field Tour on Dust in Ancient Environments and Contemporary Environmental Management

Field Tour: October 8 - 11, 1998
Conference: October 11 - 13, 1998
Battelle Conference Center, Seattle, WA

Background: Soils derived from wind-transported dust, or loess, cover more than ten percent of the earth's surface and support the majority of the world's rainfed cereal grain production. China, Russia, Ukraine, Central Asia, Western and Central Europe, North America, and Argentina have extensive covers of loess. Loess soils and loess deposits are the product of global glacial-interglacial climatic cycles during the Quaternary Period or Ice Ages of the last 2 million years. Productive loess soils worldwide were formed by past extreme episodes of wind erosion, transport, and deposition of dust. Not surprisingly, contemporary use and management of loess soils has led worldwide to problems of wind erosion, with consequent degradation of soil and air quality and human health. Can the lessons of the geologic past inform our strategies for use and conservation of loess soils today and into the future?

Plan to attend this first-of-its-kind conference exploring the connections between human uses of loess soils, wind erosion of fine aerosol particulates, and global-geologic cycles of dust deposition. This is a unique opportunity for interchange of ideas and research strategies between environmental/agricultural and geologic communities.

Estimated Fees & Costs ~ see the April 1998 mailing for full final details!

Conference Registration Fee	$ 275
Student Conference Registration Fee	$ 75
Pre-Conference Field Tour	$ 395
Conference lodging (sgl/dbl per night)	$85/112

PRE-CONFERENCE FIELD TOUR

Plan to attend the optional pre-conference field tour. This three-day excursion will traverse the dryland farming region of the Columbia Plateau in eastern Washington. It will explore the Palouse loess deposits, the deepest deposits of loess in northwestern North America; and will cross the famous Channeled Scabland, site of the largest glacial outburst floods in earth history. Dual themes will be: 1) to visit intensively instrumented wind erosion research sites and farms that are implementing new erosion-control best management practices, and 2) to explore classic exposures of the Palouse loess, examine loess strata and paleosols, and reconstruction of Ice Age environments and cycles of dust deposition. The tour includes a winery tour and tasting in the heart of Washington's wine country on the last day. The tour departs from Spokane, Washington and will end at the Battelle Center in Seattle for the start of the conference. The fee includes all transportation, lodging, guidebook, and most meals. Tour limited to 40 persons.

CONFERENCE

Who Should Attend

- Quaternary geologists, soil scientists, agricultural engineers, agronomists, air quality specialists, environmental scientists, climatologists and paleoclimatologists, and land managers. Students in agriculture, environmental sciences, and geology.

Proposed Conference Topics

- Climatic events and other drivers of loess depositional cycles during the Quaternary Period
- Comparisons of modern and ancient dust transport and deposition in mid-latitude areas
- Dustfall magnitude into ice-age oceans and wind trajectories
- Sub-Milankovitch millennial- and century-scale dust events and their linkages and causes
- Possible role of dust aerosols as a feedback in last-glacial climate change
- Natural and anthropogenic sources, transport mechanisms, and deposition of dust aerosols today and impacts on urban air quality, human health, and the global environment
- Measurement, prediction, transport modeling, and control of wind erosion from agricultural and natural areas

Conference Program Committee

- Alan Busacca, Washington State University
- An Zhisheng, Chinese Academy of Sciences
- Keith Saxton, U.S.D.A. Agricultural Research Service
- Nicolas Fedoroff, INRA, CNRS, France

Cooperating Sponsors

- International Union for Quaternary Research (INQUA)
- Chinese Academy of Sciences
- USDA Cooperative States Research, Education, and Extension Service (USDA CSREES)
- Washington State University Department of Crop and Soil Sciences

Conference Lodging

The conference center is in the heart of Seattle near the University District. Lodging at the Battelle conference center is limited; so space has also been set aside at the nearby Silver Cloud Inn. The Silver Cloud Inn is within walking distance, and also offers complimentary shuttle service to the Battelle Center. Costs range from $85 to $115. Full details will be provided with the conference registration brochure.

SUBMISSION GUIDELINES

Papers at the conference may be presented either orally or in poster form. Prospective authors of papers and posters are encouraged to submit a proposed title with brief description **by May 1, 1998** for review and consideration by the program committee. Submit proposals by surface mail, E-mail, or Fax to Alan Busacca. Notification regarding acceptance of papers and posters will be sent in late May.

A proceedings volume of extended abstracts will be published by Washington State University (in a recognized publication series) and is planned to be available to attendees at the conference. Deadline for submission of camera-ready extended abstracts in English is **July 15**. These should be no more than four pages in length, including text, tables, figures, and references. Detailed guidelines will be sent with the full program and registration materials in April, 1998.

Note: *All presenters must register for the meeting and pay the appropriate registration fee.*
English will be the official language of the conference.

Proposals must be received no later than May 1, 1998. Submit to:

Alan Busacca
Crop and Soil Sciences
P.O. Box 646420
Washington State University, Pullman,
WA 99164-6420 U.S.A.

Phone: 509-335-1859
FAX: 509-335-8674
E-mail: busacca@wsu.edu

Conference homepage: http://www.eus.wsu.edu/c&i/programs/dust.htm

ALL PROPOSALS MUST INCLUDE THE FOLLOWING INFORMATION:

- Presentation Title
- Description: Maximum 200 words. Include objectives and presentation type (oral or poster presentation)
- Presenter information (Include full information for ALL presenters)
  - Name
  - Position
  - Address (full mailing address)
  - Phone, fax, e-mail, website address
  - Media/equipment requirements

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Separating sediment

China's Three Gorges project has taken all the headlines. But on the Yellow River a second large and complex dam is also rising.

Report by Adrian Greeman.

Vast grey semi-cylindrical buttresses tower against a sheer cliff face, with tiny figures moving here and there. Behind the vertical pylons, giant caverns penetrate the sheer rock like the entrance to a Pharaonic tomb in the Valley of the Kings. A wide river runs sluggishly below and plains stretch beyond.

But the painted hieroglyphs here are in Chinese not Egyptian characters, and the towering temple shapes will not be rescued from the river but become part of it. This is the intake structure for China's "other" major dam project, Xiaolangdi on the Yellow River, known as the "mother of Chinese civilisation".

The huge slots and runners in the towers will control flows of water into no less than 16 different tunnels when completed, an extraordinary number reflecting the extraordinary functions of the dam project. It is, uniquely, a dam to control and hold back silt, says Massimo Malvagna of Italian contractor Impregilo, leading the Yellow River Contractors which is building 154m high embankment dam across the river. It will be China's biggest rockfill.

Secondary functions are to generate power, control floodwaters, and on a local scale, feed irrigation. Tunnels and valves, being built by a second European consortium, CGIC JV sponsored by Germany's Zublin, will allow discharge of heavily sedimented water in the rainy season, or deeper level flushing of already settled silt, or feeding of clearer water to the power house, as appropriate. Other tunnels will cope with flood level flows and irrigation and there is also a big open spillway.

A third group, Xiaolangdi JV, led by Dumez and Philipp Holzmann, is building the underground powerhouse where six 300MW turbine generator sets will produce a total 1,800MW output during about nine months of the year.

The Yellow River probably has the world's most heavily sedimented flow, hence its name. It flows through a plain of loess, a fine, wind-deposited material tens of metres deep, and eroded into deep gullies and hillocks of weird and wonderful shapes. The run-off means the river is carrying up to 900g/litre of material at some peak periods, which, as CGIC deputy project director Olivier Colin puts it "is not water, it is mud". Even heavily silted rivers usually peak at 200g/litre levels.

Over the centuries the river has been depositing silt in the river bed at an average 100mm per year. Not surprisingly the clogged river often changes course and regularly bursts its banks causing widespread flooding and loss of life. Controlling it by raising hundreds of kilometres of river bank levee costs the Chinese state huge sums.

A dam which holds back the largest part of this silt would be a boon. Although the Xiaolangdi will be limited to some 20 years as far as siltation is concerned, the benefits outweigh the costs according to its designers, the Xiaolangdi Engineering Consulting Company formed by China's Ministry of Water Resources. The World Bank, which is partly funding the $900M (£550M) project, agrees.

Dams have been built before further upstream but these have been aimed primarily at power generation, and have mostly failed, with reservoirs heavily silted even before completion.

Xiaolangdi is located at a key point on the river where the loess hills give way to flat flood plain. Upstream is the major catchment for the river, some 92.3% of its total. A reservoir will form here with a 12,650M.m^3 capacity, of which 5,100M.m^3 will be "live". The remaining dead volume will hold back much of the annual 1.6Mt wash-off sediment.

After 20 years, the Chinese engineers concede, "we will have to think of something else". Power, however, should continue to be generated and other functions will continue.

The project, under the control of the client Yellow River Water & Hydroelectric Power Development Corporation, has been under way since the early 1990s when 22 different Chinese construction bureaux were drafted in to prepare the site.

The preparation was "excellent", according to Malvagna who arrived in late 1994 when the Yellow River Contractors began working on the £195M earth and rockfill dam, one of three sections of the works. Roads, quarries and borrow areas were sorted out and resettlement of the 170,000 population affected by the scheme was well under way. In the immediate area this means people from the small but bustling township of Xiaolangdi itself, built, like many of the villages in the region from cave houses dug into the soft but stable loess. Most of the village has been used for borrow since.

YRC is led by Impregilo, and its 36.5% share is matched by Germany's Hochtief, with the remainder is made up by Italy's Italstrada and China's Water Conservancy & Hydropower Engineering Bureau 14. And it is doing well according to Malvagna.

"We were supposed to have completed the diversion dam by the end of October this year and around 11.6M.m³ of the earthmoving. In fact we have completed nearly 16.7M.m³," he says, which represents 32% of the task against a programmed 22.5%.

The diversion was carried out on 28 October with a choreographed line of rock trucks completing a sealing dyke for the starter cofferdam, in the presence of Chinese premier Li Peng, himself a civil engineer. A small downstream cofferdam was also finished and the water pumped out of the river bed.

Since then work has proceeded apace completing the 15m high starter cofferdam, and now on building up the main 55m high upstream cofferdam. This must be ready for the flood flows of the river next summer.

The cofferdam will eventually be incorporated into the 154m height of the main dam linked by a final impermeable layer to the inclined core of the main dam. The core is built from the surrounding loess "which is a good impermeable material", says Malvagna.

The outline of the big structure is already visible on the right bank where much of the 1.665km crest length embankment will run. Impregilo was given a dispensation to push forward construction away from the riverside and has built up the rock and earthfill embankment to within 30m of final height, though the Engineer has stopped further work for fear of slips.

On the opposite bank, which is mainly dominated by tunnelling and powerhouse works for Lots Two and Three, the dam outline is also picked out, this time as a concrete layer across the side of the river gorge. Malvagna explains that the underlying rock is a sandstone, usually overlain on flat ground by a 5m layer of claystone under 10m-15m of loess. On the abutment as little as 5m has needed to be taken out. But the Chinese Engineer has asked for a concrete facing to the abutments where they contact the core, says Malvagna.

German engineer Dominik Godde, in the YRC planning department, adds that he believes that a European Engineer would have chosen a direct cleaned rock for core placing rather than concrete. The flexible core material can then accommodate any settlement in the fractured sandstone.

"But the Russian/Chinese philosophy is to make sure of the contact by forming a smooth surface," he says. Malvagna says a layer of relatively weak 15N/mm² concrete 200mm to 300mm thick has gone on. "We have placed 100,000m³ of concrete for that though 40,000m³ was originally calculated," he adds.

On site now a grout blanket is being installed across the river bed and work is starting on an up to 80m deep cutoff wall. Bachy Soletanche is subcontractor for this and will use hydrofraises to key 1m or so into the rock.

The wall is said by the subcontractor to represent the first use on a dam for a new technology involving "plastic concrete". The wall panels are formed in between right angle panels set across the line of the main wall. The transverse panels are made of plastic concrete which means the main panel can first be easily cut into the side panel at either end to form a watertight key. Secondly if the main panel goes off the vertical it still has the full width of the right angled side panel to cut into.

The silt blanket that will immediately form in the reservoir is a major safety factor, he points out, giving the dam an unusual self-healing capacity.

Work so far has been relatively amicable, says Malvagna. "We are prepared to approach the Chinese mentality," he says. "They are very pragmatic and though discussions are very long they never lose sight of the end point. If you are willing to compromise so will they, though you have to gain some respect at first. But if you insist on sticking to principle you will get nowhere. But the paperwork is unbelievable!" he adds.

On the complex DM900M (£310M) Lot Two tunnel works, things have not gone so smoothly, and early on the contractor accumulated a year's delay. Things are going better now and the first critical deadline, completion of the diversion tunnels and their plunge pools, was met 10 days ahead of 28 October date, says Olivier Colin from French firm Spie Batignolles.

Colin is deputy project director for the CGIC JV which is led by Germany's Zublin. Tunnel firm Wayss & Freitag and Strabag, both out of Germany, Salini from Italy and two Chinese firms, Ministry of Water Resources Bureaux No 7 and No 14, make up the group.

Most of the delays are down to exceptionally difficult ground, he says.

Tunnels are driven predominantly through a sandstone, he says, which has a tendency to pull away in blocks. The tunnels were driven by conventional drill and blast methods, and the overbreak can be high which demands extra excavation and extra concrete.

The problem is worsened by a sub-horizontal bedding crossing the axis of the tunnel at around 15°. Finally a number of faults intersect the tunnel. "Once you meet a fault you know you have met it for good," he exclaims.

CIGC experienced 21 collapses in a six month period. Three were large says Colin, several thousand cubic metres of rock coming down. A big pullback in progress has been achieved, but there is a stand off on the current outstanding £105M in claims. The Engineer maintains that the contractor's risk assessment should cover the situation.

One section of the work is proving particularly interesting. The sediment tunnels, circular and 6.5m in diameter, are being given a prestressed concrete lining. An unusual technique, only twice used before, is being incorporated. "Instead of using a duct, the prestress strand is cast directly into the concrete," explains Colin.

"The strand is coated with a polyethylene cover and greased which means it can move. Strands go in as circular 'hoops' every 500mm instead of every 250mm and you can still get a better distribution of forces."

Meanwhile large claims and difficult rock conditions are also dogging work on the Lot 3 contracts. Some £30M of mainly rock condition claims are being submitted on the £82M job for the construction of the power facilities.

British engineer Maurice Thornton is contract manager for the job as part of the German firm Philipp Holzmann. France's Dumez sponsors the project and Chinese firm the Sixth Bureau makes up the joint venture.

"Technically the difficult bit is the powerhouse, which is both very large and very complicated inside," says Thornton. And a major additional problem is the steel penstock lining work for the power tunnels where they reach the powerhouse and then drop down vertically to the turbines.

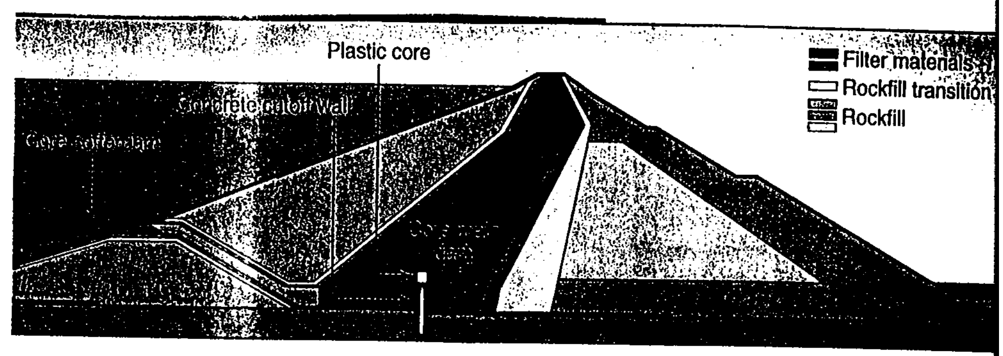
Rock troubles were a major part of the story on the excavation of the powerhouse, says Thornton, especially early on in the roof. There 325 prestressed tendons were ordered by the Engineer for the roof vault once work had begun. The powerhouse is 251.5m long, 25m across and 61.5m high.

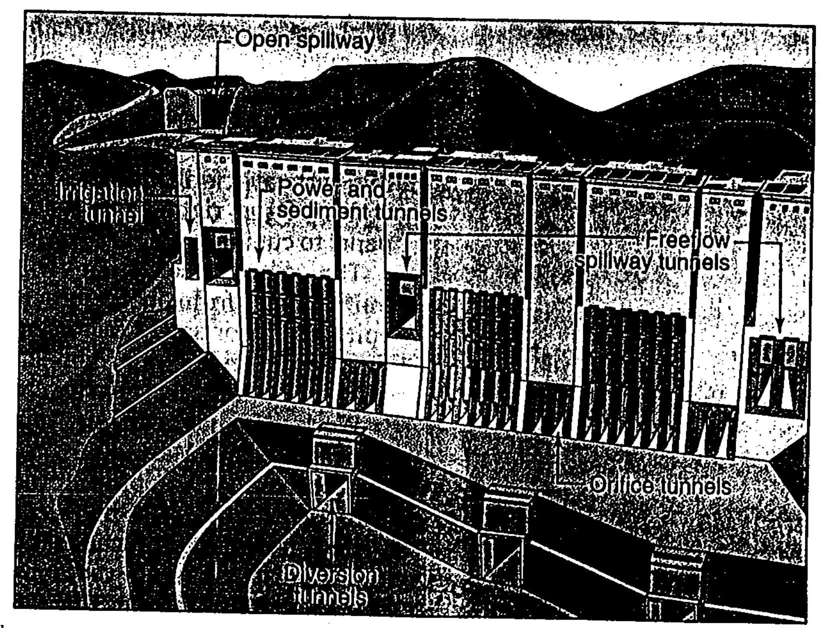
Again the bedding and faulting of the rock has proved very difficult. There have been difficulties too with the installation of penstocks which are running behind schedule.

How much of the problems will eventually be accepted as reasonable claims remains to be seen. Thornton says that on much of it the Engineer maintains conditions were foreseeable by the contractor.

One problem perhaps, he says, is that the scale of additional expenditure for machine and expatriate workers is not always appreciated by some of the engineering staff, especially if they have not had previous contact with western firms.

Despite all that, he says relations with the Engineer and the Chinese side are not bad, and the contractor has learned a lot about how to adapt to conditions.





HISTORY OF SOIL SCIENCE

– International Perspectives –

Dan H. Yaalon & S. Berkowicz (Editors)

ADVANCES IN GEOECOLOGY 29

A Cooperating Series of the International Society of Soil Science (ISSS)

ISBN 3-923381-40-9

The book, comprising a collection of 22 papers, presents a wideranging international perspective on the History of Soil Science. History of a scientific subject can be treated not only in a chronological manner but also by examining the activity of its outstanding practitioners, or recounting the development of certain specialized topics or some regional features of it. In the present context all these aspects are represented.

Four articles introduce the subject of soil as an object of study, including a broad overview of its history, concepts of humus and of soil horizon nomenclature. A landmark first international conference and precursor to the many subsequent conferences rates special mention. In Part II some questions related to the history of soil classification and mapping are dealt with, which complement a number of recently published articles on these topics.

Part III deals with a number of selected topics in physical and chemical soil science: pH as an early diagnostic tool, aspects of soil mineralogy and micromorphology in the USA and soil physics in Central and Eastern Europe. In the following part we include five papers dealing with certain regional aspects, including early soil science in the 19th century in Germany, reviews of the history of soil science in Australia and New Zealand, of Soviet paleopedological studies and of fertility management of Indian soils.

Die Deutsche Bibliothek - CIP Einheitsaufnahme
History of soil science : international perspectives / Dan H. Yaalon & S. Berkowicz (ed.). Reiskirchen : Catena Verl., 1997
(Advances in geoecology ; 29)
ISBN 3-923381-40-9

Contents

Part V: Some outstanding personalities

Finally in the last section we have assembled six papers on outstanding personalities and contributors to soil science, not necessarily the major innovators whose biographies and achievements are generally fairly well known. But we hope that these selected examples will spur others to prepare similar stories and biographies of all those who made important contributions to the subject matter and should not be forgotten by this and future generations of soil scientists. We owe our predecessors that their efforts and achievements, frequently outstanding in the context of their time even though now obsolete, be recounted from time to time.

Research on soils is by comparison to other natural sciences a very young science indeed, as the articles in this book amply document, with as yet no comprehensive documentation of its history. Though sporadic publications appeared, organized activity in history of soil science started modestly as a Working Group (no Committee) of the International Society of Soil Science (ISSS) only in 1982. Subsequently Symposia on historical topics have been organized in the framework of the ISSS Congresses (Kyoto 1990, Acapulco 1994) and a Newsletter is issued from time to time.

Advances in GeoEcology 29, 1-13 Reiskirchen 1997

History of Soil Science in Context: International Perspective

Dan H. Yaalon

1 Introduction

The aim of the present exposition is to describe the history of soil science not only as a simple chronology of events and new contributions, but to evaluate the historical developments in the context of their period and to trace, albeit briefly, the most significant conceptual changes.

The essay thus has two parts. In the first section a thumbnail sketch of the history of soil science is presented, beginning with the recognition of soil differences by early agriculturists. In subsequent sections the emergence of the various subdisciplines of soil science is traced. In such a general survey it is impossible to give justice to the many innovators who have contributed to the present status of soil science. It will be my aim to bring the descriptive history, both with respect to the main people involved and their achievements to about 1930, when the monumental *Handbuch der Bodenlehre* edited by E. Blanck was published and modern soil research took off at an accelerated rate. A full treatment would require more space than available in this volume. The section will also serve as a suitable framework for the following discussions.

In a separate part the historical development will be compared to models of scientific growth and change. For soil science a few major and several lesser paradigm shifts can be identified and will be evaluated. In the historical section I shall argue, like others before me (Tandarich et al. 1991), that early soil science developed along two separate pathways, the agricultural soil chemistry path and the weathered rock and agrogeology path with little interaction between them. Later some additional guiding assumptions or concepts broadened the field of study and established the modern trends of research in soils.

The history of soil science has been a rather neglected subject. Several older and some newer general reviews exist (Jarilow 1913, Neuss 1914, Giesecke 1929, Ehwald 1962 and 1969, Strzemski 1975, Simonson 1968, 1989) which contain a

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Advances in GeoEcology 29, 377-391 Reiskirchen 1997

L.S. Berg and the Soil Theory of Loess Formation

I.J. Smalley & C.D.F. Rogers

Summary

L S Berg was the chief proponent of the 'Soil' theory of loess formation. This held that loess was formed in situ and specifically denied any validity to the idea of aeolian deposition. The 'Soil' theory grew directly from the teachings of V V Dokuchaev and requires loess to develop via a process of 'loessification', which converts non-loess material into loess and which must, in turn, mean that the loess has a significant carbonate content. The theory was influential in the Soviet Union from about 1920 to around 1970, and still affects current Russian and East European thinking on problems of loess origin.

1 Introduction

"According to my own theory" wrote Berg (Berg 1964 p.1) "loess and loess-like rocks have one and the same origin: they form in situ, out of various fine-earth rocks which are necessarily carbonatic, such formation resulting from weathering and soil-forming processes in a dry climate".

The problem of how loess deposits form has been discussed for many years, in fact since Charles Lyell first gave loess widespread visibility on the world stage via the brief mention in 'Principles of Geology' (Lyell 1833). Lyell opted for a lacustrine origin but this rapidly proved to be irreconcilable with many of the geomorphological aspects of the deposit, in particular the way it is draped over the landscape. There was much discussion of origins in the latter part of the nineteenth century, which has been well surveyed in many places (e.g. Russell 1944, Kriger 1965, and recently Rozycki 1991). By the end of the nineteenth century there appeared to be a developing consensus that loess material was carried by the wind and then deposited. Sub-aerial deposition gives the loess its characteristic place in the landscape and most of its characteristic features, such as a tendency to subsidence when loaded and wetted. Richthofen (1882) has been allocated the credit for the aeolian theory of loess deposition and his famous letter to Geological

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Dan H. Yaalon & S. Berkowicz (Editors): History of Soil Science

Magazine in 1882 does present a forcefully argued case for that particular mechanism of formation.

In Russia and the Soviet Union the chief supporter of the aeolian theory was V A Obruchev (see Obruchev 1952, Alekseyev & Dodovov 1989), who was an active proponent of this theory for the first half of the twentieth century. However a rival theory grew up in Russia, and for a time displaced the Obruchev approach. This was the Berg 'in-situ' theory. The purpose of this paper is to discuss the rise and fall of the 'in-situ' theory, to attempt to explain how it came to be proposed, and to analyse the influences which operated on Berg and on loess investigation in the Soviet Union during the critical years. Berg's theory depended on Dokuchaev, the founder of soil science, and the story of Berg's loess theory is in many ways an illustration of the influence of Dokuchaev on Soviet science.

2 Loess

Interest in loess in Europe was initiated by Karl Caesar von Leonhard in his book 'Charakteristik der Felsarten'. This great work was published in three volumes in the years 1823-1824 and is now very rare. Von Leonhard was concerned with the loess around Heidelberg and the sites he investigated and described are now regarded as providing the 'locus typicus' for loess (Kirchheimer 1969). This new sediment might have remained in obscurity, but it gained the interest of the influential Charles Lyell, famous as the author of 'The Principles of Geology' and apostle of uniformitarianism. In 1834 he published in the Edinburgh New Philosophical Journal a paper that did much to bring loess to the attention of the geologists and interested laymen of the day. Lyell's paper was called 'Observations on the Loamy deposit called "Loess" of the basin of the Rhine' and was read before the Geological Society of London on 7 May 1834. His observations had been made during the previous summer when he was travelling in Germany. His definition is worth quoting:

> "It may be as well to state, that the Loess consists of a pulverulent loam of a yellowish grey colour, containing a certain quantity of carbonate of lime, according to Leonhard about a sixth part. When not associated with gravel it exhibits no signs of stratification. It contains almost everywhere embedded terrestrial and aquatic shells of species still living in Europe, which have usually lost their colour, but are for the most part entire."

At Heidelberg Lyell talked to Professor Heinrich Bronn 'who has devoted much time to the study of loess' and it was suggested to him that the loess was not formed suddenly by a transient flood, but gradually by successive deposition. Lyell accepted this view but still felt it necessary to record that:

Perhaps, at the end of the day, it is all a matter of linguistics: a problem of language rather than of science. If loess is a soil then obviously it comes into being by soil forming processes; if loess is a rock then lithogenesis forms it. It is probably best seen as a sort of transitional material. Geological factors control the formation of a loess deposit, but it may become a significant soil. Chernozems form on/in loess deposits. In the western parts of the Soviet Union, where Berg and Dokuchaev worked, the loess has transformed into chernozem. The idea of loess transforming into chernozem was the insight that led to the invention of soil science. But even inspired insights can be taken too far.

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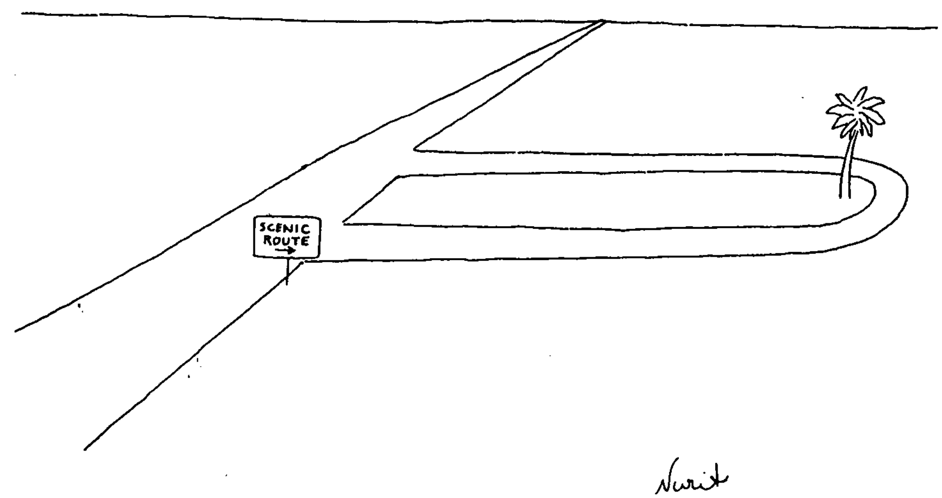

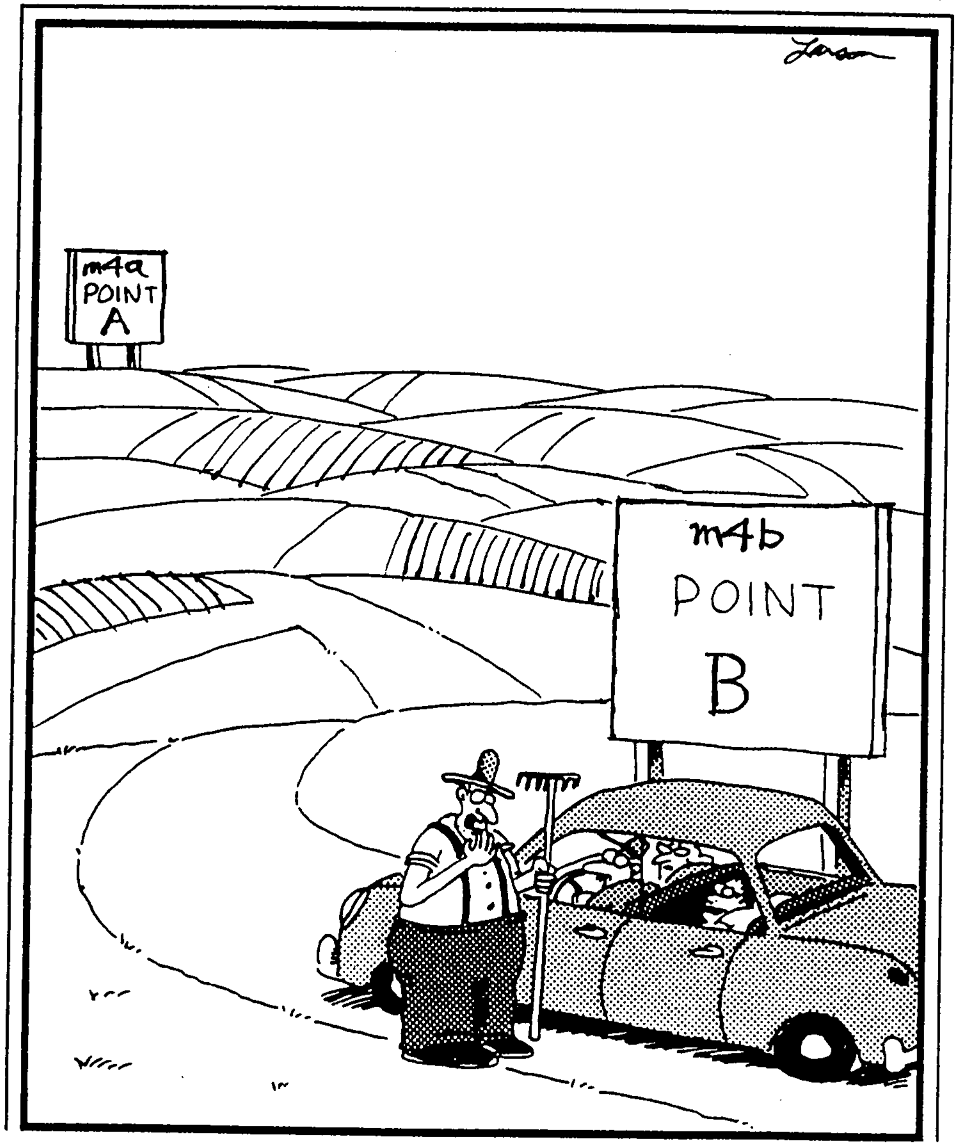

"Well, lemme think. ... You've stumped me, son. Most folks only wanna know how to go the other way."

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Loess studies in central United States: evolution of concepts

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Abstract

Few words in the realm of earth science have caused more debate than "loess". It is a common term that was first used as a name of a silt deposit before it was defined in a scientific sense. Because this "loose" deposit is easily distinguished from other more coherent deposits, it was recognized as a matter of practical concern and later became the object of much scientific scrutiny. Loess was first recognized along the Rhine Valley in Germany in the 1830s and was first noted in the United States in 1846 along the lower Mississippi River where it later became the center of attention. The use of the name eventually spread around the world, but its use has not been consistently applied. Over the years some interpretations and stratigraphic correlations have been validated, but others have been hotly contested on conceptual grounds and semantic issues.

The concept of loess evolved into a complex issue as loess and loess-like deposits were discovered in different parts of the US. The evolution of concepts in the central US developed in four indefinite stages: the eras of (1) discovery and development of hypotheses, (2) conditional acceptance of the eolian origin of loess, (3) "bandwagon" popularity of loess research, and (4) analytical inquiry on the nature of loess. Toward the end of the first era around 1900, the popular opinion on the meaning of the term loess shifted from a lithological sense of loose silt to a lithogenetic sense of eolian silt. However, the dual use of the term fostered a lingering skepticism during the second era that ended in 1944 with an explosion of interest that lasted for more than a decade. In 1944, R.J. Russell proposed and H.N. Fisk defended a new non-eolian, property-based, concept of loess. The eolian advocates reacted with surprise and enthusiasm. Each side used constrained arguments to show their view of the problem, but did not examine the fundamental problem, which was not in the proofs of their hypothesis, but in the definition of the term.

Between 1944 and about 1950, the debates about loess reached a maximum level of complexity. The main semantic problem was submersed in peripheral arguments about physical properties and genetic interpretations. The scholarly treatment of the subject by Fisk and Russell stimulated quality responses from a diversity of earth scientists interested in academic and applied studies, particularly geo-history, pedology, soil mechanics and stratigraphy. The long-lasting popularity of loess studies during the bandwagon era lasted to about 1970. By that time, the analytical and technical interests had attracted the mainstream into the fourth era with a focus beyond the old arguments. Although Fisk and Russell found themselves defending an unpopular theory, they stimulated a scientific interest in the late Quaternary history of the Mississippi Valley that may never be exceeded.

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1. Introduction

The character and distribution of silty deposits known as loess have been the subjects of much debate. The definition and application of the term has varied since its inception by discipline or provincial perspectives. In the United States loess has come to be known as eolian silt in general, but other concepts are still employed. Local scientific and applied studies within the Mississippi River drainage basin of the central US have attracted much international attention, but a regional view of its character and distribution has not been attempted in any rigorous way. This reflects two main difficulties in drawing together loess-related research: (1) the central US (Mississippi River basin, including the Missouri River basin) region is larger than the interest and responsibilities of the researchers; and (2) the nature of the research ranges across many disciplines, principally agriculture, geo-sciences and engineering. This review will be selective and focus on the history of loess studies in the Mississippi Valley region and on the evolution of concepts that continue to be debated. In this way some current regional aspects can be explained and may serve to encourage further research on unresolved problems.

Lyell was the first to recognize loess in the US along the bluffs of the lower Mississippi River in 1846 (Smalley, 1975; Snowden and Priddy, 1968). Numerous studies of loess for a broad range of purposes have been made over the years (Smalley, 1975). However, none of the studies attracted more attention than those concerning the origin and definition of loess. Before about 1900 loess was commonly thought to be a fluvial deposit. By 1930 the popular opinion in the US had shifted to believing that loess is wind-blown (eolian) silt. Disagreement still persists in the international community of researchers and gives another purpose for this review. The main issue is not one of correctness but point of view or purpose. Two mutually exclusive points of view have been proclaimed by some opponents in this debate. At one end of the spectrum is a complex and empirical definition of loess that evolved from the original use of the term, which attempts to accommodate all important characteristics of loess as criteria. Many variations of this view are reviewed by Smalley (1975) and the position has been defended in great detail by Pecsi (1990) who paraphrases a longer definition by stating that "true (typical) loess can be described as a loose deposit with coarse silt predominant in grain size, unstratified, porous, permeable, stable in steep walls, easily erodible by water, "structured light loam" of pale yellow color due to finely dispersed limonite (iron hydroxides), quartz as main mineral constituent (40–80%), subordinate feldspar content, variable amounts of clay minerals (5–20%) and carbonates (1–20%)". This is a description of a material. Pecsi recognizes typical loess as an eolian accumulation but treats the sedimentary factor as secondary. He emphasizes the role of pedogenesis in the formation of many of the characteristics that are typical of loess deposits. This process is described as loessification, which gives a silt deposit its "diagnostic" loess characteristics. This concept of producing loess accommodates the eolian factor but a modified concept put forth by Russell (1944) and defended by Fisk (1951) specifically excluded the eolian factor. They envisioned a sequence of events that transform backswamp deposits into loess by weathering, soil creep and carbonate cementation.

In contrast at the other end of the spectrum is a simple and functional definition of loess that it is eolian silt. This concept has gained popular appeal in the US because it gives a lithogenetic name to eolian silt and provides a better framework for explaining the distribution of properties in silt deposits that are known or interpreted to be eolian. In this sense loess is a term that is analogous to dune sand. All other "typical" characteristics noted by Pecsi (1990) are attendant properties that aid correlation and provide a basis for further classification. Perhaps the trend in thinking in the US took the course it did because the character of the loess on the uplands along the Mississippi River Valley is unmistakably eolian, i.e., a mantle of silt covering all parts of the landscape must be eolian. However, not all people agreed. Russell (1944) and Fisk (1951) challenged the genetic part of the interpretations and set into motion a renewed research interest in loess. What may have seemed to be a two part issue, the empirical verses functional view of loess, now became complex; new factors were added that created classification problems. Much was learned during this era of renewed interest, which lasted for about 20 years. Then research interests evolved to the application of new technologies that were developing at a rapid rate by 1970. However, some issues were still unsettled and continued to be debated. To summarize all the debated issues is difficult because they cover a broad range of subjects that reflect different points of view, assumptions, and applications. Virtually all aspects of loess studies have been controversial at one time or another. Based on interests and accomplishments the history of loess studies in the central US can be divided into intervals or "eras". Clear boundaries can not be drawn because the style and purpose of so many studies are unconnected and nonsequential. In spite of the persistence of competing hypotheses and conflicting interpretations, some features stand out that help define four eras of loess studies: (1) Discovery Era – 1846–1900; (2) Era of conditional acceptance – 1900–1944; (3) Bandwagon Era – 1944–1970; (4) Analytical Era – 1970 to present.

2. Discovery Era – 1846–1900

The first era of loess studies in the central US was a time of discovery, curiosity, and uncertainty. Multiple loess units were discovered, basic concepts were developed, but no standards of study or interpretation were in practice. As discovery revealed the nature and distribution of silt-rich deposits called loess, the urge to explain their origin became the primary attraction. By the end of the 19th century, popular scientific opinion favored an eolian explanation but also viewed the question of the origin of loess as complex and indeterminate (Smalley, 1975). Among the many studies that were published during the 1890s, Chamberlin (1987), Udden (1898), and Leverett (1899) captured the spirit of the time. Chamberlin's title "Supplemental hypothesis respecting the origin of the loess of the Mississippi Valley" signifies the scope of the loess question. He proposed a combined glaciofluvial and eolian hypothesis for the origin of loess. The evidence for eolian deposition of silt on uplands was recognized in many reports but it was considered circumstantial evidence and not adequate for explaining the origin of the Mississippi Valley loess. At the time most investigators thought that better or other evidence could be found. Critics at the time favored a water-transport hypothesis and thought that the lack of eolian landform and stratification features were fatal flaws in the argument for the eolian hypothesis. In the US the debates about loess by the end of the era were totally focused on the process of formation and the original meaning of the term was suspended from technical discussions. However, the term continued to be used in a broader sense, which served as a reminder that its meaning was not firmly established. The enthusiasm on the subject seemed to be driven by the desire to find a universal solution for the so called "loess question".

3. Era of Conditional Acceptance – 1900–1944

The attitudes concerning the loess question in the US reached a general consensus around 1900 and lasted until 1944. During this era most researchers accepted loess as eolian silt but typically with reservations based on speculation and uncertainty. It was acceptable to dismiss the question of origin and go on to other aspects of loess studies. Loess-derived soils became well known during this time through the work of the soil survey organizations throughout the US. A common knowledge of loess and soil profile characteristics developed, and became the foundation for the classic study by Smith (1942). Building on a long background of studies, he recognized testable relationships between the primary characteristics of the loess and the secondary (pedogenic) characteristics of the soil. Smith examined many soil profiles in Illinois and found clear relationships among soil type variation, loess thickness, and particle-size distribution. His study demonstrated predictable relationships that are best explained by eolian processes.

The concept of soil employed by Smith requires that the parent material and a sequence of soil horizons known as the soil profile be treated as separate entities, i.e., loess is the primary entity (parent material) and the soil profile is the secondary entity or an alteration product of the parent material. This distinction is useful and necessary for understanding soil genesis. As a concept it reached a paradigm status within the soil science circles at the time. However, to many people outside of soil science, the distinction between soil and loess is not recognized or is dismissed as an unimportant issue. The dismissal of this distinction has caused much of the uncertainty in the understanding of loess.

The distinction between soil and loess was only one of the concept splits that occurred or developed during this era. Some splits were along disciplinary lines and others were caused by geographic or language factors. Researchers who had a prime interest in the physical properties of loess developed concepts based on physical properties and other observable characteristics. In general these concepts recognize loess as it was originally defined as a "loose silt". However, these concepts forced creation of an undesirable term – "loess-like". Altered or weathered eolian silt and all other silt deposits that do not satisfy all the descriptive criteria had to be given a different name, which by default was "loess-like". This concept that evolved was open-ended and forced the grouping of all uncertain silty deposits into one vague class. When this idea is applied to buried soils in a loess sequence, which is commonly called a loess-paleosol sequence, the buried B horizon of a soil profile is commonly called "paleosol" and the other intervals are called "loess". This creates an undesirable dualism because the whole sequence is loess, which has experienced different degrees and kinds of pedological alteration.

Those who add genetic information to physical-property based concepts of loess commonly acknowledge that it has an eolian origin. In some cases loose eolian silt is referred to as "true loess" and is distinguished from other "kinds of loess" such as colluvial, alluvial, in situ and other variations. The most common pattern observed in the literature is the use of the term "loess-like" for silty materials of unknown or uncertain geological origin.

The most challenging concept split during this era occurred in Europe and did not immediately influence research thinking in the US. In 1916 Berg proposed a soil theory on the formation of loess, referred to as in situ formation (Smalley, 1975), which became the basis for the loessification concept. In the early arguments on in situ formation, the sedimentological origin of the "loess" was not a contention but as the concept evolved to its extreme form, eolian formation was excluded as an explanation. The extreme position was never popular because it put total emphasis on the soil theory and disregarded the geological factors. Advocates of a more holistic approach have attracted a much greater following, which has been recently defended by Pecsi (1990). The main theme in the definition by Pecsi is that loess is a pedogenic transformation of eolian dust.

The debates in Europe on loess formation eventually reached the Mississippi Valley region with a big impact and brought an end to the era of conditional acceptance of the eolian theory. R.J. Russell (1944) with the aid of H.N. Fisk presented a provocative dissertation on a backswamp-loessification theory that surprised earth scientists in the US. The reactions greatly stimulated loess studies in the Mississippi Valley (Wascher et al., 1948; Leighton and Willman, 1950; Fisk, 1951). Russell was attracted to the European idea of loessification and while working with Fisk on the geology of the Lower Mississippi Valley (LMV), developed a new theory on the transformation of backswamp sediments into loess and rejected the in situ theory and the eolian theory. In retrospect it seems incongruous for Russell (1944) and Fisk (1951) to have been unaware of Smith's work in Illinois and the established scientific evidence for widespread eolian silt in the Mississippi Valley region. The circumstances suggest that they were caught up in older arguments and chose not to examine the new evidence. Also, their isolated position with others is indicated by another event that occurred in 1944, which gave impetus to the growing popularity of loess studies. They did not participate in a symposium on loess in Nebraska that was convened not to

address the origin of loess, which all participants acknowledged to be eolian, but to go beyond the origin question and discuss the stratigraphy of loess deposits, the characteristics of loess-derived soils and uses of loess in engineering applications (Elias, 1945).

Although much significant work had been accomplished in all areas of loess research by 1944, collectively it had not quite produced a paradigm, an understanding among the research community of acceptable assumptions that reflected trust in the eolian model. It remained popular to express doubts on any proposed answer to the loess question, but for practical purposes a single mainstream of thought on the eolian origin of loess existed in the US by 1944. Russell acknowledged in his 1944 paper that he had once supported the eolian theory, but then was influenced by his experiences to challenge a problem inherent in the property-based concept of loess. He correctly assessed that too many silty deposits are called loess, but failed to recognize the significance of the dualism in terminology that existed. He believed that a unique solution was possible, in which the names, definitions and interpretations can be in harmony. Russell wanted a name for a sediment type based on properties but the main stream wanted and needed a name for a sediment type based on geological origin. One can only wonder why Russell failed to see the dualism and not see that the eolian advocates had built a reliable foundation for an eolian silt paradigm, or a reliable framework within which to study other loess research problems. The consequence of the success of the genetic-based argument redefined loess for Americans or at least established a valid second meaning for the word.

4. The Bandwagon Era – 1944–1970

The renewed interest in loess stimulated by Russell and Fisk propelled research in the Mississippi River basin into a new era. It became so popular that it took on a bandwagon character. The main thrust in most research during the early phase was seeking more and better proofs for the eolian origin of loess. This brought attention to the fact that not all silty deposits are loess and that more attention is needed on how to differentiate the different types of silty deposits. Regional studies on loess stratigraphy and parent material distribution for loess-derived soils became important. Multiple loess sequences were known at this time but correlations beyond state borders were only speculations. Although the stimulus to study loess was largely driven by the desire to understand its genesis and distribution, the eolian nature of the "upland facies" became self-evident and ceased to be an issue for a majority, so a paradigm for loess had arrived. The slope and valley facies were recognized in most studies as being more complex and were commonly recognized as including sediments from other depositional processes, often referred to as redeposited loess or secondary loess. In many studies loess was excluded as an interpretation of "silt beds" on slopes or in valley-fill sequences. Eolian silt interbedded with colluvium or alluvium is rarely interpreted as loess, even to the present day. Loessification as a useful concept was usually dismissed without comment in most studies during this era because it confused the relationship between loess and soil. Soil and related weathering processes were recognized as a post-depositional alteration of the primary deposit, and to some geologists as early stage diagenesis.

Early loess studies along the Mississippi and Missouri rivers, were largely limited to areas no larger than a state, because of the size and uncertainty of the region covered by loess. Studies in the third era led to the recognition of loess in most of the Mississippi River basin (Fig. 1). The first attempt of a regional synthesis with some detail was the preparation of the eolian map of the US (Thorp and Smith, 1952). Collaborators from nearly every state contributed information on the distribution of eolian sand and silt, which were differentiated and subdivided by total thickness classes and by percent of land cover. The map correlates the loess across the region on the basis of chronostratigraphic (time) units but recognizes only one – the Wisconsinan. No attempt was made to differentiate lithostratigraphic units probably because the popular belief at the time saw no need for it. At the time, standard practice combined chronostratigraphic and lithostratigraphic con-

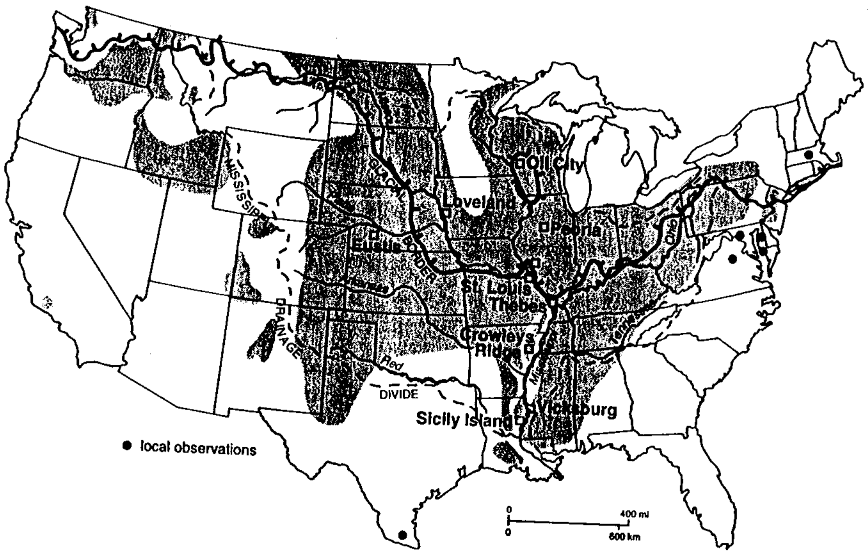

Fig. 1. Recognized loess distribution in the conterminous US. The surficial loess is the Peoria loess (or silt) at most places.

cepts into one monolithic or monotaxonomic classification system.

The loess problem during the bandwagon era generated so much interest that it attracted State Geologists in the upper Mississippi basin to organize a field conference in 1947 to examine loess correlations from South Dakota to Illinois. This led to the major field conference in 1949 to review the loess record from Illinois to Louisiana (Leighton and Willman, 1950). This conference was largely focused on interpretations made by Russell (1944) and Fisk (1944). The 1949 guidebook contained 15 figures from Fisk's report because his geological interpretations of the LMV had a significant bearing on the loess question. The Leighton and Willman (1950) report reaffirmed the eolian nature of the major loess deposits along the Mississippi River and pointed out the defects of the loessification model proposed by Russell. The fundamental defect is that it creates a cascade of increasingly complex relationships that require unrealistic explanations, such as 300 ft of tectonic uplift in the LMV, alluviation of greater extent than the present valley, and greater depths of valley cutting during erosion cycles (Leighton and Willman, 1950). Fisk (1951) tried to sustain the non-eolian theory of loess formation but by then such notions had lost credibility and had little application to the current research problems. However, Fisk's scholarly approach begged serious attention from others and served to stimulate interest for years after.

The forward-looking research interests at the time turned toward recognition of loess, the distribution of loess units, relationships to glacial events and physical properties of loess. Most work was limited to areas within a state but correlations were commonly projected into neighboring states, which spawned continuing debate and interest about some issues. The relationship of the loess in the central Great Plains with the glacial succession in Iowa was examined by Frye et al. (1948). Loess stratigraphy in the Great Plains at the time was largely based on vertebrate paleontology that could not be applied in the Midwest because of a poor vertebrate record. They recognized that a correlation with the glacial record could be made by using volcanic ash beds, buried soils and fossil mollusks.

Wascher et al. (1948) studied the loess units in

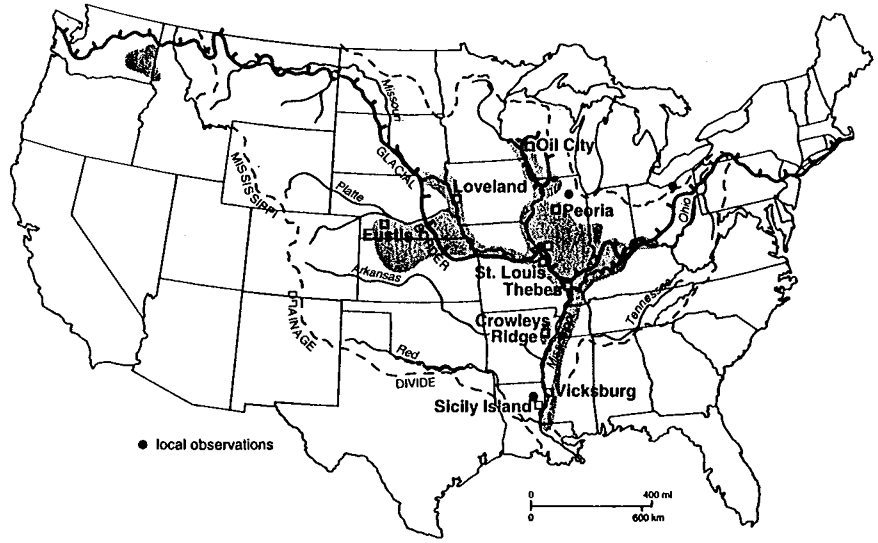

Fig. 2. The distribution of the 2nd loess – Roxana silt and equivalents.

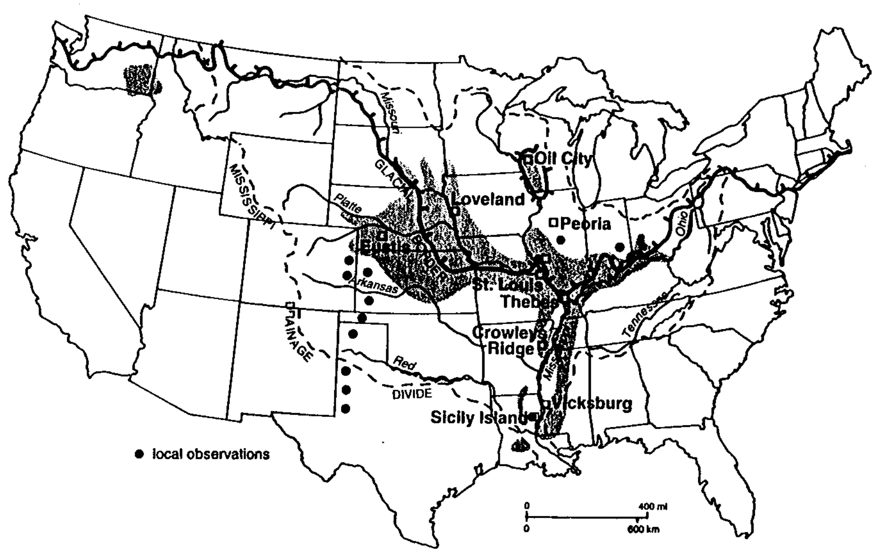

Fig. 3. The distribution of the 3rd loess – Loveland silt (or loess) and equivalents.

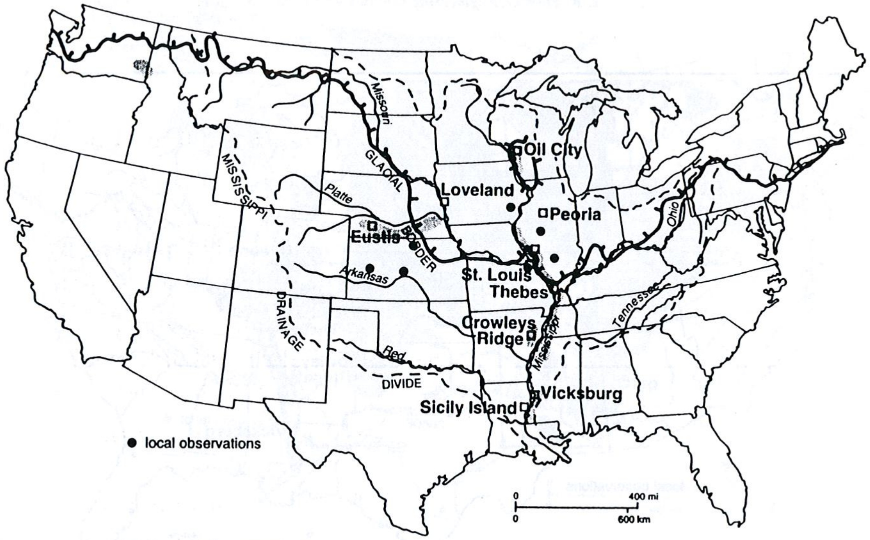

Fig. 4. The distribution of the 4th and older loesses.

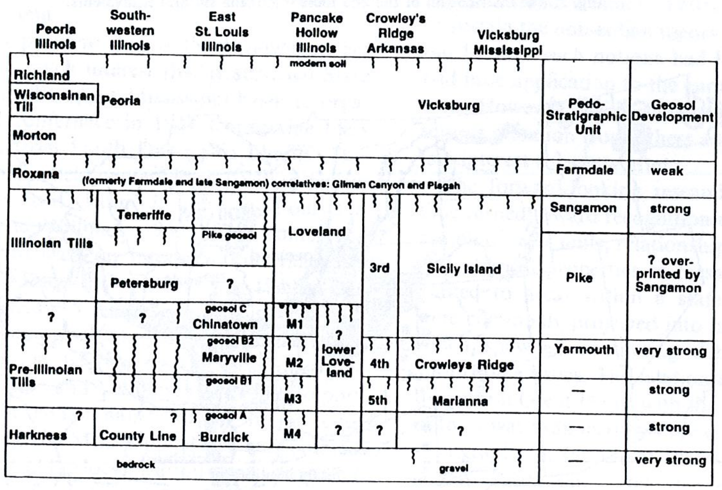

Fig. 5. Correlation of loess terminology and pedostratigraphic units in the Mississippi Valley region.

outside of Nebraska. The Bignell Loess is youngest and was placed in the latest part of the Wisconsinan. It overlies the Brady Soil that has been carbon-14 dated between 9000 and 10 000 years B.P. By present standards the Bignell is Holocene or post-glacial in general terms, even though it clearly has a valley bluff relation along the Platte River, which has been generally accepted

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Loess Letter (LL) is the newsletter of the INQUA Loess Commission. INQUA is the International Union for Quaternary Research, which encourages and correlates research and investigation on Quaternary topics, within the ICSU framework. ICSU is the International Council of Scientific Unions which looks after World-wide science. The Quaternary is the last 2 million years (more or less), and loess is that remarkable wind-blown silt which provides the basis for the best agricultural soil in the world (the parent material for Chernozems to form in).

Loess stratigraphy provides an excellent terrestrial opportunity to study climate change and the sequence of Quaternary events, and this is probably the most popular research topic within the loess community at the moment.

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In particular contact him if you are interested in the major current Loess Commission project "Palaeoclimate teleconnection in the mid-latitudes recorded by dust deposits in the last glacial cycle". This project is organized by An Zhi-Sheng, N Fedoroff, Liu Tung-sheng and G J Kukla and participation is invited. The other project for the 1995-1999 inter-congress period is "The structure and hydro-collapse properties of loess soils" organized by the CSRG at Nottingham Trent.

Winter Night *1954. 13 x 9¼'*