LL12 October 1984 ISSN 0110-7658

La LETTRE du LOESS
LOESS LETTER 12

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ELDAAG
OAG'84

LL12: October 1984

Loess Letter is published by Quaternary Research and Geological Engineering Groups of the University of Waterloo; it is the newsletter of the INQUA Loess Commission. LL appears twice a year, normally in April and October. Requests for copies, and material for publication, should be sent to Professor Ian Smalley, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. Brief research papers are published, also reviews of recently published material, and news items and announcements. Inquiries about the work of the INQUA Loess Commission can be addressed to the President: Professor Marton Pecsi, Geographical Research Institute, Hungarian Academy of Sciences, H 1112 Budapest, Budaorsi ut. 43-45, Hungary.

At the Loess Commission meeting held in Moscow during the International Geological Congress (August 1984) the present status and future of LL was discussed. The aim remains the same - to disseminate information on world-wide loess activities and to provide a channel of information and contact between members of the Loess Commission. In this issue (LL12) we publish some observations on LL by Marton Pecsi, President of the Commission. In accordance with the wishes of the Commission the editorial board of LL is being expanded; several new members were appointed in Moscow and the current board consists of the following members:

The Commission would like to promote loess investigations in Africa and South America - please send any suggestions or ideas to Budapest or Waterloo.

LL12 is a special issue for the November (1-4) 1984 meeting of the Canadian Association of Geographers, Ontario Division (CAGONT), the East Lakes Division of the Association of American Geographers (ELDAAG) and the Ontario Association of Geomorphologists (OAG) at the University of Waterloo. Canadian loess is being actively sought - please report any sightings to Stewart Sweeney, Earth Sciences Department, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. The feature article in LL12 is the report presented by Marton Pecsi at IGC Moscow '84. We also publish a tribute to A.S. Kennard to mark the 40th anniversary of his classic 1944 paper on the Crayford Brickearths in the Proceedings of the Geologists Association.

Cover: The cover largely consists of Fig. 106 from the new book by Jan Sajgalik and Igor Modlitba on 'Loesses in the Danubian Lowland and their Properties'. This is published in Slovak; we publish an extended English summary.

CHINA '85

A Loess Commission meeting will be held in China in 1985 - probably in late August: accommodation is strictly limited. For details contact Professor Liu Tung-sheng, Institute of Geology, Academy of Sciences, P.O. Box 634, Beijing, China. A suggested itinerary is: 3 days in Beijing for initial discussions; move inland to Xian, and then head north into the classic loess regions.

MICROMORPHOLOGY

In 1985 the 7th International Working Meeting on Soil Micromorphology will be held in Paris. The organizing committee has decided to have a symposium on 'Paleosols in Loesses: Progress achieved with micromorphology and possibilities of new developments.' Loess investigators are invited. The meeting date is 8-12 July, 1985. For details contact: Dr. N. Fedoroff, INA-PG Department des Sols, 78850 Thiverval-Grignon, France.

POLAND '85

An international symposium on 'Problems of the Stratigraphy and Paleogeography of Loesses' will be held in Poland in September 1985. The Committee of Quaternary Research of the Polish Academy of Sciences invites loess scholars and investigators to the meeting which will be based at the Marie Curie - Sklodowska University in Lublin, 6-10 September 1985. For details contact: Professor Henryk Maruszczak, Department of Physical Geography, Univ. Marie Curie - Sklodowska, Akademicka 19, 20-033 Lublin, Poland.

I N Q U A

Commission on Loess

Outline proposal for a Project on:

"The genetic classification of loessic sediments: criteria for recognition and differentiation of genetic types"

Coordinator: Edward Derbyshire

1. An initial phase designed to establish current practice. Questionnaire survey to determine the following:

   (i) Types of loessic material recognised in different countries by different workers
   (ii) What criteria (both field and laboratory techniques) are used to differentiate types?
   (iii) What genetic terminology is used?
   (iv) What sequence do the types occur in?
   (v) What are the standard reference works used in the classification process?

2. Dissemination of the results of the questionnaire to interested Corresponding Members, perhaps leading to critical re-evaluation of criteria leading towards agreement on general principles of classification on a world-wide basis (i.e. a general classification scheme).

3. Publication of a monograph summarizing the results of 2 and illustrating it from widely separated parts of the world.

4. Critical application of the revised genetic criteria to carefully selected loessic samples from all continents. This will be both a laboratory and a field study. Laboratories in several countries will conduct an integrated, comparative exercise over a four year period, supported by a series of cooperative evaluations of selected "key" loess sites.

This programme will seek to determine critical sedimentological characteristics of loess and loess-like materials and will clearly interface with the project on the engineering properties of loess.

It is anticipated that phase 1 will take one year and phase 2 a second year. Major discussions at this stage could be scheduled for the Ottawa '87 meeting of INQUA. Phase 3 will take at least 1½ years but phase 4 can begin in the third year and should run for at least four years, with a view to completion by the 1991 INQUA.

Printed in the Geographical Research Institute, Hungarian Academy of Sciences, Budapest

Doc. RNDr. Ján Šajgalík, CSc.
RNDr. Igor Modlitba

SPRAŠE
PODUNAJSKEJ NÍŽINY A ICH VLASTNOSTI

LOESSES IN THE DANUBIAN LOWLAND AND THEIR PROPERTIES

Vydanie prvé.
Vydala VEDA, vydavateľstvo Slovenskej akadémie vied,
v Bratislave roku 1983 ako svoju 2447. publikáciu.
Strán 242. Náklad 500 výtlačkov.
AH 16,56 (text 11,26, ilustr. 5,30), VH 17,18.

Loess sediments extend over a large area. They are found on all continents, mostly in Europe, Asia and America. Their areal extension on the earth's surface attains as much as 13 millions km^2, according to Sergejev (1976).

Much contradictory literature has gathered about loess, and therefore we tried in the introduction of this publication to present a chronological survey of the views on genesis and composition of loess not only in Czechoslovakia, but in the world generally. This publication treats only the essential problems of loesses, namely their genesis and lithology, and to some extent also stratigraphy, but this only with the aim of clarifying the stratigraphic concepts that had been introduced into Czechoslovak literature.

There are many publications dealing exceptionally with genesis of loesses. From among the large number of authors we chose only the main protagonists or supporters of one or another school or theory to be mentioned here. Development of the views on genesis and lithology of loesses is given chronologically; also all important loess sediments of the world are presented here, so that the reader can acquire a total information on this problem.

Discrepancy of the views on loess genesis has also reflected in its definition. This is why we analyse here the problems of this definition. However, we do not only analyse, we do also try to present synthesis of knowledge which is of far-reaching practical importance and emphasize that the problems of loess sedimentation are not simple at all. We think that the main criterion for the definition of loesses should be the genetic view-point and not the mechanical, or descriptive one. We presume that the opinion is well-founded that each proper definition should involve the process of formation of the relevant rock, in this case loess, as one of the main criterion. On the basis of a detailed survey of loesses in the Danubian Lowland and other regions of Czechoslovakia we have arrived at the conclusion that loess sediments can be essentially divided into two categories:

1. Loesses
2. Loessoid or loess-related earths.

Loesses we consider eolian aleuritic siliceous sediments with predominating grain size composition ranging from 0.005 to 0.063 mm, macroporous, more or less calcareous and usually re-setting.

It is natural that also eolian loesses can differ in grain size composition, porosity, content of carbonates, etc., because simultaneously with the formation of loesses also the process of weathering and formation of soils took place. If we want the composition of these loesses be expressed more precisely, the use of auxiliary synonyms such as sandy loess, loamy, clayey loess, etc. would be well suited.

Anyhow, we shall always bear in mind that these loesses were formed by eolian activity, and that their grain size composition and partly also inner structure did change owing to subsequent processes "in situ" only. Regarding the definition of loesses, the synonym represents only a partial change of composition.

Loessoid earths display similar morphology and habit as loesses but their genesis is of different character. Among the latter we rank those sediments which were formed by eolian activity and were not loessified; loessified earths of various genesis; or resedimented, usually redeposited loesses.

Loesses occupy in Slovakia an area of about 5.500 km^2. With respect to our classification there are loesses as well as loesoid earths found in the Danubian Lowland.

They form an almost continuous cover on uplands and river terrace benches of the Danube tributaries (i.e. the rivers Váh, Nitra, Žitava, Hron and Ipeľ). Thickness of loess sheets varies attaining its greatest dimension, up to 35 metres, in the central part of the upland — Trnavská pahorkatina.

The stratigraphic interpretation of loesses of the Danubian Lowland hasn't been carried out on the basis of geological methods only. During work was based also on paleontological, paleopedological, and archeological analyses issuing from geomorphological development of area and studying the inner structure and the process of sedimentation of particular stratigraphic horizons in detail. On the basis of the latter we also tried to clarify the climatic—sedimentary cycle of loess sedimentation in the Danubian Lowland.

The sedimentary and petrographic analyses showed that loesses contain minerals, which can be divided into the light and heavy fractions, according to specific gravity. Among the light fraction minerals quartz shows greatest percentual representation. It forms 31—92% of loess mass. The content of feldspars varies from 5%—33.8%. Miccas form 1—10% of the mass. Minerals of the heavy fraction form 2% of the mass only; here the greatest percentual representation show ore minerals, garnet, amphibole, zircon, apatite, staurolite, epidote, rutile. Less frequent are augite, sillimanite, tourmaline, hypersthene, and others. We studied also composition of the fine-dispersed mass — plasma, mainly quantitative representation of clay minerals.

The inner structure, relation of skeleton to plasma and other aspects of the microtexture of the main lithofacial types of loess were observed by a scanning microscope.

G/M fossil soil complex is represented by rubefied brown-earths which originated on aleuropelitic sediments. The skeleton of the sediment is formed by quartz; feldspars are not present in the skeleton. Quartz grains sre considerably corroded (Fig. 37). The plasma is usually coagulated. It shows a skelsepic and mosepic inner structure (Fig. 38).

Riss loesses do microscopically differ from older and younger loesses. They are considerably sandy. The plasma is mostly formed by montmorillonite, illite, kaolinite; the skeleton is formed not only by quartz, but also by feldspars. The skeleton grains are perfectly sorted and worked up (Fig. 42).

The Late Pleistocene in the Carpathian system begins with the R/W Interglacial, during which a polycyclic soil complex was formed on the loess substratum.

The character of sediments showed that this period was divided into several climatic phases, characterized by fluctuations and oscillations. The skeleton is of aleuritic texture. In hillwash and solifluction horizons aleuritic texture alternates with aleuropsammitic.

The minerals of the skeleton are weathered and cracked. Characteristic of illuvial horizons of these fossil soils is the zone of acicular calcite (Fig. 43). The zones of this calcite are precipitated at the lower rim of mineral grains, thus giving evidence of their epigenetic origin as product of evaporation and capillary rise of solutions in loesses. The optically oriented clay in plasma indicated that processes of inner-soil weathering were taking place in soil in situ.

The interstadial W1/2 is of mighty development. It is characterized by differentiation of the soil profile. The humus horizons have been studied microscopically. The skelet contains quartz, feldspars, micas, accessories and carbonates. The plasma does not display any marks of movement. A large number of larger and smaller pores divides the plasma into structural elements of several groups. The microaggregates are mostly rounded, separated by cavities and pores, the majority of which is intergranular. The mineral predominating is illite and fine-dispersed quartz; subsidiary minerals are montmorillonite, hydromicas and kaolinite (Fig. 44).

The loesses of the Würm stadials are typologically coincident. The majority of the loess mass is formed by a skeleton composed of quartz, feldspar, mica, carbonate, accessory grains (Fig. 45). Percentual representation of plasma, when compared to skeleton, is small. In places where thickness of loesses is greater, or at higher hypsometric levels, the number of microstructural elements in the plasma of Würm loesses, which partly envelope or at least contact larger mineral grains increases through the influence of hydrochemical processes of lithification (Fig. 47).

Through the application of new methods in tracing the texture and structure of loesses, and owing to the knowledge of their chemical properties and lithogenesis it is possible to classify more precisely the loesses or foundation soil in the engineering-geological profile. We tried to approach the result of this detailed knowledge to civil engineers and convince them that their idea of loess homogeneity is very simplified. As a matter of course, such simplified ideas, applied for geotechnical purposes bring with themselves only simple models of geological profiles. These profiles, due to unreal idealization, are not sufficiently evidenced by physical, deformation and strength characteristics. The assumption is therefore substantiated that this is the very factor that causes frequent discrepancies between the calculated prognosis and real behaviour of foundation soil. Essentially it may be said that correct determination of the calculated characteristics and precise delimitation of their validity in the frame of the created engineering-geological model of foundation soil is one of the main preconditions of reality of calculated prognoses of the reaction of foundation soil, mainly with application of matematical sophisticated methods.

As to the engineering geological body, in the second part of the book we tried to create real models of foundation soil on the territory of the Danubian Lowland distinguishing the homogeneous lithological and genetic types of loesses.

We have distinguished the following lithological and genetic homogeneous types of loess: (Würm 3, Würm 2, Würm 1, Riss 2, Riss 1 and Mindel — i.e. loesses of stadial) and fossil soil complexes: (Würm 2/3, Würm 1/2, Riss/Würm, Riss 1/2 and Mindel) Riss — i.e. loesses of interstadials and interglacials). In distinguishing we concentrated mainly on the quality of the complex of geological properties, such as the genesis, age, texture, structure, mineralogical composition, etc. As regards the proved continuity of geological properties with physical or mechanical properties of loesses we may consider the distinguished types as homogeneous also from the view-point of physical and mechanical properties.

Grain size composition of loesses and fossil soil complexes is relatively monotonous and not completely corresponding to general nations of grain size of typical loesses in Europe. The loesses in the Danubian Lowland have a higher value of the median *Md*, and a negative coefficient of asymmetry, α_φ; sorting of grains evaluated by means of S_o or τ_φ is lower. In grain size composition the aleuritic fraction — 55—65% predominates (in average values). The content of clay fraction varies from 21,7 to 31,8%, and of sandy fraction from 11,6% to 15,4% (in average values). Essentially, a regular change in grain size due to age and conditions of loess genesis may be stated. On the contrary, neither areal nor depth zonality has been verified. The graphical and numerical presentation of grain sizes is given in Tables 7 and 8 and Figures 49 to 53.

On the basis of the Terzagi's plasticity diagram (Fig. 54) the loesses of the Danubian Lowland correspond to inorganic clays of low to medium plasticity. Only Mindel loesses are higly plastic. The average values of liquid limit, W_L, and plasticity number, I_p, are given in Tables 9 and 10. The interglacial and interstadial loesses affected by pedogenetic processes of weathering in the process of their development are characterized by plasticity values that are relatively higher than those of stadial loesses.

The average values of natural humidity, W_N, vary from 13.2 to 18%, with humidity increasing from younger to older loesses that are typical of stadial loesses. This tendency was not observed in interglacial and interstadial loesses, which had average values of humidity roughly at the level of 17.3% (±0.6%) (Figs 57 and 58 and Tab. 12).

According to consistency number, I_C, stadial, interstadial and interglacial loesses of the Danubian Lowland are mostly stiff and solid, however, sporadically also hard or soft (Tab. 13).

The degree of saturation, S_N, varies from 40.0 to 81.1% on average; interglacial and interstadial loesses display higher average values. In stadial loesses the increasing tendency of average values, S_N, with increasing age and depth of deposit has been stated (Tab. 14).

The range of average values of volume weight of dry earth, ϱ_D, of loesses in the Danubian Lowland was established from 1.50 g . cm^{-3} to 1.67 g . cm^{-3}. Comparing the average values given in Tables 16 and 17 we can observe their increasing tendency in direction from loesses of the Würm 3 (i.e. youngest) to the Mindel (i.e. oldest).

Porosity, as characteristic property of loesses, is conditioned by the occurrence of macropores. In professional literature the concept of macropores is interpreted in various ways. For the purposes of porosity study of loesses in the Danubian Lowland we consider optimal the classification of macropores on the basis of genesis, time factor and according to composition. According to genesis we distinguish the phylogenic, coagulation — crystallization, pedogenic, gaseous and suffose macropores. According to the time factor, the primary and secondary, macropores, and according to composition, unstable macropores in unstable structures, unstable macropores in stable structures, weakly stabilized primary and secondary macropores and stable primary and secondary macropores of various origin may be distinguished.

In Table 18 the average values of porosity, *n*, are given for the distinguished homogeneous types of stadial and interstadial, or interglacial loesses with percentual representation from 38.5 to 45.2%. The average values display a sinking tendency from Youngest Würm loesses to those of the Riss and Mindel. The maximum values of porosity do not exceed 50% and minimum ones are higher than 33%.

The content of carbonates, O_u, in loesses of the Danubian Lowland is very variable (Tab. 19). This variability is conditioned mainly by the mode of occurrence. Carbonates in loess are inequably scattered, mostly in form of bizarre new forms — loess dolls, coatings, needles and concretions, which are often concentrated in zones. It has been proved that the carbonate component consists not only of calcium carbonate but also of dolomite and aragonite. The least share of dolomite component have Early Würm loesses; loesses of the Würm 1 and Würm 2 show the highest content of dolomite component. The presence of montmorillonite-group minerals and clay mica, as well as of chlorite-group minerals and quartz. In insoluble residues of carbonates was proved by derivatographic analyses. Enrichment of loesses with carbonates may be explained by the so-called neutral carbone process. Micro- and macroscopical enrichment with secondary carbonates can be observed in fine fractions together with formation of carbonates in fine- to coarse-sandy fraction.

Re-settling of loesses in the Danubian Lowland was observed by the so-called one-curve method and is expressed by the value of the re-settling coefficient, I_{mp}. When we use the criterion of re-settling, $I_{mp} > 1\%$, then mainly loesses of the Würm 3/$I_{mp} = 2.17\%$, of the Würm 2/3 and of the Würm 2 may be considered re-settling. Taking into account the maximum values, then re-settling can also occur in

loesses of the Würm 1/2 and the Würm 1. Riss and Mindel loesses will probably not be re-settling (Tab. 23). In this case, the re-settling process is conditioned by high porosity ($n > 42\%$), humidity ($W_N < 13\%$), degree of saturation ($S_N < 46\%$), content of clay fraction (<14%) and by the number of plasticity ($I_p < 14.5$). In evaluating the re-settling through oedometric tests, it is necessary to take into regard also the way of sampling (outcrop, blind shaft, borehole, monolith, drill core in metallic casing) which has considerable influence on the final result (Tab. 24).

According to the notions obtained through a complex study of the properties of loesses in the Danubian Lowland, re-settling is mainly a function of compactness and structural bonds, in which the main role should be ascribed to clay plasma and capillary adhesive forces.

The average values of the oedometric moduli and of the effective and total sliding parameters for the distinguished types of loesses are given in Tables 25, 26, 27 and 28. Correlations of the properties mentioned to physical properties are shown in Figures 83 to 95.

In geotechnological utilization of loesses as foundation soils it is necessary to foresee the possility of their re-settling and to precede their activation introducing preventive or active measures, which reduce or completely eliminate the possibilities of re-settling. The following measures are considered preventive: suitable dimensioning of sewerage and water pipeline; effective surficial drainage; securing of excavation pits against accumulation of water; effective isolation against penetration of water from the object into underfoundation; reduction of contact voltage, etc. These measures do not eliminatere-settling but reduce considerably the risk of re-settling activation. Among active measures belong: surficial compacting by heavy plates; deep compacting by vibration; moistening; ramming; hydraulic obturators and underground explosions; thermal, and chemical hardening of loesses, and others.

Analyses of the causes of destruction of loesses in the Danubian Lowland revealed that the most frequent cause of destruction of objects was the change in loess structure, evoked by higher content of water, tremors, caving of underground galleries, material pits and combined causes. Through field surveys it was possible to distinguish the following 6 grades of destructions:

Grade I — represents destruction of objects through hair cracks (up to 0.5 cm), which are not activated further;
Grade II — inactive fissures (0.5—1.0 cm) in objects;
Grade III — unstable active fissures (1—3 cm) — repair of objects affected should follow as soon as possible;
Grade IV — unstable active fissures (3—6 cm) — reconstruction of objects affected is necessary and protecting measures are to be taken;
Grade V — active fissures (6—12 cm) — immediate sanitation of objects necessary, danger of destruction;
Grade VI — represents complete destruction of parts or of the whole object.

GEOMORPHOLOGY

A meeting of the Loess Commission will be held as part of the 1st International Conference on Geomorphology. The conference will be held at Manchester, England - 15-21 September 1985. For more details of the Geomorphology Conference see LL11 pp. 26-27 or contact Professor Ian Douglas, School of Geography, University of Manchester, Manchester M13 9PL, England. For more details of the Loess Commission meeting contact Professor Edward Derbyshire, Geography Department, University of Keele, Keele, Staffordshire ST5 5BG, England.

Reprinted from International Karakoram Project Volume One
edited by K J Miller

printed at the University Press, Cambridge

The loess of Tajik SSR

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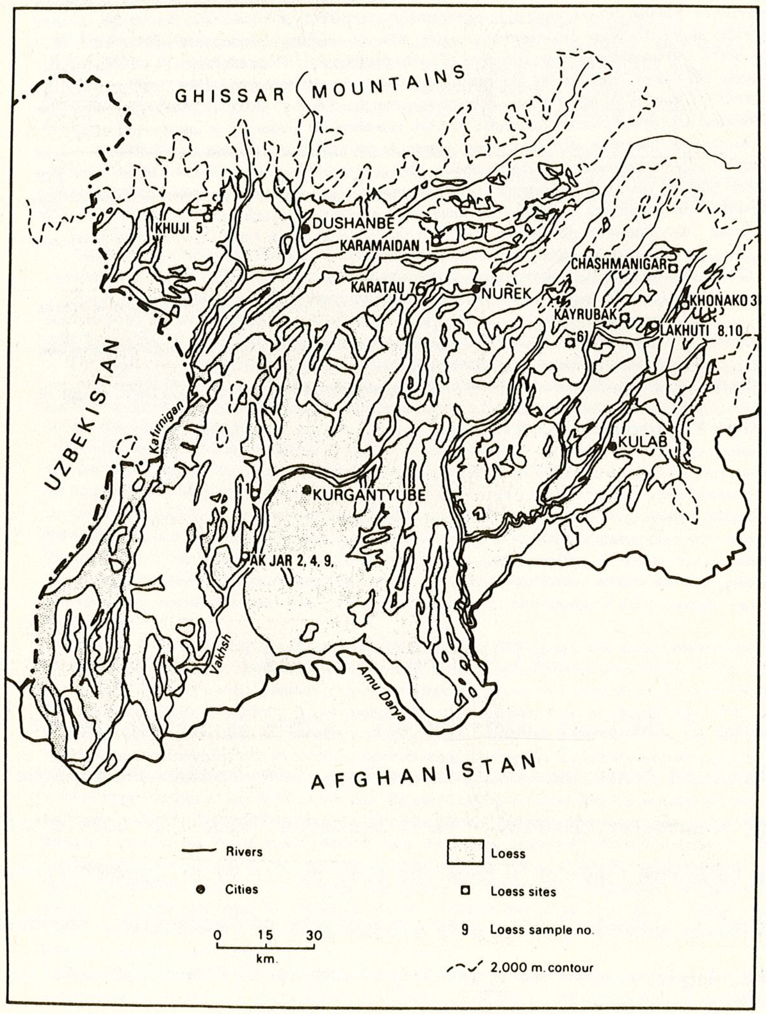
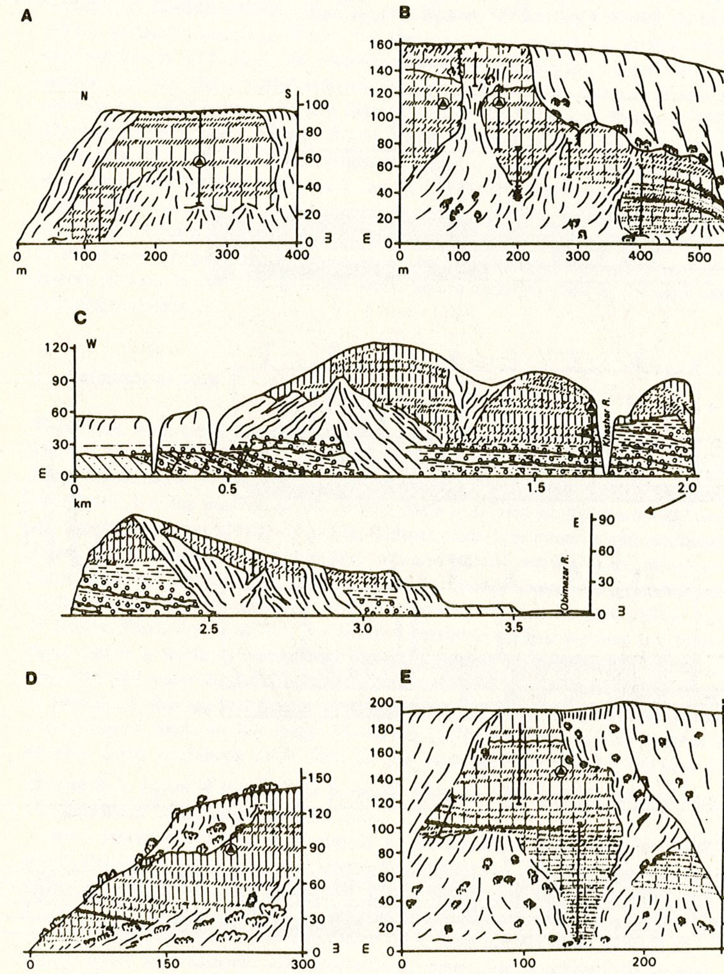


FIG. 1. DISTRIBUTION OF LOESS IN TAJIKISTAN AND LOCATION OF LOESS SAMPLES

ABSTRACT

The loess of the Tajik SSR is some of the thickest on Earth and contains many late Pliocene and Pleistocene palaeosols that Soviet workers have dated by palaeomagnetic and thermoluminescence methods. Grain size, chemical and mineralogical data are presented together with analyses of grain characteristics (shape, roundness, surface texture) determined by scanning electron microscopy.



Palaeosols are represented by diagonal shading.

MODIFIED FROM DODONOV et al (10)

FIG. 2. SELECTED LOESS SECTIONS FROM TAJIKISTAN: A. KHONAKO I, B. KHONAKO II, C. LAKHUTI, D. KAYBRUBAK, E. CHASMANIGAR.

INTRODUCTION

Tajikistan, part of Soviet Central Asia, has a southern frontier with Afghanistan and is bounded on the north by the Ghissar mountains and on the east by the Pamirs. The southern part of Tajikistan has, for much of the Tertiary and Quaternary, been an area of aggradation, and the subaerial aggradation sequence contains alternations of buried soils and loess deposits which provide climato-stratigraphic information extending over the last 1.5 to 2 Ma. Soviet workers have studied these sections intensively and have undertaken palaeomagnetic and thermoluminescence dating of the sequences, together with pollen analysis. In September 1979 observations of these sections were made by two of the authors and representative samples were collected (see Fig. 1 and Table 1). Most of the sites lie at about 1400 - 1900 m above sea-level, and much of the land below about 2000 m has a loess cover.

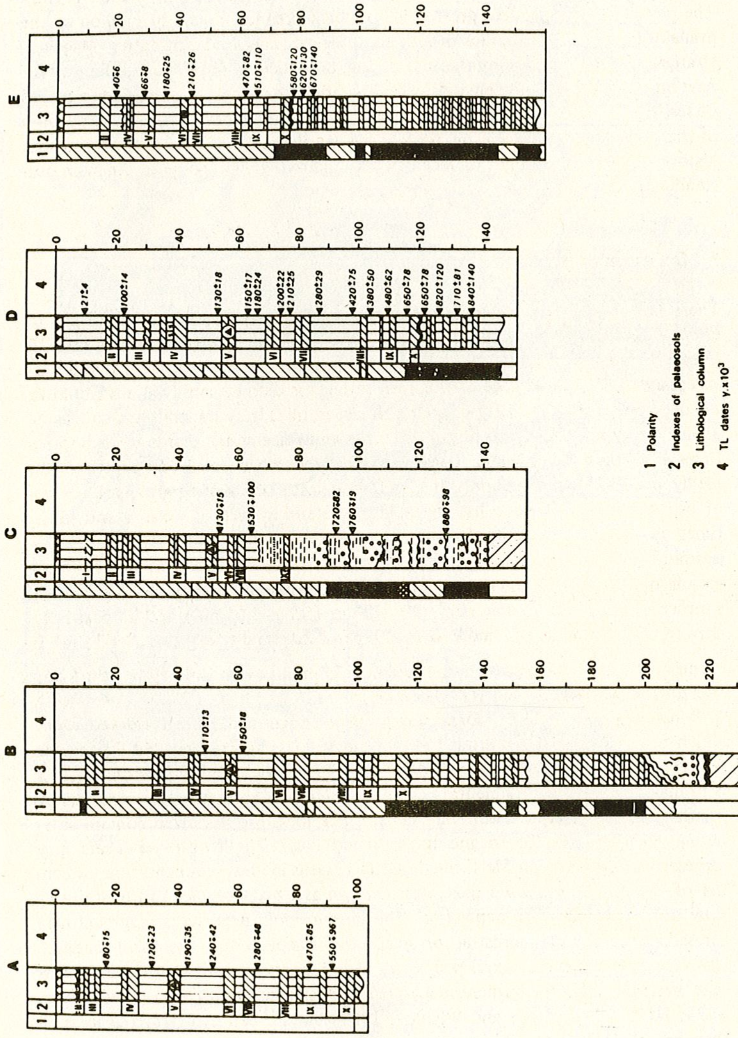


FIG. 3. DATED LOESS AND PALAEOSOL PROFILES OF SECTIONS PORTRAYED IN FIGURE 2 MODIFIED FROM DODONOV et al (10)

Volume 8 Number 2 June 1984 176

Progress in Physical Geography

Loess

by Kenneth Pye

Loess has been studied scientifically for almost two centuries and there is now a voluminous multidisciplinary literature on the subject. Smalley (1980a) has compiled a partial bibliography of loess but there are few textbooks in English which deal exclusively with loess. An edited collection of earlier papers is contained in Smalley (1975). Other useful volumes reporting more recent research in various parts of the world are Schultz and Frye (1968), Pecsi (1979) and Wasson (1982). The past 10 years have seen great strides in loess research, in part spurred on by the availability of new techniques of sedimentological analysis and of dating. Magnetostratigraphy and thermoluminescence dating, in particular, have opened the way for new interpretations of the environmental significance of loess and provided a means of testing a number of long-standing theories concerning loess genesis. The purpose of this review is to provide a summary of the distribution, nature and environmental history of loess in the light of recent work, and to highlight some of the main outstanding problems.

I Definition of loess

There have been many attempts to define loess (derived from the German *löss* or *lösch* = loose) and no single definition, including that proposed by the INQUA Loess Commission (Fink, 1976; Lill and Smalley, 1978), has gained universal acceptance. For the purpose of this review, loess is defined simply as a windblown silt deposit consisting chiefly of quartz, feldspar, mica, clay minerals and carbonate grains. Heavy minerals, opal phytoliths, salts and volcanic ash shards are also sometimes important constituents. Loess is typically homogeneous, non-stratified and highly porous. Most commonly it is buff in colour, but may be grey, yellow, red or brown. When dry, loess has the ability to stand in vertical sections and sometimes shows a tendency to fracture along systems of vertical joints, but when saturated with water the shear strength is greatly reduced and the material is subject to subsidence, flowage and sliding. The grain size distribution of typical loess shows a pronounced mode in the range 20–40 μm (5.70–4.65 phi) and is positively skewed. Loess containing more than 20 per cent sand-size grains (>63 μm) is defined here as *sandy loess*; if the sediment contains more than 20 per cent clay (<2 μm) it can be described as *clayey loess*.

Wind-deposited *primary loess* should be distinguished from *reworked loess*, which consists of material eroded from primary loess and redeposited by running water and slope processes (Yaalon and Dan, 1974; Sneh, 1983). *Weathered loess* is primary loess whose sedimentary characteristics have been markedly modified by weathering, soil formation and diagenesis. Thick loess profiles often contain alternating layers of weathered and unweathered loess. The weathered layers may represent a single soil profile formed during a hiatus in loess sedimentation, or consist of several superimposed palaeosols (known as a *pedocomplex*) formed during slow or intermittent dust deposition. The term *loessoid* deposits is suggested here for sediments or soils consisting of a mixture of aeolian dust and other material. The mineralogical and textural properties of sediments in many desert fringe areas have been significantly influenced by aeolian dust deposition (Yaalon and Ganor, 1973; 1975; 1979; Smith and Whalley, 1981) but are better regarded as loessoid than as 'true' loess. *Loess-like* deposits are sediments which possess many of the sedimentological properties of aeolian loess but which have not been deposited by wind. They include overbank alluvial silts, lacustrine silts and some colluvial slope-wash deposits. Such sediments have previously been referred to, particularly in the Soviet and European literature, as 'alluvial loess', 'colluvial loess', 'proluvial loess' or 'deluvial loess', but in the interests of clarity the term 'loess' should not be used for non-aeolian deposits. Loessite is a term originally proposed by J.B. Woodworth to describe lithified loess rock in the sedimentary record. As yet, few ancient loessites have been positively identified (Edwards, 1979).

II Loess distribution

The thickest and most extensive loess blankets are found in China, Soviet central Asia, the Ukraine, Siberia, central Europe, Argentina and the Great Plains of North America (Figure 1). In China, the thickest and most extensive deposits occur in the north-central part of the country (Figure 2), particularly on the Loess Plateau of Shensi, Shansi and Gansu provinces, where loess covers more than 300 000 km^2 (Barbour, 1927; 1935; Liu Tung Sheng and Chang Tsung Yu, 1961; Derbyshire 1978). Significant deposits also occur in northwest China and in Mongolia (Krylkov, 1982).

In Soviet central Asia, loess deposits occur in a broad belt extending from Kirghiz SSR and Kazakhstan, through Uzbekistan and Tajikistan to Turkmen SSR (Penck, 1930; Mavlyanov, 1958; Lukashev *et al.*, 1968; Dodonov *et al.*, 1977). Loess covers extensive areas of the Ukraine and south Russian Plain (Ivanova and Velichko, 1968; Gerasimov, 1973; Zolutun, 1974; Kraev, 1975; Veklich, 1979) and is found in Siberia around Lake Baikal and the Lena, Ob and Yenesei rivers (Péwé *et al.*, 1977; Péwé and Journaux, 1983). The Ukraine loess belt extends westwards into the Baltic socialist republics and into Poland, East Germany, West Germany,

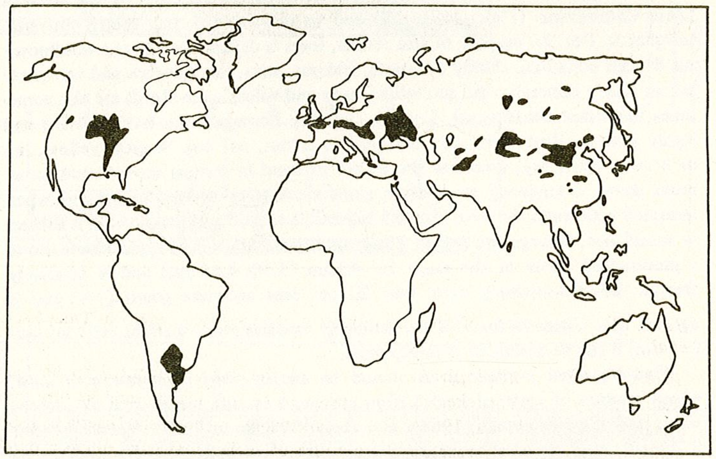


Figure 1 Global distribution of major loess occurrences.

France and the Low Countries (Mojski, 1968a; 1968b; Brunnacker, 1968; Lautridou, 1977). Major deposits are also found in the Danube Basin of Czechoslovakia, Austria, Hungary, and Rumania (Smalley and Leach, 1978; Fink, 1968; Lozek, 1968a; 1968b; Pecsi, 1968). In Britain, true loess occurs only in a few isolated pockets, chiefly along the south coast (Pitcher *et al.*, 1954; Weir *et al.*, 1971; Harwood *et al.*, 1973; Catt and Staines, 1982) and in northwest England (Lee, 1979; Lee and Vincent, 1981; Vincent and Lee, 1981). Elsewhere in Britain, loess is

mainly weathered, reworked or mixed with non-aeolian material (Catt, 1977; 1978; 1979; Lill and Smalley, 1978; Avery *et al.*, 1982; Perrin *et al.*, 1974; Burrin, 1981).

The largest area of loess in North America forms a belt south of the Great Lakes and extends from the Rocky Mountains to western Pennsylvania, with a southern extension along the Mississippi River valley into Louisiana (Thorp and Smith, 1952; Figure 3). Smaller deposits are found in Washington and Oregon, New Mexico, Texas and Alaska. In South America significant loess deposits are restricted to the *pampas* region of Argentina (Teruggi, 1957). There are localized occurrences in Israel (Ginzbourg and Yaalon, 1963; Yaalon, 1965; Ginzbourg, 1971), Iran (Fookes and Knill, 1969), Iraq (Kukal and Saadallah, 1973) and New Zealand (Young, 1964; 1967; Bruce, 1973a; 1973b; Selby, 1976; Milne and Smalley, 1979). True loess is rare in Australia and Africa. Small occurrences of carbonate loess have been recorded in Victoria (Gill, 1973; Gill and Segnitt, 1982) and relatively thin deposits of clayey loess ('parna') occur in New South Wales, Victoria and South Australia (Butler, 1956; 1974; Walker and Costin, 1971;

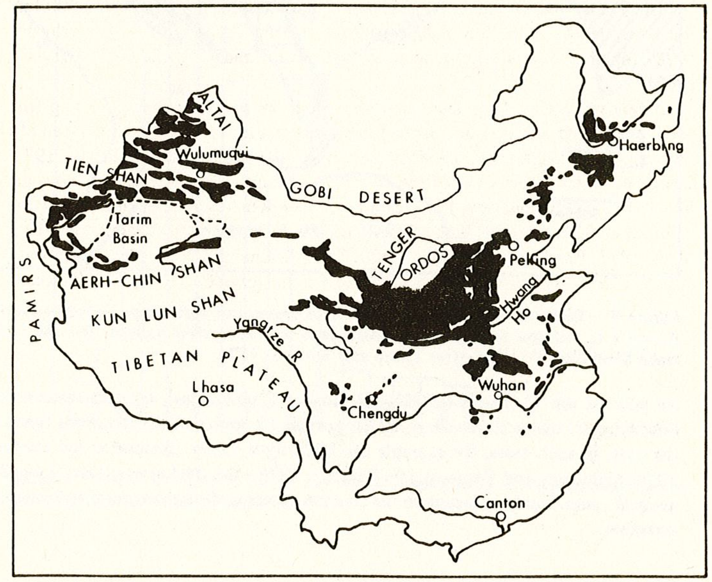


Figure 2 Distribution of loess in China (partly modified from Liu Tung Sheng *et al.*, 1982).

Blackburn, 1981). In North Africa, much of the material reputed to be loess (Rathjens, 1928; Brunnacker, 1973) appears to be fine aeolian sand or silty sand (Smalley and Vita-Finizi, 1968). The so-called loess of northern Nigeria is also a sandy silt and probably represents a mixture of aeolian and non-aeolian material (Smith and Whalley, 1981). Mixtures of relatively thin loess and loessoid deposits are found in the semiarid lands of Pakistan (Kusumgar *et al.*, 1980), Afghanistan (Bal and Buursink, 1976; Pias, 1971) and northwest India (Agrawal *et al.*, 1979).

Loess typically occurs as a blanket, covering a variety of relief forms including river terraces, pediments, alluvial fans, steep mountain slopes, and infilling intermontane basins. Loess deposits occur near sea level in northwest Europe and at altitudes of more than 2000 m in central Asia and China. The thickest loess sequence so far recorded in the literature (335 m) is near Lanzhou on the Loess Plateau of China (Derbyshire, 1983a). In central Asia thicknesses in excess of

150 m are common (Dodonov *et al.*, 1977; Davis *et al.*, 1980). In the Danube Basin, Argentina and parts of the Great Plains, thicknesses occasionally exceed 60 m, but 20–30 m is more common. Elsewhere loess sequences are generally less than 30 m thick.

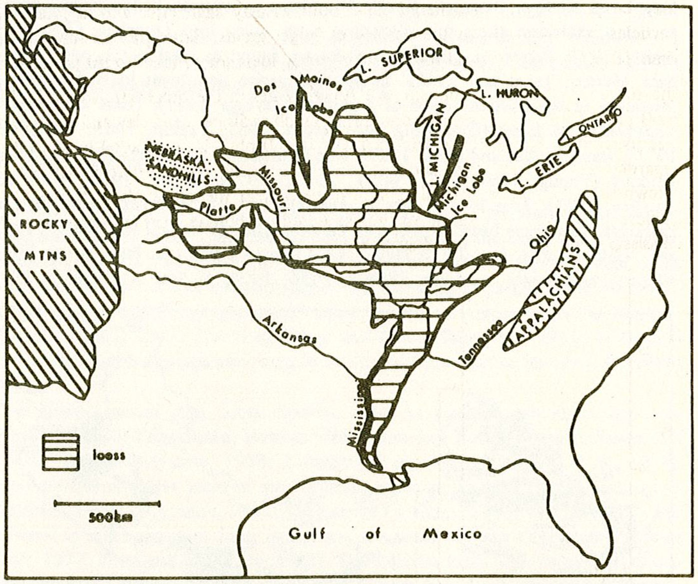


Figure 3 Distribution of loess in the Great Plains and Mississippi Valley of North America in relation to major late Pleistocene ice lobes, river valleys, and the Nebraska Sandhills. Modified after Thorp and Smith (1952).

As pointed out by Penck (1930) and Smalley (1972), many loess deposits occur downwind of major river valleys which provided a source of silt at various times in the past. In such cases, for example the Mississippi Valley (Simonson and Hutton, 1954; Krinitzsky and Turnbull, 1967; Handy, 1976), the thickness of loess is usually greatest immediately adjacent to the riverine source and decreases in the downwind direction.

III Physical and chemical properties of loess

Table 1 Range in the median size of loess reported in the literature. (Methods of pretreatment and analysis vary so data are not exactly comparable.)

Area	Range in median size (phi)	Average (phi)	sample size	Authors
Nebraska	4.42–4.56	4.47	4	Swineford and Frye, 1951
Kansas	4.29–5.59	5.00	43	Swineford and Frye, 1951
France	4.85–6.55	5.59	4	Swineford and Frye, 1955
Germany	4.95–5.70	5.29	8	Swineford and Frye, 1955
Argentina	4.00–5.10	4.38	12	Teruggi, 1957
Yakutia	4.18–6.88	5.10	26	Péwé and Journaux, 1983
New Zealand	4.40–6.35	5.51	33	Young, 1964
Mississippi	4.99–5.93	5.76	42	Snowden and Priddy, 1968
Tajikistan	5.70–6.93	6.31	11	Goudie *et al.*, in press
China	5.10–7.15	6.36	12	Derbyshire, 1983c

1 *Grain size*

The grain size of loess varies in different parts of the world (Table 1), but in general silt (2–63 μm) comprises 50–80 per cent of the sediment. Up to 20 per cent clay may be present in unweathered loess both as clay aggregates and as individual particles which adhere to the surface of larger grains. Sand grains comprise less than 10 per cent of typical loess, but in sandy loess may make up 40 per cent of the total sediment. The median size typically lies in the range 20–40 μm (5.75–4.60 phi). Weathered loess can contain as much as 50 per cent clay and the median size usually lies in the range 15–35 μm (6.0–5.0 phi). Unweathered loess is often regarded as a poorly sorted sediment with phi sorting values between 1.0 and 3.0 Skewness, which is almost always positive, lies in the range +0.30 to +0.70. A typical grain size histogram of unweathered carbonate-bearing loess from the Mississippi Valley is shown in Figure 4.

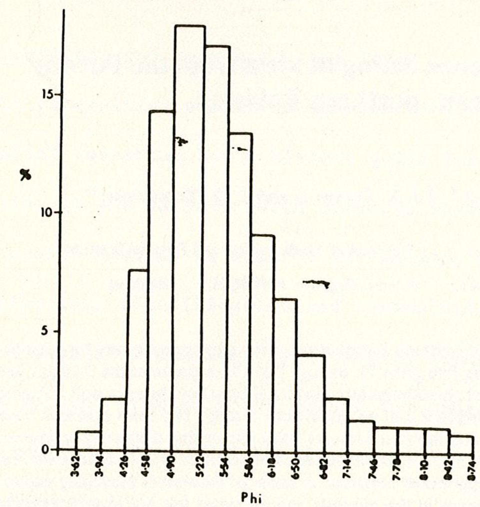


Figure 4 Grain size histogram of carbonate-bearing loess from Mississippi (determined by Coulter Counter analysis).

ENGINEERING GEOLOGY

A special issue of the journal 'Engineering Geology' is being produced which will be devoted entirely to papers on practical aspects of loess research. The editor of this special issue is Dr. Alan Lutenegger, Department of Civil and Environmental Engineering, Clarkson College, Potsdam, New York 13676, U.S.A. - papers or enquiries should be sent to him.

PACT

9 1983

Revue du groupe européen d'études pour les techniques physiques, chimiques et mathématiques appliquées à l'archéologie

Journal of the European Study Group on Physical, Chemical and Mathematical Techniques Applied to Archaeology

THIRD SPECIALIST SEMINAR ON TL AND ESR DATING

Helsingør (Elsinore), Denmark, 26-31 July 1982

Thermoluminescence dating of loess from the Potwar Plateau, northern Pakistan

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Abstract

The loess deposits of northern Pakistan present a good opportunity for establishing a chronology using fine grain TL dating. The TL response of the 2-10 µm size fraction of polymineral (predominantly quartz/feldspar) mixtures is well behaved with linear dose-dependence and no anomalous fading. The loess horizons have very similar uranium and thorium contents, thus minimising dosimetry problems, and the fairly arid climatic conditions reduce the errors in water content estimation, at least for the uppermost horizons. A series of laboratory bleaching experiments reveal uncertainties in the absolute age estimates but not in their relative values.

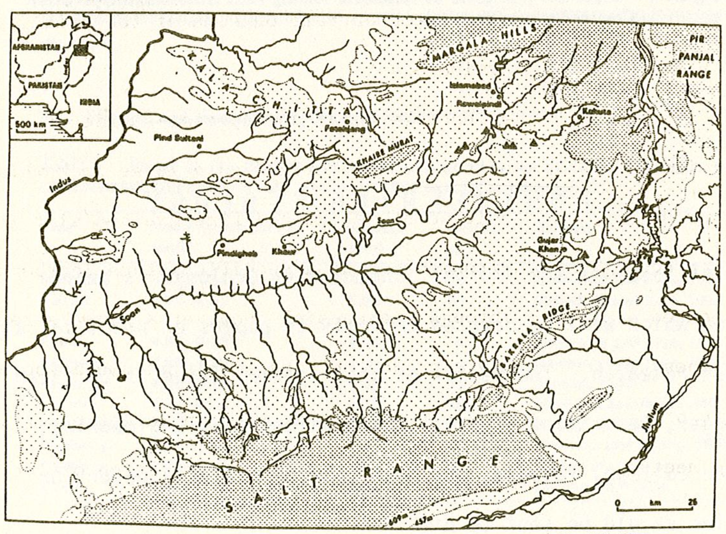


Fig. 1. Potwar Plateau, northern Pakistan

CONTEMPORARY PROBLEMS OF LOESS RESEARCH REFLECTED BY THE ACTIVITY OF THE INQUA COMMISSION ON LOESS

by

Márton Pécsi

Extracts from a paper delivered at the meeting of the Geotechnical Working Group during the International Geological Congress, Moscow 1984.

I. <u>Chronology and terminology of loess</u>

1. The recognition and investigation of loess as a Quaternary subaerial formation has a history going back nearly 150 years. Although the various Earth Sciences have achieved substantial research results as regards the origin, evolution, global distribution, identification and chronological subdivision of loess the number of problems to be solved seems to be increasing. This is evident from both the number and rising standard of investigations as well as from the increase in the number of new questions being asked.

Here we wish to concentrate on some of the principal problems of loess terminology.

In manuals, encyclopedias and special studies describing its lithology loess is characterized as a loose rock which after subaerial deposition of medium and fine grained silt in a given ecological environment gains a specific porous /carbonate/ cemented structure through diagenesis. However a given stratum of loess is not merely a product of the simple accumulation of dust or silt and it is to be regretted that in recent papers one can meet such inaccurate definitions as "accumulation of loess deposits", "deposition and accumulation of loess" and "loess accumulate on ...". But such definitions are not only attributable to inaccurances for according to some authors accumulations of dust or silt in all circumstances result in the formation of a loess stratum. On the other hand it is well known that in the most important vertical sections loess strata intercalate with buried soils and other sand and clay deposits of subaerial origin. Consequently the deposition of dust or silt is not always followed by the formation of loess. This fact has recently been emphasized by K. Pye /Loess Letter No. 11, 1984/ who states that: "If the rate of dust deposition is low, syndepositional weathering will be pronounced and the ultimate result will be a clay-loam soil". In other words given the right climatic and environmental conditions buried /fossil/ soils may have originated directly from slowly accumulating mineral deposits rather than from soil forming processes during on a previously formed loess stratum.

A more exact interpretation and explanation of loess series and associated fossil soils is also indispensable for absolute dating purposes. Both in Europe and Asia true loess formations are underlain by fossil soils and loam deposits, which in turn according to some specialists were formed postgenetically from loess.

Whether such subaerial formations should be regarded as a sequential part could be proved by investigation into their time of development.

In recent years a number of characteristic loess profiles of the European and Asian loess zone have been analyzed by absolute chronological methods. For most of the repeated paleomagnetic analyses the lithologically sensu stricto true loesses are not

hardly older than the Jaramillo event /0.9 m.y.B.P./.

In certain regions there are underlain by a subaerial formation differing both petrologically and pedologically from true loess formations. Its thickness is considerable but uneven and it consists of sequence of predominantly pale pink, reddish, brownish-reddish, sometimes gleyed clays, loams, silty clays and paleosols. The different paleosols are separated from one another by partly weathered sandy or clayey silts of similar colour. This formation differs from loess proper and consisting mainly of paleosols has been turned a "loess-like" formation or "loess-derivate" by some authors. Based on paleomagnetic investigations the formattion of this group including predominantly paleosols, red and mottled clays and silts can be traced back to the middle /1.8 m.y. B.P./ and early /2.4 m.y.B.P./, Matuyama respectively, or occasionally as far as the Gauss epoch /Gauss-Gilbert boundary, 3.4 m.y. B.P./.

2. For the investigation of the many-sided problems of loess a Subcommission on Loess Stratigraphy under the leadership of Prof. J. Fink was formed within the INQUA Commission on European Stratigraphy in 1961. At the time the problems of loess chronology and typology were to the fore and an independent Commission on Loess was established at the INQUA Congress in Paris in 1969. Since then loess research coordinated and directed by the Commission has been extended to loess regions outside Europe leading to the establishment of two regional working groups in 1973 -- the Working Group on Western Hemisphere Loess and the Working Group on Pacific Loess. Research however remained focused on chronology and the preparation of the Loess Map of Europe until the Birmingham

Congress of 1977, since when the Commission's attention has turned more towards geotechnical investigations. These efforts have not only been aimed at widening the international research programme but also at increasing the number of experts involved and the users of the research results. The involvement of environmental geology and soil mechanic research in the activities of the Commission is not only serving the international exchange of views but also has practical applications.

II. Main practical relations of loess research

The loess regions of the Earth have played a considerable role in sustaining the population and even recently these regions coincide with the most populated areas.

The loess regions provide favourable natural conditions for agricultural production and in many places the loess has been used as a building material.

As a result of technical activity and agricultural production loess is easily erodable, generally it is compacted under buildings and its durability is being degraded in this way. Therefore, the investigation of loess and of its soil cover has practical applications which include maintaining and increasing agricultural production on the one hand and establishing and ensuring the operation of economic and technical establishments, on the other.

Practical loess research from an engineering point of view has therefore inevitably become more important for the following reasons.

1. From the practical point of view the critical property of loess is manifested in the fact that the rock-forming fine-detrital minerals are cemented /by lime/, giving it a porous uncompact structure. Different bonds are present in the pores water in addition to air, and these factors decisively affect its stability.

   Consequently, among the true loesses and loess-like formations the loess category that behaves critically from the engineering-geological point of view, should be distinguished. This classical variety of true loess should be distinguished by means of physical and chemical parameters from the loess-like deposits being not of critical behaviour from other engineering aspects. This is all the more needed, since experts dealing with the genetics of loess include ever more loess-like varieties into the category of "loess formation".

2. The investigation of the lithological structure and different types of loess is necessary for the agricultural production because of their relation to the fertility and erodability of loess soils.

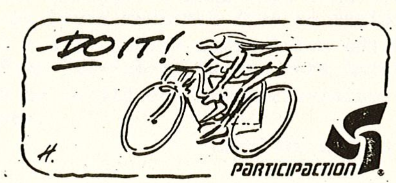
3. Some loess types are more abundant in nutrients and therefore the analyses and mapping of the physical, chemical and pedological characteristics of the loess and loess-like sediments are closely connected with agrogeological investigations.

4. For the most part empirical observations and a limited number of measurement figues have been used to explain the relations between soil erosion and the cultivation method /i.e.: irrigated land use/. Thus, the way of cultivation must be fitted to the natural ecological equilibrium of the surface.

5. The dynamic changes /strength, collapse, slide, compaction, solution and mechanical suffosion, gully erosion of loess etc./ in the loess forms and loess areas due to the effects of natural processes and the economic-technical activity, present a multifold research task for engineering geology. Accurate engineering-geological and soil-mechanical investigations of the physico-mechanical, dynamic and even the seismic features of the loess areas and loess strata are indispensable for planning and construction engineers.

The number of papers dealing with practically oriented loess research has been increasing in the last decade. Recently complex investigation and practical evaluation of the natural characteristics and economic utility of loess have become a major concern in regional planning and construction.

These various developments brought two new working groups into existence at the last INQUA Congress held in Moscow, in 1982, namely the Working Group on the Geotechnical Properties of Loess and the Working Group on the Geochemistry and Environmental Chemistry of Loess. The first deals with problems concerning engineering geology and soil mechanics, while the latter concentrates on the investigation of chemical and toxic processes taking places within loess. Both working groups elaborated objectives to be attained and prepared detailed plans of activities.



III. Lithological classification of loess types and investigation of standard loess profiles

1. Unfortunately the preparation and publication of the Loess Map of Europe has been delayed and this has hindered the formulation of an unambigous loess terminology. The criteria and parameters for the identification and differentiation of the most significant genetic and litological types have not yet been worked out, and there together with the general question of ampping should be based on the exchange of experiences at the international level. Up to now research methods on the origin, lithology and soil mechanics of loess have not even been coordinated within countries. Professor E. Derbyshire has submitted a proposal to the Commission on this matter, and his suggestions entitled "The genetic classification of loess, criteria for recognition and differentiation of genetic types" are welcomed as a useful and timely undertaking. The successful conclusion of this task would be furthered by involving as many researchers as possible.

2. Investigations into loess chronology are regarded by the Commission as an important task since loess series play an important and indispensable role in the subdivision of the Quaternary. Accomplishment of this task again necessitates international cooperation and as a first step verified type profiles should be selected within each main loess region. Comparisons among these key sites should be based on similar parameters using the most sophisticated methods and international teams should also be organized for the chronological lithological investigations of some of the sections. Research into loess stratigraphy naturally includes the classification of genetic and lithological types on the basis of uniform

criteria.

IV. Publications

1. By means of regular and special publications the Commission is trying to provide opportunities for the establishment of regular international contacts and an exchange of experiences and it is in this context that Loess Letter edited by Dr. I. Smalley is published twice yearly. The staff of the Commission and the editor now intend to widen the editorial board so as to enlarge the information basis of the journal.

2. It is proposed to publish the papers presented at the regular meetings as well as the guides of field excursions organized by the Commission as a special series of publications. The Commission also encourages the organization of symposia at INQUA Congresses and the publication of the proceedings. The most recent volume is that containing the papers presented at the "Loess and Paleosols" symposium held during the 11. INQUA Congress and was published in Budapest in 1984.

3. The publication of a multi-lingual loess dictionary is also a high priority, while the issue of national and international bibliographies is now under way and is highly appreciated, the publication of the Loess Map of Europe. There is a suggestion concerning the preparation of a loess map of the world.

V. Activity of the Commission on Loess between 1982-1984

1. Following the INQUA Congress held in Moscow the re-organized staff of the Commission /vice-president: Professor K. Brunnacker, secretary: Dr. J.P. Lautridou/ and the newly founded two working groups on the Geotechnical Properties of Loess /convener Dr. Kriger N.I./ and on the Geochemistry and Environmental Chemistry of Loess /convener Professor O. Franzle/ began their activities and complete the Commission's network. Beside the six elected regular members about 100 corresponding members have been invited to participate and a list of about 150 loess researchers is being compiled.

2. The five-year research programme of the Commission and working groups was finalized by the middle of 1983 through personal meetings and correspondence /Circular No. 1/1983/. The president was able to confer with the vice-president and secretary when they visited Budapest in 1983 and simultaneously able to study Hungarian loess.

Two business meetings[x] have been organized for 1984 -- at the 27th IGC in Moscow[1] and at the 25th IGU Congress at Paris[2]. As part of the preparations for this meetings the president personally consulted with Dr. Kriger N.I., convener of the WG on Geotechnical Properties of Loess and with the vice-president Professor K. Brunnacker during visits to Moscow and the FRG. The main topic discussed at the latter meeting was concerned with the organization

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[x]Papers to be presented at these sessions:

[1]M. Pécsi: Contemporary problems of loess research reflected by the activity of the INQUA Commission on Loess.

N.I. Kriger: Problems of the engineering-geological studies of loess and activity of the WG on Geotechnical Properties of Loess.

[2]M. Pécsi: Information on the actual tasks of the INQUA Commission on Loess.

J.P. Lautridou: Investigation of the extreme Western Loesses of Europe.

and scientific problems of Commission meetings planned for the symposium and field excursions to be held at the forthcoming INQUA Congress in Canada in 1987 was also discussed.

3. Under the leadership of the president an editorial board was formed in Budapest in the autumn of 1982, for the publication of the proceedings of the "Loess and Paleosols" symposium held during the INQUA Congress in Moscow. It was disappointing that most authors were rather late in submitting final versions of their contributions some of which were not entirely ready for the printers. Two-thirds of the papers were submitted in English, and the remainder were either in Russian or German. Given to the difficulties that arose about the publication of non-English texts most of the latter had to be revised in the course of translation and the figures re-drawn.

4. The Loess Letter, information brochure of the Commission edited by Dr. I. Smalley appeared four times /LL No. 8-11/ between 1982--1984 and five supplements were also issued. Regular and corresponding members of the Commission are requested to enrich this information base with sending in proposals, short reports and the results of investigations of common interest.

5. The following important proposals have been launched as part of the programme of the Commission and their realization is strongly supported:

   - Investigation of the extreme Western loesses of Europe proposed by J.P. Lautridou;
   - The genetic classification of loess, criteria for recognition and differentiation of genetic types -- by E. Derbyshire;

   - Sources and distribution of loess material in North America -- by I. Smalley.

VI. Forthcoming meetings of the Commission

1. 6-12 September 1985. Commission meeting in Poland, organized by the Polish INQUA National Committee and Professor H. Maruszczak. The first circular has been distributed among commission members and other interested parties. The topic of this meeting is "Problems of the stratigraphy and paleogeography of loesses" and includes plenary meeting with paper sessions and field trips covering the area between Lublin and Cracow. By the request of president Dr. Velichko A.A. this event will be organized as a joint meeting with the INQUA Commission on Paleogeographical Atlases.

2. 1985. The First International Conference on Geomorphology will be held at Manchester between 15-22 September. A special workshop in the framework of the conference has been suggested by our Commission entitled "Geomorphological and environmental geological -- geotechnical and geochemical -- problems of loess regions". Guidance has been taken by E. Derbyshire, member of the Organizing Committee and I. Smalley.

3. Presidency of our Commission has requested INQUA vice-president Professor Liu tung-sheng to initiate a meeting of the Commission on Loess during this inter-congress period in China. Wu zi-rong, secretary-general of the China Quaternary Research Association in a letter informed us on his efforts undertaken in the organization of this meeting. During his recent stay at Beijing

E. Derbyshire negotiated this topic with Chinese colleagues.

4. 1986. Secretary of the Commission J.P. Lautridou will coordinate a field trip originating in Caen, France and visiting Jersey, Mont-St-Michel Bay, St-Brieuc Bay and the Northern coast of Britanny. The theme of this field trip will be "The most Western loess of Europe".

5. 1987, Canada. Concerning a special symposium of our Commission at the 12th INQUA Congress the president contacted Mr. J.S. Vincent of the Programs Subcommittee supporting the idea and giving "Stratigraphical and environmental geological /geotechnical and geochemical/ problems of loess" as a topic of this meeting. Negotiations has also started on possible excursions. There are two suggestions: that of by Dr. A. Lutenegger and Dr. I. Smalley to study the South Canadian and American loesses while Professor T.L. Péwé has proposed another venue -- the recent loesses of the Yukon Territory, Alaska. Probably we should try to organize both of them; the first as a pre-congress, the latter as a post-congress trip. Suggestions above will be discussed at the two business meetings of this year and at the next year's sessions. Those intending to deliver lecture/s/ are requested to send applications with an indication of the proposed topic/s/ to the Programs Subcommittee by the end of March 1986. Contributions should be tailored to fit the symposium programme outlined above. The staff of the Commission is planning to pre-publish congress papers as was suggested by the Organizing Committee. It will only be possible to accept for publication papers that are ready for print and which are

received by the president of the Commission by 31 January 1986. The next circular will contain detailed instructions concerning the submission of contributions.

6. Members of the Commission are requested to show activity during the next years advertising theoretical and practical importance of Quaternary research for it is one of the most comprehensive and multidisciplinary science serving protection of the ecological environment and able to open perspectives for a rational environmental management.

Budapest-Moscow-Paris, August 1984

ISRAEL '86

It has been proposed that a meeting largely devoted to 'Desert Loess' should be held in Israel during the northern hemisphere summer of 1986. Queries to Professor D.H. Yaalon, Geology Department, Hebrew University, Jerusalem, Israel.

FRANCE '86

A Loess Commission field meeting on the theme 'The most westerly loess of Europe' will be held in 1986 (probably August or September). The meeting will be based in Caen, France and will visit Jersey, Mont St. Michel Bay, St. Brienc Bay and the northern coast of Britanny. More information from: Dr. J.P. Lautridou, Centre de Geomorphologie du CNRS, rue des Tilleuls, 14000 Caen, France.

1985

1st International Conference of Geomechanics in Tropical Lateritic and Saprolitic Soils, Tropicals 85, Brasilia, Brazil, February 11–14, 1985.
Information: Hanico A. C. Jacomo, Tropicals 85, SDS, Ed. Venancio 3000, 12ᵉ andar, Bloco P, 70000 Brasilia, Brazil.

***4th International Symposium on Remote Sensing for Soil Survey,** Wageningen, Netherlands, March 4–8, 1985 (replacing the Remote Sensing Symposium in Dakar, Senegal, end 1984 or January 1985, as announced earlier); see announcement on p. 14 of this Bulletin.
Information: Dr. M. A. Mulders, Dept. of Soil Science and Geology, Agricultural University, P.O. Box 37, 6700 AA Wageningen, the Netherlands.

Colloquium on Energy Flux at the Soil Atmosphere Interface, International Centre for Theoretical Physics, Trieste, Italy, May 5–9, 1985.
Information: Dr. D. Gabriëls, Dept. of Soil Physics, State University of Ghent, Coupure links 653, B-9000 Ghent, Belgium.

***International Symposium on Reclamation of Salt-affected Soils,** Beijing, China, May 13–21, 1985.
Information: Dr. J. P. Abrol, Chairman ISSS Subcomm. A, Central Soil Salinity Research Institute, Karnal, Haryana, India. *or*: Prof. Shi Yuanchun, Dean of Post-graduate School of Beijing Agricultural University, Beijing, China.

International Conference on Soil Dynamics, Auburn, U.S.A., June 17–19, 1985.
Information: William R. Gill, Conference Coordinator, National Tillage Machinery Lab., P.O. Box 792, Auburn, AL 36831-0792, U.S.A.

Third International Symposium on Iron Nutrition and Interactions in Plants, Lincoln, Nebraska, June 24–28, 1985.
Information: Dr. R. B. Clark, USDA-ARS, 101 KCR (Agronomy), Un. of Nebraska, Lincoln, NE 68583-0817.

* * ***7th International Meeting on Soil Micromorphology,** Paris, France, July 8–12, 1985 (ISSS Subcommission B).
Information: N. Fedoroff, c/o INA P-G Dépt. des Sols, 78850 Thiverval-Grignon, France.

Symposium on Potassium in Agriculture, Atlanta, Georgia, USA, July 8–10, 1985.
Information: D. Amstrong, Potash & Phosphate Inst., 2901 Buford Highway, N. E., Suite 401, Atlanta, GA 30329, USA.

10th Conference of the International Soil Tillage Research Organization (ISTRO), Guelph, Canada, July 8–12, 1985.
Information: Prof. Dr. J. W. Ketcheson, University of Guelph, Ontario Agric. College, Dept. of Land Resource Science, Guelph, Ont. N1G 2W1, Canada.

***International Symposium on Soil Fertility, Soil Tilth and Post-clearing Land Degradation in the Humid Tropics,** Ibadan, Nigeria, July 21–26, 1985 (ISSS Commissions IV and VI, Soil Science Society of Nigeria). Earlier announced as 'International Conference on Land clearing and Post-clearing Management for Soils of the Humid Tropics'; see announcement on page 11 of this Bulletin.
Information: Dr. E. J. Udo, Dept. of Agronomy, Univ. of Ibadan, Ibadan, Nigeria.

***Intercongress Excursion on Soil Mineralogy and Genesis in SE and SW USA: Pre-AIPEA Trip,** July 21–27, 1985 (ISSS Commission VIII). See announcement on page 25 of this Bulletin.
Information: Dr. J. B. Dixon, Dept. of Soil Science and Crop Sciences, Texas A & M University, College Station, Texas 77843–2474, USA.

8th International Clay Conference, Denver, USA, July 28–August 2, 1985 (AIPEA).
Information: Organizing Committee, P.O. Box 25046, Mail Stop 917, Denver, Colorado 80225, USA.

International Conference on Science and Technology Education and Future Human Needs, Bangalore, India, August 8–15, 1985 (ICSU-CTS).
Information: J. L. Lewis, Malvern College, Malvern, Worcestershire WR14, UK.

IX Congreso Latinoamericano y III Congresso Colombiano de la Ciencia del Suelo: 'Conservación de Suelos en America Latina', Palmira, Colombia, Agosto 26 al 30 de 1985.
Informes: Dr. Francisco Silva M., Secretario Ejecutivo. A. A. 51791 Bogota, Colombia.

9th International Symposium on Soil Biology, Sopron, Hungary, August 27–30, 1985.
Information: Dr. Eva Bakondi-Zámory, Centre of Plant Protection and Agrochemistry, Budapest, P.O. Box 127, 1502 Hungary.

***International Colloquium on Soil Zoology,** Moscow, USSR, August 1985.
Information: Prof. M. Ghilarow, Morph. Evolution and Animal Ecology, Lenin Avenue 33, 117071 Moscow W-71, USSR.

International Workshop on Hydrologic Applications of Space Technology: Input to Hydrologic Models and Geographic Information Systems, Florida, August 1985 (IAHS and WMO).
Information: A. I. Johnson, ICRSDT, 7474 Upham Court, Arvada, Colorado 80003, USA.

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1986

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The Crayford brickearths and other loess materials in the Thames valley

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Forty years ago A.S. Kennard published his review of the work carried out on the Crayford brickearths and he stated that 'Crayford figures so largely in Pleistocene geology that no apology is needed for an attempt to collect all the available evidence and to see what legitimate deductions can be drawn from it' (Kennard 1944). The fame of Crayford may have diminished somewhat in the intervening years but some of the problems associated with brickearth remain, and indeed with the growing interest in the discovery and investigation of loess in Britain are gaining welcome attention. The aim of this paper, in addition to offering a modest tribute and memorial to Kennard, is to consider the status of loess material in S.E. England (in particular the lower Thames Valley deposits, including Crayford) and to raise some questions relative to brickearth as loess, or loess as brickearth.

Kennard was mainly interested in faunal remains but he did discuss the geology of the brickearth deposits and speculate about their origins. He described three 'well-marked divisions' in the Crayford series:

1. The basal sands and gravel; the 'Crayford Gravel' up to 15 feet (about 4.5 m) thick.

2. The Lower Brickearth including the Corbicula Bed; up to 30 feet (about 9 m) thick.

3. The Upper Brickearth, including the 'trail', up to 20 feet (about 6 m) thick.

These are (were) considerable thicknesses; if the brickearths are of loess material they make a handsome loess deposit. 'Trail' is defined by Arkell and Tomkeieff (1953, p. 120) as solifluction gravels, sometimes filling ice-gouged pits or furrows (see King and Oakley 1936, p. 65 footnote on this point). Kennard concluded that the Lower Brickearth is the product of a sluggish stream, not very deep, six feet at the most... The Upper Brickearth is not a river nor an aeolian deposit, but is the result of sludging from higher ground during a period of greatly increased rainfall.

A brief discussion on loess by Kennard (1944, p. 129) should be noted. He quoted the opinion by Bull (1942, p. 44) that the Upper Brickearth is 'probably a weathered and decalcified loess' but he did not agree, but neither did he like the idea that loess could be an aeolian deposit. There was no discussion of the nature of the brickearth material other than a passing mention that the Upper Brickearth appeared more clayey than the Lower, and that this might indicate a different origin. One of the most encouraging trends in the last forty years has been a growing interest in the actual materials comprising the loess/brickearth deposits.

Earth History

Interest in Crayford goes back a long way. The earliest item in Kennard's bibliography is a piece by J. Morris published in 1838 in the Magazine of Natural History (Morris 1838-Kennard has a small but confusing citation error). It seems likely that the first visit to the Crayford brickpits by the Geologists' Association was in 1869, at a time when no Proceedings were published. They went again in May 1870 (PGA 2, 34-35), and again in April 1871, Morris being excursion director (PGA 2, 229) and the visits continued through the closing years of the nineteenth century. This was a time when London was expanding and the suburban railways were stimulating large scale house building. Of course this expansion never stopped and the process which exposed the brickearths to the keen (usually amateur) geologists of the day has ensured that the pits were eventually built over and largely lost to view.

A richer source of contemporary brickearths appears to lie north of the Thames in South Essex - Between the rivers Thames and Crouch are many promising areas and it seems likely that a reasonable assumption might be made that the brickearth at (say) Grays would be similar to that at Crayford. Kennard was lured away from Crayford by the re-opening of the brickearth pit at Grays and some other north-of-the-Thames excavations and constructions. Are the Crayford and Grays brickearths significantly different? If not the loss of the Crayford deposit to commuter housing is less critical. The London geologist can actually still see the products of the Crayford brickpits; Crayford bricks were used in the construction of the Scotland Yard building on the Embankment.

Essex

The brickearths of S.E. Essex were investigated by Gruhn, Bryan and Moss (1974) and they stated clearly that many of their samples were loess. Their Cherry Orchard Lane section even had a palaeosol separating and upper loess from a lower loess. Lill (1976) looked at the Cherry Orchard Lane material both 'in-situ' and in the laboratory and his application of Lysenko's (1973) 'loess test' suggests that it is loess.

Cherry Orchard Lane	Depth	M_d	K_{in}	S_o	C_d/F_d
TQ 857898	2.0m	44 µm	3.85	1.86	7.33
	0.5 m	45	4.77	2.07	5.76
	DT	34	4.69	1.60	5.45

K_{in} is an inhomogeneity ratio defined as $K_{in} = d_{60\,\mu m}/d_{10\,\mu m}$ i.e. the ratio, in weight percent, of particles with diameter of less than 60 µm and less than 10 µm.

$$S_o = d_{75\,\mu m}/d_{25\,\mu m}$$

Values of K_{in} for loess fall in the range 2-11, usually around 3-7;

S_0 for loess is equal to or less than 2.5.

$$C_d/F_d = d_{50}\,\mu m - 10\,\mu m / d_{10}\,\mu m - 2\,\mu m$$

and is the coarse to fine particle ratio. Lysenko puts this at in excess of 1.3-1.5 for loesses, so the Cherry Orchard Lane observations are well into the loess range. It must be realised that the Lysenko tests are arbitrary tests designed to be applied to loesses in the Soviet Union where identification of a true loess (i.e. a material which can be expected to subside under construction loads) is an important practical problem.

The median particle diameter M_d should ideally be around 25 μm for loess material. The Atterberg limits of the Cherry Orchard Lane samples also fit fairly well with observed loess criteria.

	Depth	LL	PL	PI
Cherry Orchard Lane	2.0 m	29	22	7
TQ 857898	0.5 m	30	22	8
	DT	26	24	2

The upper loess contains virtually no carbonate but the lower loess contains appreciable amounts. This is very clearly illustrated by the thermogravimetric results given by Lill (1976, p. 227); the 0.5 m sample contains negligible carbonate but appreciable clay mineral material, the 2.0 m sample contains carbonate but little clay. The DT sample was taken from a drainage trench. At Cherry Orchard Lane, as at Crayford, the carbonate free material was used for making bricks to avoid the 'blowing' problem caused by carbonates.

The brickearth used in the Thames valley for the actual making of bricks appears to be very similar to the material used all across Europe for the same purpose. It is recognised as loess in most countries and probably should be in Britain.

Pedological Influences

Arkell and Tomkeieff (1953, p. 13 and 40) defined brickearth as 'Loam used for making bricks. Especially in the Pleistocene of the Thames valley.' The term earth comes from the Old English 'eorde' - recorded back to at least A.D. 950. In 1667 John Evelyn wrote in his diary that 'We went to search for brickearth.' The various earth terms moved from mining to geology as that science developed, and were used by the mappers as the first geological surveys were carried out in south-east England. After the mapping was completed there appears to have been little further geological interest in the brickearths - they were seen as minor superficial deposits. There were some perceptive observations made, for example Webb (1896) listed a classic set of loess snails in his observations on the Chelmsford brickearth and French (1888), investigating the Felstead deposits, declared that 'it seems almost certain that some of the upland brickearths at least were a product of glaciation.' But a greater appreci-

ation of the significance and scientific consequences of the brickearth has developed as a consequence of the investigations of the pedologists. As Catt (1977, p. 223) has stated..' the widespread occurrence of thin, weathered loess has only been recognized more recently through pedological work, mainly by the Soil Survey of England and Wales.' A new set of surveyors - and brickearth becomes loess.

Catt (1977, p. 223) has indicated that unweathered, calcareous loess, which has not been reworked by fluvial or colluvial processes, forms a continuous deposit over Chalk, Lower Tertiary sediments, and river terrace gravels in areas adjacent to the Thames estuary (north Kent and south-east Essex), but occurs only rarely elsewhere. This appears to be largely overlain by a carbonate-free material which was used for the actual bricks. The mineralogical data and the palaeosol observations at Cherry Orchard Lane suggest the existence of two definable loess deposits. It appears that we still need an explanation as to why the lower one is calcareous and the upper one is clayey. Worsley (1983) has recently reviewed some aspects of loess in Britain and he summarized Catt's view of loess origins as:

1) a loess blanket derived from then contemporary glacigenic sources, and

2) extensive post-depositional erosion to produce the fragmentary outcrops which occur at the present time.

As far as the formation of the loess material and the loess deposits is concerned this would appear to place the Thames Valley loess firmly into the glacial category, close to the original formulation of such material (Smalley 1966). The question of how the loess material for the Crayford deposit was formed can be clearly answered; what still remains to be elucidated is the mechanism of emplacement and the extent of subsequent erosion and dispersion.

The Fauna

Kennard (1944, p. 160) stated that palaeontology always has the last word; his statement reflected his view of the Crayford brickearth as a rich depository of faunal material rather than a sedimentary (or economic) deposit. His major achievement is probably the fact that Crayford is still considered a significant site in studies of the British Quaternary - and his work is still being cited. Sutcliffe (1976) discussed Crayford in some detail: he stated that the deposits are generally considered to be Ipswichian, though this has not been demonstrated on palaeobotanical grounds. Sutcliffe found the entire Crayford assemblage to ve 'very strange' and in need for more study. He found it difficult to accept that it represents the end of the Ipswichian and suggested that it might be more logical to regard it as antedating the hippopotamus warm stage, probably slightly older than the Tornewton Glutton Stratum. At Crayford there is an abundance of horse, and other animals include wolf, fox, brown bear, lion, ox and bison, red deer, giant deer, abundant mammoth, rare straight-tusked elephant, rare musk ox and rodents. The land and fresh-water molluscs are believed to indicate conditions warmer than the present, but the predominant rhinoceros is the whoolly rhinoceros, and

Dicerorhinus is rare. Kennard claimed that the musk ox is not the present day form, but a new species which he named *Ovibos spurrelli* (after the Spurrells, father and son, who worked on the Crayford deposits).

It seems very unlikely now that the Crayford brickearths can be considered Ipswichian; Catt's (1977, p. 224) early late Devensian age appears more likely, and Wintle's (1981) thermoluminescene dating of other brickearths in S.E. England supports this Devensian dating. Loess is formed during a glacial phase, it is a cold-climate material and one would expect it to contain a cold-climate fauna. King and Oakley (1936) described the fauna of the Lower Crayford Brickearth as mainly of cold steppe type, including *Elephas primigenius*, *Rhinoceros antiquitatis* and *Ovibos moschatus*; they also commented that there seemed to be a conflict between the mammalian fauna and the molluscan fauna - indicating cold and warm conditions respectively. Kennard's 'last word' still needs some deciphering.

The Crayford Brickearths/Loess 1944-1984

In forty years there has been no diminution in the nuber of questions which need to be answered and, in fact, if we recognize that the Crayford brickearth and similar deposits are loess than a few more questions become available. How many definable deposits are there at Crayford? Does the simple division into upper and lower brickearths have validity? Do the two deposits represent two phases of loess deposition, and does the Cherry Orchard Lane palaeosol represent a significant period elapsing between the upper and lower deposition times? How can we account for the cold mammals and the warm molluscs? Is any of the loess in its original form as an aeolian deposit or has it all been reworked? Is there a reliable test which will allow loess to be recognized?

This last question is a significant one for workers in the fringe areas of loess deposition. Where loess is thin and patchy it can be very difficult to identify; one of the most effective tests for primary aeolian loess is that used by Fookes and Best (1969) on the East Kent loess - loading and wetting in an oedometer reveals loessic collapse characteristics very clearly. It would be useful if some remnants of the Crayford Brickearths could be located and subsidence tests applied to them. It would also be interesting if the Cherry Orchard Lane palaeosol could be further investigated, and possibly dated. Thanks largely to Catt we have a model of a loess sheet covering much of S.E. England; this gives us a framework in which to fit our observations and it would be useful if some more could be forthcoming from Crayford - but finding an accessible section of the famous brickearth may be the most difficult task of all.

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LL12: OCTOBER 1984: Contents

LL12 was produced by Ian Smalley and Eleanor Cummings in the Department of Earth Sciences and printed by the Graphic Services Section of the University of Waterloo. LL welcomes participants to the CAGONT-ELDAAG-OAG meeting at UW, 1-4 November 1984.