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La LETTRE du LOESS
LOESS LETTER 11

LL11: April 1984

Loess Letter is published by the 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 Martan Pecsi, Geographical Research Institute, Hungarian Academy of Sciences, H 1112 Budapest, Budaorsi ut. 43-45, Hungary.

LL11 is a special issue for the 27th International Geological Congress to be held in Moscow 4-14, August, 1984. There is some emphasis on geotechnical topics and we include a survey of applied loess studies in the U.S.S.R. based on material published for the 1982 Moscow INQUA Congress. The features article is by Kenneth Pye of Cambridge University on "Some perspectives on loess accumulation". Dr. Pye has just published an interesting review paper on loess (Prog. Phys. Geog. 8, 176-217, 1984) - LL welcomes the appearance of reviews on all aspects of loess - reviews are important. This is the eleventh issue of LL. This has some special significance - see below.

Supplements; for the 27th IGC, and following the geotechnical theme, we issue two new LL supplements: Stoilov on Bulgarian Loess, and Sweeney and Smalley on Loess and Hydrogeology. The first supplement, on Loess and Agriculture, and the second, on Loessic materials in Australia are still available. Write to LL for copies or pick one up at IGC Moscow. LLS3 is still in preparation; it is a translation into English of B.V. Pyaskovskii's 1946 paper on "Loess as a deep soil formation". This was published in Pochvovedenie, and the translation will be available from the Librarian, NZ Soil Bureau, Lower Hutt, New Zealand.

Cover: to symbolize the major geotechnical problem encountered with loess - the problem of collapse when loaded and wetted, which leads to foundation failure. We have borrowed the major part of the cover illustration from the advert. by Geopac Inc. which appears in 'Geotechnical News'. Geopac offers 'Dynamic consolidation of foundation soils.'

LL11/elelеleven; the gaudy issue. Gaud, also Gaude. One of the the larger beads placed between the decades of 'aves' in a rosary; therefore the eleventh item, particularly in a series. Gaud. A trick, prank, pretense, also a pastime, a toy, a gewgaw, a piece of finery; fine things; idle display. Gaudy. Rejoicing, merry-making, brilliantly fine or gay, showy.

Loess Comission News

The President and Secretary of the INQUA Loess Commission met in Budapest between September 26 and September 30, 1983. Meetings attended by the President of the Commission, Professor Pecsi and his team, and the Secretary, J. P. Lautridou, were held at the Academy of Sciences in Budapest and at local field sites.

In the field, notably at Paks, Mende, Basaharc and Dunafoldvar, the Continental sequences of the recent and mid Pleistocene were compared with those of western Europe. The most recent Loess deposits in Hungary appear to be more dilatant and contain several important palaesols (chernozems and brown forest-steppe soils) like Basaharc base (BA) and Basaharc double (BD) and Mende Upper (MF).

At the Academy of Sciences, discussions were held concerning the classification of loess according to its sedimentary characteristics (currently being studied at the Academy of Sciences). J. P. Lautridou proposed using a new granulometric parameter (ratio of fine clay to total clay content). The loess of western Europe is characterized by a high ratio.

The program of events for future years was also discussed. J. P. Lautridou will organize with Professor Pecsi a meeting for the International Congress of Geography at Paris (1984) for all geographers interested in the problems of loess. Professor Maruszczak, of the University of Lublin, has proposed that he organize a meeting of the Commission in Poland for 1985. In 1986, the Secretary of the Commission, J. P. Lautridou, will coordinate a field trip originating in Caen, France and visiting Jersey, Mont-St.-Michel Bay, Saint-Brieuc Bay and the northern coast of Britanny. The theme of the field trip will be "The most western loess of Europe". In 1987, I. J. Smalley proposed a visit to Canada and the U.S.A. during the INQUA Congress.

For those concerned, Professor Pecsi is arranging the publication of all papers presented at the Loess Symposium held in Moscow in 1982 (INQUA Congress).

FAO news. The FAO project in Shaanxi Province, China on 'Better Utilization of Land Resources in the Loess Plateau' is proceeding very satisfactorily. A combination of vegetational and engineering methods to control soil erosion has been tested now for several years in Mizhi County, with the introduction of some new crops and grasses and rational application of inputs. In the participating villages, significant increases in yield were obtained, with resultant higher income per family, and simultaneously a better control of soil erosion. The results from our model villages are now being extended to surrounding countries.

The FAO/UNDP project in Mizhi will be terminated in 1985 and our Chinese colleagues hope to organize an international gathering on agricultural utilization of loess soils, probably around mid-1985. More information is available from Food and Agriculture Organization, via delle Terme di Caracalla, 00100 Rome, Italy.

Late Cenozoic geology and the second oldest profession.
Ward Chesworth. Geoscience Canada 9, 54-61, 1982.

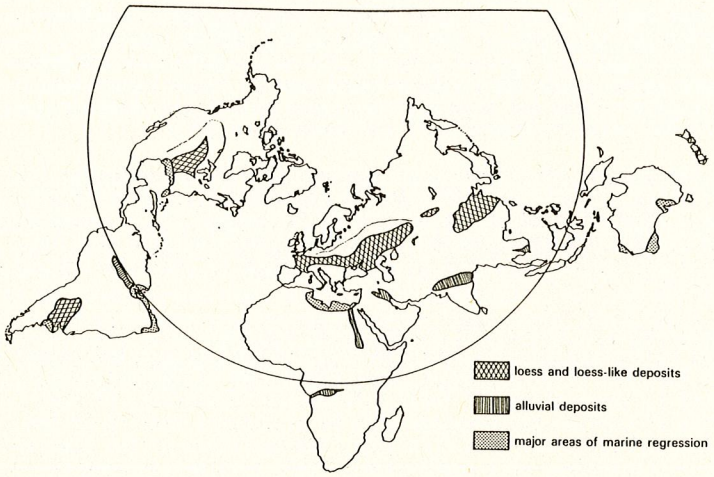

Figure 5 *Areas where sedimentary redistribution during the Cenozoic extended the effects of processes illustrated in Figure 4.*

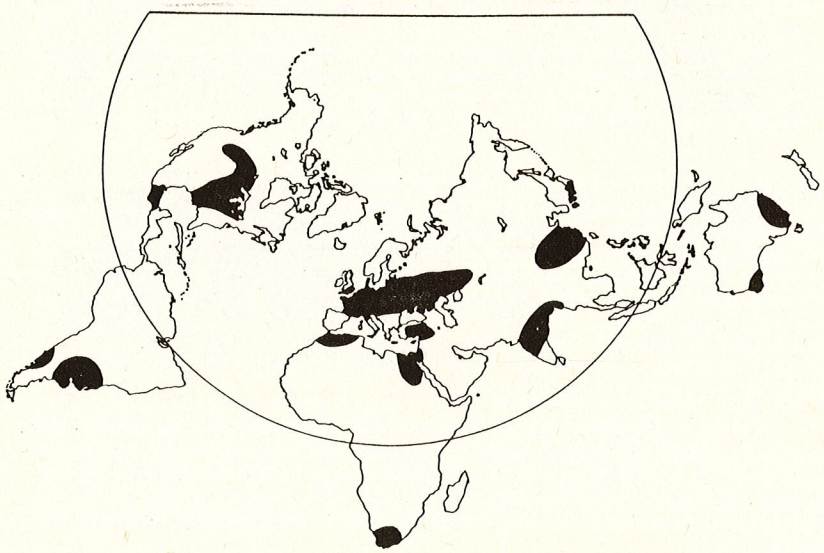

Figure 1 *The world's major croplands on Fitzpatrick's (1971) projection. Based on productivity data in Jones (1972).*

SOME PERSPECTIVES ON LOESS ACCUMULATION

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During the long history of loess investigations, many authors have sought to explain the global distribution of loess deposits in terms of available sources of silt, and much debate has concerned the mechanisms which form silt particles. By comparison, there has been little discussion of the factors which promote the deposition of dust and accumulation of thick loess deposits.

Several recent papers (e.g. Idso, 1976; Goudie, 1978, 1983) have emphasized that dust storms are important at the present day, yet, somewhat paradoxically, loess deposits of Holocene age are of very limited extent. At present, dust storms are most common in and around warm desert regions such as the Sahara, Arabia, Thar, Iraq, central Australia and parts of Soviet Central Asia. Their frequency and extent clearly indicates that these regions are important sources of silt-size material (Morales, 1979; Goudie, 1983), yet important loess deposits are not being formed on their margins. Why?

To turn the coin over, palaeoenvironmental and dating evidence conclusively shows that the great loess blankets of the world were deposited primarily during cold stages of the Pleistocene, when extensive glacial outwash plains and braided meltwater channels provided suitable source areas for dust in areas where such conditions do not exist today. Yet what meteorological or other factors were responsible for causing deposition and accumulation of thick loess relatively close to the source areas? Along the Mississippi Valley, for example, loess

deposition was restricted to within about 100 km of the bluffs, and the thickness of loess decreases exponentially with disjance from the source (Snowden and Priddy, 1968). Further east the soils have an airborne dust component but do not have the characteristics of 'true' loess.

Three main factors may determine whether dust is deposited close to the source: (1) topography, (2) vegetation characteristics, and (3) the nature of the dust transporting winds. In mountainous areas like Tajikistan, steep valley sides act as barriers to silt-transporting winds which consequently have a marked down-valley directional component. Silt blown from braided channels exposed in the valley bottoms during low flow stages is blown back onto the valley sides and terraces. In most situations loess cannot accumulate on slopes steeper than about 40° because it is rapidly reworked downslope by slope processes acting under the influence of gravity. As a result, loess deposits in such areas commonly take the form of relatively narrow valley-parallel strips which are thickest on the lower valley slopes.

Vegetation also plays a vital role in trapping silt. As noted by Yaalon and Dan (1974), where no plant cover exists, dust will not accumulate in significant amounts, since it is re-eroded in subsequent wind storms or runoff events. In the central and southern Mississippi Valley during the last glacial maximum, trapping of deposited dust was accomplished by a thick cover of coniferous forest and (further south) broad-leafed woodland. Modern analogues are found in parts of Alaska (Péwé, 1955; Trainer, 1961). In other areas, including much of central Europe, steppe vegetation was evidently effective in trapping windblown silt during the Pleistocene (Fink and Kukla, 1977). It is noteworthy that the discontinuous and seasonal

vegetation found in most desert-marginal regions at the present day has a much lower silt-trapping potential.

The distance travelled by dust in suspension is also dependent on the nature of the wind system. Local winds, such as valley winds, or winds which are restricted to the lower levels (< 1.5 km) of the atmosphere, rarely transport dust more than a few tens of hundreds of kilometres. Longer distance transport is encouraged by a high degree of turbulence in the atmospheric boundary layer and by strong vertical mixing in the overlying air column (Pye, 1984). Cyclonic disturbances are particularly favourable for raising dust into the higher levels of the atmosphere where it may be incorporated into fast-moving jet streams and be transported over distances of thousands of kilometres. In Sub-Saharan Africa, dust is raised into the middle atmosphere by convective systems associated with tropical disturbances along the ITCZ, and is then transported out over the eastern Atlantic above the Trade Wind Inversion by strong northeasterly and easterly air currents (Sarnthein et al., 1981; Schütz, 1980). A wind with velocity of 5 m/s has sufficient turbulence to keep 20 μm diameter particles in suspension indefinitely, and settling can only occur if there is a reduction in wind velocity and turbulence or if the particles are washed out in rain. Larger particles have higher settling velocities according to Stokes' Law and therefore settle out closest to the source. Very fine particles (< 10 μm) which enter the middle and upper atmosphere may be distributed worldwide.

The large extent and geochemical homogeniety of loess in the Central Loess Plateau of China suggests that much of it was transported over distances of hundreds or thousands of kilometres from source areas north and northwest of the Hwang Ho river. The great volume of loess present testifies to the existence of a very large reserve of silt in

the Hwang Ho floodplain and northern deserts during glacial times. The fact that this silt was not trapped close to the source but distributed over a wide geographical area may partly reflect the absence of a belt of efficient silt-trapping vegetation south of the Hwang Ho, but, more importantly, probably reflects more vigourous regional wind circulation at the time of loess deposition. Pollen data, faunal assemblages, and pedological evidence indicate that the loess accumulated under relatively cold, dry conditions with steppe vegetation (Liu Tung Sheng et al., 1982a). Liu et al. (1982b) have also suggested that glacial maxima in Tibet, Tien Shan and the Kun Lun Mountains were accompanied by greater frequency of cyclonic depressions in the Gobi Desert and by more effective easterly transport of dust by a westerly jet stream centred north of the Tibetan anticyclone.

For loess to accumulate in a recognizable form, the rate of dust deposition at a site must exceed (a) the rate of erosion by wind and water, and (b) the rate of weathering and pedogenesis. If the rate of dust deposition is low, syn-depositional weathering will be pronounced and the ultimate result will be a clay-loam soil. The critical rate of dust deposition for accumulation of loess is likely to vary in accordance with climatic conditions, since these directly influence the rates of weathering and pedogenesis.

Reliable data concerning rates of dust deposition during times of Pleistocene loess accumulation are scarce. Tonkin et al. (1974) reported C-14 dates which suggest an average rate of deposition of 2 mm/yr at Timaru (New Zealand) between 9,900 and 11,800 BP. Liu et al. (1982b) estimated the present rate of dust deposition in the eastern part of the Central Loess Plateau to be of the order of 0.1 mm/yr, which is insufficient for the accumulation of recognizable loess. On the basis of the limited evidence available, it seems likely that the

critical rate of dust deposition in most areas is of the order of 0.5-1.0 mm/yr. At present this is achieved only locally in relatively few parts of the world, mostly periglacial or ice-marginal. In most warm desert regions, dust is dispersed over a wide geographical area, and is often re-eroded due to lack of vegetation cover, such that the net rate of deposition falls below the critical value for loess accumulation.

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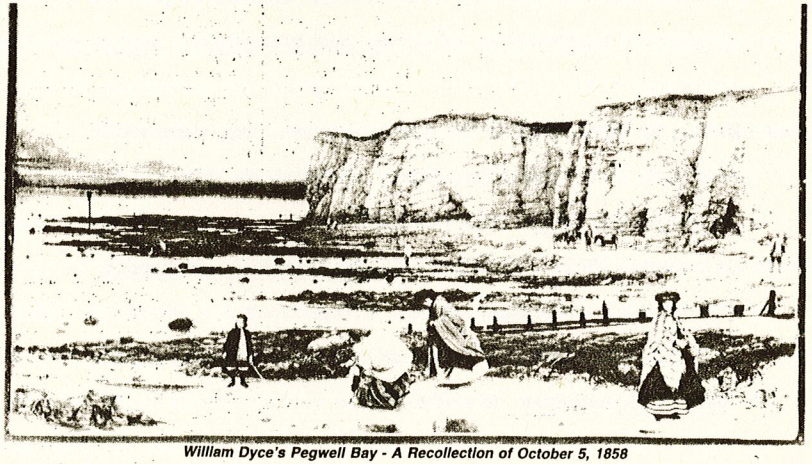
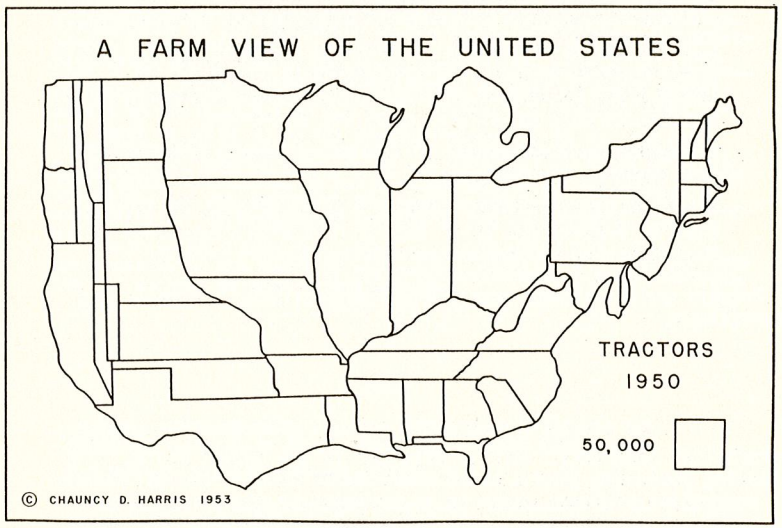


William Dyce's Pegwell Bay - A Recollection of October 5, 1858



By retaining the relative positions of the states but altering their ground areas and shapes, the cartographer has made each state into a symbol that both identifies the state and represents a thematic quantity. Here the "paper" area of each state is proportional to the number of tractors on farms in a certain year°

Working Group "Geotechnical Properties of Loess"

The decision to organize a working group to study the geotechnical properties of loess was made in August, 1982 at the 11th INQUA Congress. Dr. N. I. Kriger was elected as the convener of the working group for the period 1982-1987. He was entrusted with the drawing up of a general plan for the work of the group for the 4-year period, and the selection of regular members and corresponding members. More details of this new working group are contained in Circular no. 1 for 1983 issued by the Loess Commission in Budapest. It is proposed that, in the next period of the Commission's activities, there should be some emphasis on foundation problems and related engineering-geological topics as well as on problems of geochemistry and environmental chemistry of loesses and loess derivates. Contact Dr. Kriger at PNIIIS, Okruzhnoy proezd 18.

Working group on Geochemistry and Environmental Chemistry of Loess and Loess Soils

This new working group was established at the INQUA Congress in Moscow in 1982. The convener is Dr. Otto Franzle, Geographisches Institut der Universitat, Olshansenstrasse 40-50, D-2300 Kiel 1, Germany BRD. He suggests that emphasis in future research should be placed on the folowing fields:

- Comprehensive synthetic system models of the fluxes of potentially toxic substances.
- Determination of the variability of cationic and anionic adsorption and description of loess soils as related to individual soil horizons.
- Leaching experiments with environmental chemicals in undisturbed laboratory soil monoliths and experimental sites.
- Development of mathematical functional models simulating soil passage of chemicals.
- Systematic pedochemical interpretation of geoscientific maps on loesses and their derivatives with respect to environmental buffering capacities.

Dr. Franzle would welcome comments and suggestions, proposals and observations.

Geotechnical Abstracts: work in progress in the Soviet Union. The following abstracts give a brief overview of work on the geotechnical properties of loess which is in progress in the Soviet Union. The abstracts are taken from the three volumes published for the 1982 INQUA Congress in Moscow.

V.1 -24-

ENGINEERING-GEOLOGICAL CHARACTERISTICS OF THE STANDARD SECTIONS OF THE PLEISTOCENE IN THE UKRAINE

V.G.Balandin, V.F.Krayev (USSR)

The composition and properties of loesses in the standard sections of the Pleistocene of Ukraine, occurring under different geological-structural and zonal conditions have been investigated: in the Black Sea region - the Maritime, Roksolany, Odessa sections; in the Carpathian region - the Krukenichy section; the sections of the Dnieper basin; the Kharkov section. The properties of the sediments from certain stratigraphic units were compared with data of mass testing of loess strata, as well as with the data (M.Minkov, L.G.Balayev, G.A.Mavlianov, A.B.Minervin) on loesses of Bulgaria, the Caucasus region, Middle Asia, and Siberia. The cyclic autocorrelation, trend, and homogeneity of the fields of properties have been estimated.

Formations with various features of rhythmicality, such as buried soils, loess-like rocks, and loesses, correspond to each of the conjugate climatic subphases: interglacial, cryohygrotic and cryoxerotic. Autocorrelation of such properties as the content of dust and physical clay; the relationship of colloidal montmorillonite with hydromica and kaolinite; porosity and collapsibility is close to the parabolic. The greater degree of insufficient compaction exists in the loess parts of the rhythms.

The close to linear tendency of improvement of the properties with the age of the rhythm exists both in sections which are 35-50 m thick (Roksolany, Maritime section) and in sections of smaller thickness. This is connected with the increase of the clay content, aggregation, density, with the mineral transformations, changes in the relations between the forms of moisture in the process of diagenesis. The amplitudes of the changes in properties of this tendency are not sharp, and neighbouring rhythms are usually united into one element.

The tendencies of the "rhythm" and "age" are important for spatial predictions: in large morphostructures sampling in detail of a standard section is highly informative, being frequently equivalent to mass sampling of massifs of land reclamation. The leading role in engineering-geological predictions and correlations for substantiation of large interregional constructions belongs to generalization of the properties on the level of Pleistocene subdivisions. The interregional correlation of the data on insufficient diagenetic compaction of the loess parts of the rhythms is of theoretical and applied significance. Thus, the most probable coefficients of collapsibility (for loads of 0.3 MPa) for the Black Sea region in the deposits of the early, middle and late Pleistocene are equal to (%): 4, 8, 12; for Zaporozhye: 3, 6, 11; for northern Bulgaria: (3-4), 6, 11; and for the North-Tashkent channel: 4, 6, (9-12). With an increase of the geographical latitude the interregional comparisons by the absolute values of the indices of the properties are shaded by the zonal conditions, but the leading tendencies of the spatial variations of the fields of properties are preserved.

Stratigraphic subdivision and correlation of the loess sections are possible on the basis of engineering-geological generalization (in the complex of traditional methods).

1 -54-

REGIONAL CHARACTERISTICS OF THE CHEMICAL COMPOSITION AND SUBSIDING ABILITY OF LOESS ROCKS IN SOUTHERN KAZAKHSTAN

V.S.Bykova, N.E.Kotelnikova (USSR)

A series of regularities have been determined in the distribution and content of water-soluble salts, subsiding ability of loess rocks and their variation over the area. These variations are bound with the Pleistocene and Holocene conditions of the formation of stratigraphical-genetic complexes of loess rocks occurring on geomorphological elements of different age.

Thick beds of homogeneous loess rocks with a high carbonate content (up to 25%) and with a low content of easily soluble salts (< 0.3%) occur at the foothills of low mountains and on proluvial plains, whose formation began in the early and middle Pleistocene. The upper part of the loess sequence (> 20 m) is composed of highly macroporous rocks, characterized by substantial subsiding ability under natural and additional loads (average δ sub$_s$ - 0.01-0.05; δ sub$_3$ - 0.03-0.08). The thickness of the subsiding strata (H_s) is more frequently in excess of 10-20 m and the summary subsidence (S_s) may reach 50-100 cm and more.

The discontinuous, laminated loess-like mantles within the alluvial, lacustrine-alluvial late Pleistocene and Holocene terraces and plains are thin (up to 5 m, rarely up to 10 m), with a low carbonate content. Frequently they are salinated (> 0.3%), nonsubsiding, or subsiding under additional loads (average δ sub$_3$ - 0.03-0.04), H_s is often less than 3-5 m, S_s - less than 5 cm.

Loess rocks, distributed on alluvial-proluvial middle and late Pleistocene piedmont plains, occupy an intermediate position by its thickness, chemical composition, and subsiding properties.

Within fans, loess rocks are characterized by a varying thickness (from 1 to 40 m), heterogeneous composition and subsiding ability. The heterogeneity increases regularly with the transition from ancient to modern fans. The thickness (40 to 1 m), carbonate content (20 to 5%), subsiding ability (0.12 to 0) decrease respectively.

The dependence of the composition and properties upon the duration of their formation is characteristic of loess complexes (with the exception of regions of bedrock exposure). Loess sequences, the sedimentation of which dates from early and middle Pleistocene, are characterized by a larger thickness, higher carbonate content and subsiding ability, and the younger ones by their minimum values. This is confirmed by the map plotted for predicting the subsiding ability.

The detected characteristics are important for a predicting estimate of the economic development of the territory. For example, considerable subsidence should be expected in the foothills and on the proluvial plains, as well as the formation of suffosion cavities in wet loesses and suffosion subsidence and secondary salinization of the rock on the lacustrine-alluvial plains.

1-I77-

THE ROLE OF THE CLAY COMPONENT IN THE CHANGE OF THE STRENGTH OF LOESS ROCKS AT MOISTENING

L.I.Kulchitsky, V.I.Presnukhin, A.R.Ishchuk (USSR)

Investigation of the regularities in the change and formation of strength properties of clayey rocks has made it possible to consider from a new point of view the change of the strength of loess rocks at moistening.

The microaggregates in the loess rocks contact by means of the clay particles, which surround the larger dusty particles by a dense circle and constitute about 80% of the total specific surface of the rock. Hence, the strength of the bonds between the microaggregates depends upon the condition of the clay particles and their arrangement in space, i.e. upon the quality and quantity of contacts between the interacting clay particles.

The shearing strength of the rock has been analysed on the device for single-plane shearing VSV-25 for investigating the nature of the strength change in loess rocks at moistening from the standpoint of contact interaction of microaggregates.

The shearing strength of the investigated loess rocks is unchanged at an equilibrium relative humidity of the air $P/P_s < 0.90$ (friction coefficient tgφ is equal to ≈ 0.50). A sharp irreversible decrease of the friction coefficient down to 0.10 - 0.14 is observed at values $P/P_s > 0.90$.

The process of loess rock hydration occurring at $P/P_s > 0.90$, when loosely bound water appears, causes transformation of coagulation-condensation bonds between the clay particles into coagulation bonds proper, which impart plasticity to the rock. Just this transition is marked by a decrease of the friction coefficient.

Thus, the sharp irreversible change of the parameters of shearing strength of loess rocks at moistening is caused by two factors:

(1) at hydration change of coagulation-condensation and cementation bonds between clay particles, characterized by great strength and brittleness, into coagulation bonds proper accompanied by a considerable increase of the true contact area and decrease of the contact stress,

(2) the microswelling of the rocks, appearing already at capillary condensation ($P/P_s > 0.90$), causing reorientation of the clay particles, which also causes an increase of the true contact area and a decrease of the contact stress from the acting external force.

Spatial regulaties of the changes in properties of loess rocks with a depth, altitude, and area of distribution have also been investigated.

1-269-

QUATERNARY LITHOGENESIS AND ENGINEERING-GEOLOGICAL ESTIMATION OF ROCKS

T.G.Ryashchenko (USSR)

Lithogenesis is considered as a totality of natural processes in the formation of sedimentary rocks. It goes on stage-by-stage and can be subdivided into types in accordance with climatic zonality. Engineering geological estimation of rocks means investigation of regularities in the formation of their composition, structure and properties at different stages of lithogenesis, as well as the dynamics of transformation of these indices under the effect of natural and anthropogenic factors.

Complex information is presented by the example of the South of East Siberia on Quaternary lithogenesis and engineering-geological estimation of the rocks: a regional scheme has been elaborated on the types of lithogenesis (the following types are distinguished: humid preglacial Eopleistocene, glacial Pleistocene, periglacial Pleistocene and humid post-glacial Holocene). Wide-scale development of "loess lithogenesis" has been established: a specific process of the loess-type of weathering, occurring under arid-cryogenic conditions of the Pleistocene and Holocene. Investigation has been carried out of the influence of exogenic factors, which include modern geographical zonality, annual weathering cycles, seasonal freezing-thawing, as well as diverse anthropogenic effects.

It has been established that, considering geosystems at the level of lithogenesis, cosubordination of its objects will be as follows: types of lithogenesis - geological-genetic complexes - lithological groups and rock species. Detailed investigations have been carried out in compliance with the given scheme of the "material" features of lithogenesis: structural, chemical, physical and mechanical indices of the rocks. Generalization of the available material (37,000 different analyses) has provided for detecting the characteristics of the Quaternary mantle of the region, determining the changeability of the features depending upon the type of lithogenesis, genesis and lithological composition of the sediments, and fixing the degree of stability of the features.

When estimating quantitatively interrelations between the features of lithogenesis (programs of correlation-regression, cluster and factor analyses have been applied), it has been established that their formation and variation are reflected in several basic factors, representing certain totalities of parameters-features, describing the phenomenon most completely and having a similar dispersion in multidimensional space. The "structural" factors (content of argillaceous fractions, degree of aggregation, exchange ability and plastic properties), the factor of "salinization" (content of water-soluble salts and organic matter, medium reaction), "carbonateness" (content of carbonate and coefficient of porosity), "compaction" (density and volumetric mass), "humidity and strength" (natural humidity, coefficient of relative subsiding ability, adhesion) have been determined. The leading role belongs to the "structural" factor.

The method of quantitative prediction of the loess rock subsiding ability has been elaborated on the basis of correlation-regression analysis.

The regressive and progressive character of the influence of natural and anthropogenic factors on the features of Quaternary lithogenesis has been established by means of regime observation and simulation.

1 -286-

INFLUENCE OF CLIMATIC CONDITIONS AND TECHNOGENIC IMPACTS ON THE MICROSTRUCTURE OF LOESSES OF DIFFERENT GENETIC TYPES

V.V.Sevostyanov (USSR)

A complex study of loesses has been carried out in regions with arid, semi-arid and humid climatic conditions in Middle Asia, southern Kazakhstan and in the middle Volga. The microstructure of the loesses of different age and genesis has been investigated in detail by means of various methods of optical and scanning electronic microscopy.

It is shown that an essential influence on the microstructure of loesses is rendered not only by their genesis, but also by the climatic conditions of the ancient and modern environment. Loesses of the same genetic type, that have already been formed and exist presently under different climatic conditions, may differ sharply by their microstructure and, as a result, by the engineering-geological properties (subsiding ability, permeability, etc.).

The relatively rapid technogenic changes in the conditions of the existence of loesses (variation of rock humidity, of stress field, etc.), connected with the economic activities of man, cause in some cases essential transformation of the microstructure and respective changes in the engineering-geological properties of the loesses.

Engineering-geological typification of the loesses is proposed, linking the most significant engineering-geological properties (subsiding ability, permeability, porosity, etc.) with the characteristics of the microstructure.

1 -313-

ON THE PROBLEM OF THE EXISTENCE OF A "DEAD HORIZON" IN THE LOESS STRATA AND ITS ENGINEERING-GEOLOGICAL SIGNIFICANCE

F.S.Tofaniuk (USSR)

The idea of the existence of an upper "living" and lower "dead" horizons in the loess strata with a boundary within 2-4 m from the surface gained numerous supporters and enemies during its almost 100 year long history but had not been, nevertheless, subjected to thorough checking.

To gain objective data observations of the humidity and temperature in the loess near the Ob River to a depth of 20 m have been carried out for many years by means of special sensors. Seasonal changes of the humidity in all the horizons of the investigated strata have been established with most considerable amplitudes (20-30 %) in the intervals of 3-8 and 14-16 m, which is determined by the penetration of cold and warm temperatures into the ground, as well as by an intermittent shift of the system from open (in summer) to closed (in winter).

Thus, one of the most significant characteristics of the loess life is not the presence of a "dead horizon", but its close relationship with the natural climatic zonality, which determines the heat and moisture budget of the territory and, thereby, the character of subaerial diagenesis, forming the engineering-geological properties and their changes in time and space.

2-89-

PRINCIPLES OF ENGINEERING-GEOLOGICAL MAPPING OF LOESS AND LOESS-LIKE ROCKS

O.G.Gouneshian, N.I.Kriger, V.M.Kharchenko, V.I.Botnikov, G.A.Zimina, A.D.Kozhevnikov, A.G.Petrov (USSR)

Loose and hard rocks as well as more complex systems formed by them are subdivided into inert rocks (changing geologically slowly) and sensory ones (environment sensitive, e.g., silt, frozen rocks, weathering crusts). Loess is understood as a rock (silty calcareous loam) or a more complex system with strictly definite occurrence conditions, stratification, fossil fauna, and chronology of sedimentation. Loess is a sensory system having its distribution area and, like a living organism, adapting to modern geographical environment.

Moisture, porosity, collapsibility, strength, compressibility, electrical and seismical characteristics of loess and similar rocks depend on climate, topography, and vegetation. Equations of dependences found by us have great correlative coefficients.

Classic methods and the mapping principle of professor I.V. Popov, taking into account dependence of rock properties on conditions of sedimentation, history of tectonic movements and climatic zonality, are used during engineering-geological mapping of areas of distribution of inert rocks. When mapping loess as a sensory system, dependence of its properties and composition on geographical environment should be used in the first place and I.V.Popov's principle, in the second. Air -photo and cosmo-photo interpretations assist the study of environment.

Taxonomic engineering-geological classification of mapped loess areas should be determined by the purposes of engineering-geological investigations, by the type of projected constructions and by the nature of supposed technogenic changes of rocks and environment.

2 -136-

LITHOECOLOGY AND ENERGETICS OF LOESS: PALEOGEOGRAPHIC AND GENETIC ASPECTS

N.I.Kriger (USSR)

Loess, like soil, represents a complex system which is a part of the landscape and depends on the geographical zonality law. The composition and properties of loess are adaptable to the environment. The theory of such an adaptation is called lithoecology.

The geographical distribution and properties of loess as a system are conditioned by the mobility of atoms, the strength of crystallochemical, molecular, colloidal, and other bonds in a substance; by the amount of water and its distribution in the biosphere; by the dynamics of atmosphere and the influx of solar energy. Loess consists of minerals with the different resistance to weathering. The resistance of minerals is proportional to the energy of a crystal lattice which is described by the models of ionic (SiO_2 - 3100, $CaCO_3$ - 650, NaCl - 180 kcal/mol) or atomic (SiO_2 - 445, NaCl - 150 kcal/mol) bonds.

The processes of weathering on the Earth depend on the distribution of the radiation balance R and aridity index β, therefore the distribution of minerals is geographically zonal. It determines the zonality of loess distribution: in the loess zone $0 < R < 50$ kcal/cm^2/y., $1 < \beta < 2$. Only these values of R and β are favorable for the sedimentation of dust: when $\beta < 0.7$, the formation of clay occurs, when $\beta > 2,5$, the salinization and deflation of soils take place. The considerable thickness of loess suggests the long existence of semiarid climate and the relative constancy of R and β. If during the formation of interglacial soils these parameters were intensely changing, loess was degrading.

Porosity of the soil is the evidence of potential energy of grains. The change of this energy: $\Delta U = g\delta\delta 0,5H^2$, where g is the acceleration of gravity, δ is the density of the soil, δ is the possible compressibility, H is the thickness of a stratum. For example, with the collapse of all loess rocks of the Earth, $\Delta U = 5.4 \times 10^{17}$ J.

The loess collapsibility can be explained by the growth of pressure of new accumulating deposits with the presence of salt cement which hinders the compaction of a rock. Considering this process to be an isochore one, the change of the entropy ΔS may be calculated. In the course of geological time, the entropy S increases and ΔU and ΔS decrease, in other words, loess degrades, being transformed into loam, especially in the humid climate ($\beta < 0,7$). Technogenesis accelerates the global process of loess transformation.

3 -227-

GENESIS OF COLLAPSIBILITY OF LOESS ROCKS

Y.M.Sergeyev, A.V.Minervin, N.N.Komissarova (USSR)

In the engineering geology of loess rocks, the origin of their collapsibility is considered from two different standpoints. The first of them explains its formation by an undercompaction of dusty deposits in the dry arid climate. A natural and laboratory modeling by the authors has shown that any kind of deposition of the material, petrographically corresponding to loess, under modern hot arid conditions, results in the formation of compact, strong, noncollapsible takyr rocks rather than collapsible loess.

The authors substantiate the second standpoint: the collapsibility is a result of the loss of compaction by dusty sediments and rocks under the influence of the seasonal and perennial cryolithogenesis. Two modern concepts are of a principal significance for the explanation of the loess collapsibility: (1) epochs of loess formation are connected with Pleistocene glaciations and global coolings and (2) loess rocks, during their geological life, were repeatedly frozen, both seasonally and perennially.

Cryogenic processes create a main structural element of loess rocks, globular aggregates 10 - 100 μm in diameter. Their cores are represented by quartz, less frequently feldspar blocks of a crystallographically regular shape; the blocks have perforated calcitic shells with a polymineral coating (clay minerals, iron oxides, amorphous silica, finely dispersed quartz and carbonates). An interaction of globular aggregates in the structure of collapsible loess rocks occurs through clay minerals of surficial coatings by means of ionic-electrostatic bonds. According to the modern concepts of physicochemical mechanics, the structure of loess rocks completely corresponds to a globular model of a porous body. Loess rocks correspond to the main postulates of the strength theory, reflecting peculiarities of finely dispersed porous bodies. A theoretically possible porosity of a dispersed loess system may vary from 26 to 47.6%. The porosity of collapsible loess rocks amounts to 46 - 50%, suggesting their extremely loose state. Non-collapsible varieties of loess rocks have a porosity of 35 - 40%, corresponding to the packing of ideal spherulites, close to the most compact one.

Collapsibility of loess rocks may be formed in two ways: (1) with sublimation of ice from highly porous, heaved dusty sediments of various genesis and (2) as a result of a geologically fast degradation of permafrost and dehydration of a system under conditions of specific phase transition of water. Freezing of water-saturated loesses results in the differentiation of an interstitial solution according to its concentration and in the lowering of the freezing point of its saline part. In the course of thawing, saline ice passes into a liquid state first, forming an electrolyte which evaporates under conditions of subzero temperatures. The rise of temperature results in a gradual thawing of ice, continuous evaporation of moisture, and desiccation of ground even before the reaching of abovezero temperature, which provides for the preservation of a general porosity of the system.

After the Holocene climatic optimum, the modern zonation of different in a nature and a degree of collapsibility loess rocks has been established. Within the permafrost zone the rocks with a thermal collapsibility are distributed. Collapsibility is absent within the taiga, bog, and meadow zones. Loess rocks of steppes, deserts, and semideserts have different thermal regimes, and maximum values of their collapsibility is established at the depth of annual fluctuations of temperatures.

3 -237-

GENESIS AND REGULARITIES OF SPATIAL CHANGEABILITY OF ENGINEERING-GEOLOGICAL CHARACTERISTICS OF LOESSES IN THE CHATKAL-KURAMIN SYSTEM OF STRUCTURES

M.S.Shermatov (USSR)

1. The Chatkal-Kuramin system of structures tectonically is the most active part of the Tien Shan and the main source of an initial material for the formation of loesses of various genetic types. A certain regularity in the distribution of these loesses can be observed. Thus, loesses of proluvial and alluvial genetic types widely distributed on piedmont plains; loesses of eluvial, deluvial and alluvial genetic types are distributed discontinuously in high foothills; loesses of eluvial, deluvial, and fluvioglacial genetic types are occasionally found in low and high mountains.

2. The study and analysis of various genetic types of loesses show that there are some regular changes in their thickness, composition, and properties from the upper to lower courses of river valleys, from the upper to lower parts of piedmont proluvial plains and from the higher parts of mountain slopes to their lower parts.

3. The thickest loesses are typical of the distribution areas of the proluvial (50-70 m), and deluvial-proluvial (up to 90 m) genetic types; the thinnest are found within the distribution areas of the eluvial (0.25-3 m) and fluvioglacial (up to 3 m) genetic types. The collapsibility of proluvial loess is strong (1-2 m), of proluvial loess-like deposits intermediate (0.5-1 m), of alluvial and deluvial loess, weak (0.15-0.5 m), of eluvial loess, very weak (less than 0.15 m). Fluvioglacial loess is noncollapsible.

4. On the surface of loesses within piedmont plains, collapses, loess pseudokarst, and gully formation can be observed. Landslides, earthflows, and mudflows are characteristic of high foothills, and earthflows and sheetwash are processes occurring in mountains.

Løss og løssproblemer i Kina

Norsk geogr. Tidsskr. 36, 17–22

GUNNAR RAMSLI

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Løss og løssproblemer i Kina

Løss er et vindtransportert (eolisk) finmateriale som dekker forholdsvis store områder på jorden. Navnet skriver seg fra det alemanniske dialektuttrykket *lösch* som betyr løs, dvs. lite konsolidert.

I Europa danner løssjordarter et mer eller mindre sammenhengende belte fra Belgia i vest til den sørlige delen av Russland i øst. Lenger sør finnes større løssavsetninger på begge sider av Rhin-dalen, langs nordsiden av Alpene og videre østover i Tsjekkoslovakia og Ungarn. I Nord-Amerika har løss bl.a. stor utbredelse i lavlandet sør og sørvest for de store sjøene, og i Sør-Amerika danner løssen den viktigste jordarten på den argentinske pampas.

Både i Europa og Amerika har løssdannelsen skjedd under de kvartære istider og i tilknytning til de ismasser som den gang dekket større eller mindre deler av kontinentene. Sterke utfallsvinder fra de isdekte områdene førte til at det fineste materialet i utenforliggende, vegetasjonsløse moreneavsetninger og glasifluviale avleiringer ble plukket opp av og fraktet videre med vinden. Lenger ut, hvor det var et vegetasjonsdekke, fortrinnsvis gressvegetasjon, ble så materialet fanget opp og avsatt i større eller mindre mektighet.

Løssen har en kornstørrelse som stort sett

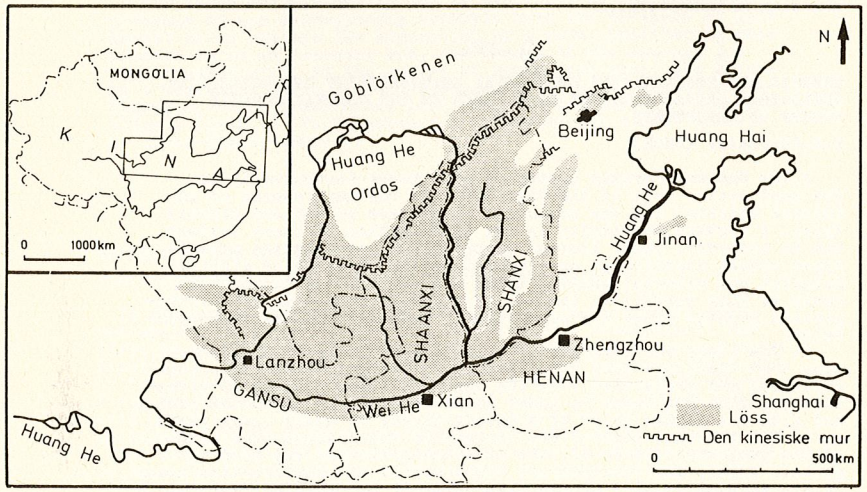

Fig. 1. Løssområdet i Nord-Kina.
The loess area in North-China.

Aust. J. Soil Res., 1983, **21**, 359–71

Effect of Climate on Morphological Features of Soils from Loess in the Southern Part of South Island, New Zealand

J. G. Bruce

Soil Bureau, DSIR, Gore, New Zealand.

Abstract

Soils developed in thick loess deposits in subhumid and humid climatic zones in the southern part of the South Island, New Zealand, form a continuum in which the morphological features occur in sequential order. The sequence consists mainly of soils belonging to the Fragiochrept and Dystrochrept great groups.

The climatic factor, particularly the moisture regime, is considered to be largely responsible for the differing morphological features.

The principal morphological features are fragipans and stratigraphically equivalent horizons that are not 'fragic'; gammate colour patterns; and mottling and gleying above the fragipan. These features show an interrelationship that is explained by the progressive modification and destruction of the fragipan due to the impress of the moisture regime.

Introduction

Soils developed in thick loess occur widely on terraces and downlands in the southern part of the South Island, New Zealand (Raeside 1964; N.Z. Soil Bureau 1968; Bruce 1972, 1978). This paper considers the properties and genesis of a sequence of loess soils developed within the region (Fig. 1).

The soils occur in subhumid and humid climatic zones (Garnier 1950) in which annual rainfall ranges from about 600 mm to more than 1100 mm, while the potential evapotranspiration is 615–645 mm (Table 1). Within these lowland regions the soil temperature regime is mesic (soil temperature regime and soil moisture regimes follow those of U.S. Department of Agriculture (Soil Survey Staff 1975)), and the soil moisture regime ranges from ustic to udic and perudic, and in places aquic.

Compared with climate, other environmental factors are regarded as having minimal effects on the broad pattern of soil morphological development. The loess parent material, though derived from a wide variety of rock types and source areas, is primarily a silt-textured aeolian deposit, which accumulated during the latter part of the last glaciation (Raeside 1964; Bruce 1973; Ives 1973). The topography in which the deep loess soils occur has local variations in slope, aspect and drainage, but in general the majority of soils are developed on flat to easy rolling land (0°–7°; 0–12% slope). The natural vegetation pattern was largely controlled by climate and over much of the region, at the time of European settlement (about 1840 A.D.), was tussock grassland and scrub. In places, particularly the moister southern

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Airborne dust fall on the California Channel Islands, U.S.A.

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A thin, light-colored, silt-rich deposit covers soils of various ages on the California Channel Islands. The widespread distribution of this layer and data on its particle size distribution, particle morphology and mineralogy suggest that it is of aeolian origin. Examination of Landsat imagery indicates that the main source for aeolian dust is the western Mojave Desert when easterly Santa Ana winds prevail several times each year. Dust fall rates on San Clemente Island are in the range of about 28–31 g/m^2/year and may reflect accelerated erosion of soil surfaces disturbed recently by human activity in the Mojave Desert.

Introduction

A distinctive surface horizon is present on many of the soils of the arid southern California Channel Islands. This horizon is generally thin (about 5 cm), massive, light-colored (10YR 6/3, dry; 10YR 4/3, moist) and has a silt loam texture with a silt content of around 60–65 per cent. It is abruptly underlain by clayey subsurface horizons with differing structure, texture, color and mineralogy. The silty layers are present on geomorphic surfaces ranging in age from less than 3000 to greater than 1,000,000 years and show no changes with age of surface. The purpose of this paper is to demonstrate that these layers have probably resulted from the accumulation of airborne dust.

Study area

The Channel Islands are located off the California coast (Fig. 1) and are sometimes divided into a northern and southern group. The present study is concerned with the origin of silty layers on the southern group (Santa Barbara, San Nicolas, San Clemente and Santa Catalina Islands).

Field and laboratory methods

Representative samples of the silty surface horizons were collected from geomorphic surfaces of various ages mainly on San Clemente Island (Table 1). Some samples were also collected from San Nicolas Island and samples from Santa Barbara Island were kindly provided by D. L. Johnson. Reconnaissance studies were made on Santa Catalina Island and the California mainland. Dust fall was measured at two locations (on the east and west sides) on San Clemente Island over a period of 1 year (July 1977 to July 1978) in dust traps consisting of metal boxes secured to the ground with iron stakes and filled with carefully cleaned unweathered beach cobbles. After the collection period, the accumulated dust was

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0140–1963/83/030223+16 $03.00/0

GRAIN SURFACE TEXTURES AND CARBONATE CONTENT OF LATE PLEISTOCENE LOESS FROM WEST GERMANY AND POLAND[1]

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ABSTRACT: Energy-dispersive analysis and X-ray mapping of West German and Polish loess grains observed under the scanning electron microscope (SEM) have shown that carbonate occurs primarily as detrital calcite and dolomite grains and not, as some earlier workers have suggested, as surface encrustations or "gnarls" on quartz and feldspar grains. This provides strong evidence against a process of "loessification" and indicates that the loess has experienced only slight postdepositional weathering and diagenesis. Secondary carbonate encrustations are sometimes found on grains in the B horizons of soils present within the loess, but such layers form only a relatively small proportion of the total loess thickness. All of the larger loess grains examined exhibit "rough" surface textures because of adhering fine silt- and clay-size particles of quartz, feldspar, mica, and calcium carbonate. No differences were observed between the surface textures of grains from fresh carbonate-bearing loess and those from decalcified samples treated with 50 percent HCl. Much of the fine debris can be removed from the grain surfaces by sonic vibration or, in more resistant cases, by HF treatment. The surface textures of quartz grains treated in this way typically show fresh, angular breakage features which are consistent with a glacio-fluvio-eolian origin.

INTRODUCTION

Loess may be defined simply as an eolian silt deposit consisting chiefly of quartz, feldspar, mica, and, in some cases, carbonate grains. It is distinguishable from pyroclastic ash-fall deposits in containing few, if any, volcanic glass shards. An eolian origin of loess has not been universally accepted, however, and some authors (Russell, 1944; Berg, 1964) have maintained that the characteristic properties of loess reflect postdepositional modification of noneolian deposits. A compromise position, adopted by Lozek (1965) in discussing the origin of Central European loess, is that "loess does not originate only by the accumulation of wind-blown dust, but also by a particular soil-forming process (loessification) that impresses to dust accumulations typical features of loess, especially the structure, calcareousness and colour."

Although agreeing that some postdepositional weathering and diagenesis of loess must occur, most workers now accept an eolian origin of the deposits (Smalley, 1975). However, the question of the nature and origin of calcium carbonate in loess has not been satisfactorily resolved. The problem was reviewed by Smalley (1971) who concluded that further detailed investigation was required. Attempts were subsequently made by Smalley and his co-workers to gain insight into the genesis of loess using scanning electron microscopy, a technique which has been shown to be a valuable tool in studies of the nature and environmental history of sand grains (Krinsley and Margolis, 1969). Smalley (1970) examined loess grains from Karlsruhe, West Germany, and found the particles to exhibit "rough" surface textures under the SEM. Three components were suggested as contributing to the rough textures: adhering clusters of clay minerals, adhering fine quartz, and calcium carbonate encrustations. Smalley and Cabrera (1970) proposed that much of the adherent material on these grains and others from the Nebraska loess represented comminution debris formed by glacial grinding. This interpretation was questioned by Warnke (1971) but reaffirmed by Smalley et al. (1973). It was also concluded from the SEM studies (Smalley, 1970; Cegla et al., 1971) that calcium carbonate in German and Polish loess occurs as sec-

[1]Manuscript received March 5, 1982; revised November 16, 1982.

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 0022-4472/83/0053-0973/$03.00

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Publié en octobre 1983

ENGINEERING GEOLOGY

Microstructural Sensitivity of Loesses

by

Barbara GRABOWSKA-OLSZEWSKA

Presented by W. POŻARYSKI on February 16, 1983

Summary. The paper presents the results of studies on the factors determining collapse in loesses, conducted for many years by the author. Late Pleistocene subaerial loesses and some older ones, occurring within the extent of seasonal frost, were found to be most susceptible to the development of this phenomenon. The collapse takes place due to a rupture of weak bonds supporting clay bridges between loess aggregates, resulting from the influence of water. This is accompanied by a change in distribution of the size of pores. The collapse appears connected with reduction of micro- and mesopores 1–1000 μm in size and also a part of macropores. The total percentage of these pores is estimated at slightly over 10% of rock porosity. Micropores below 1 μm in size do not take part in this process despite their marked share in the total porosity.

Collapse is one of the most interesting phenomena observed in some lithological types of loesses which are saturated. Existing literature on that subject is considerable but its ordering appears rather difficult. This is because individual authors used to present various criteria in evaluating that phenomenon, depending on the knowledge of factors determining its development. For several years much work on this phenomenon has been done in Poland [3–5, 8–11, 14 and others] on the basis of which it was assumed that the i_{mp} values*) can be related to the origin, lithology (including moisture) as well as general structural–textural features of loesses.

The results of my investigations on loesses, carried out for many years in various regions in Poland, show that:

*) i_{mp}—a coefficient for qualitative representation of collapse defined in oedometer tests according to the formula: $i_{mp} = (h - h') : h_0$, where h_0 is the original height of a sample with a natural moisture content prior to the application of stress, h—the height of the sample with a natural moisture content under a given stress, o.g. 0.2 MPa- h'—the height of the sample completely saturated with water under the same stress, e.g. 0.2 MPa. When the i_{mp} value ⩾ 0.02, loess structure is defined as unstable (which means that the loess represents a hazard in construction work), and when i_{mp} is below 0.02—as stable.

Geochemistry of loess, continental crustal composition and crustal model ages. S.R. Taylor, S.M. McLennan and M.T. McCulloch. Geochimica et Cosmochimica Acta 47, 1987-1905, 1983.

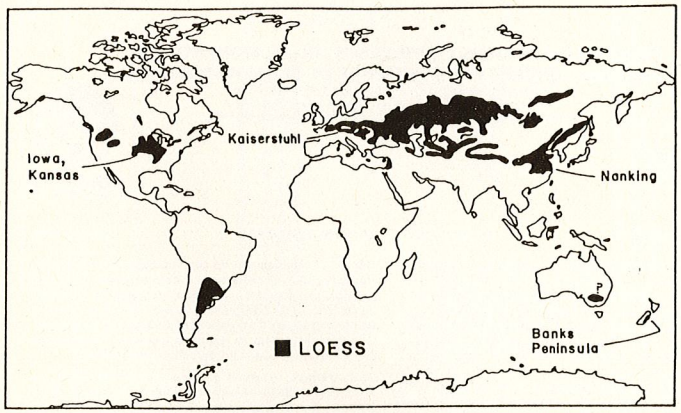
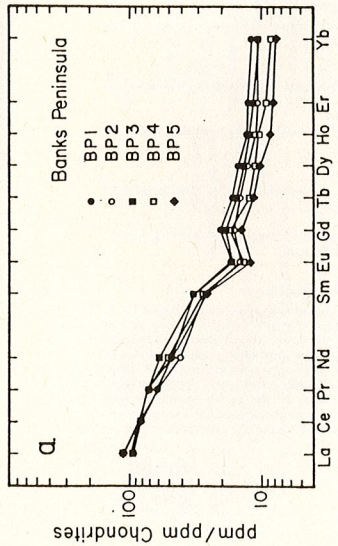


FIG. 1. Map showing the distribution of loess deposits. Loess covers approximately 10% of the world's land surface.



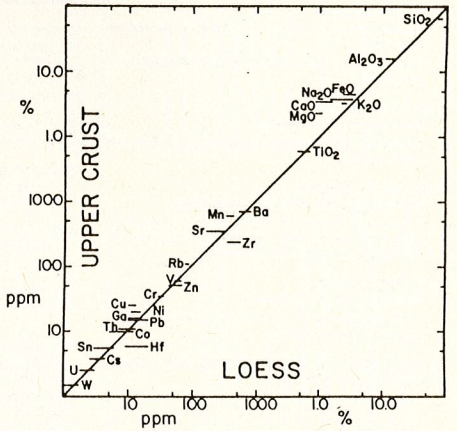


FIG. 2. Comparison diagram for the major and trace element composition of the upper continental crust (TAYLOR and MCLENNAN, 1981) and the range of relatively unweathered and non-carbonate loess samples (*i.e.* excluding Nanking and Rhine Valley samples). Loess is enriched in silica and depleted in most other major elements when compared to the upper crust. This is most likely related to preferential enrichment of quartz. Note that there is a general agreement between upper crustal abundances and loess for many trace elements. The strong enrichment of Zr and Hf in the loess is particularly noteworthy and is related to concentration of zircon.

FIRST INTERNATIONAL CONFERENCE ON GEOMORPHOLOGY
Geomorphology, Resources, Environment and the Developing World
Manchester 15-21 September, 1985

FIRST INTERNATIONAL CONFERENCE ON GEOMORPHOLOGY
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Organised by the British Geomorphological Research Group
Organisé par le British Geomorphological Research Group
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BGRG

SECOND CIRCULAR December 1983

Over 600 people from 65 different countries have responded to the first circular, copies of which are still available from the address above. A strong academic programme of paper presentations, discussions and poster sessions has been developed, and it is expected that leading geomorphologists from all continents and from private industry, government organisations and academic institutions will attend. This circular contains a booking form, a formal call for papers which requires the submission of an abstract. Conference participants are asked to take particular note of the deadlines included in this circular. The Conference has two official languages, English and French. Abstracts and papers must be in one of these two languages. The Conference Organisers are unable to provide a translation service.

The Conference Programme

Evening plenary sessions

Sunday, 15th September:
Opening session and introductory lecture on the development theme
Geomorphology, Resources, Environment and the Developing World.

Tuesday, 17th September:
The Future of Geomorphology
A forum to discuss the development of the subject with invited speakers.

Wednesday, 18th September:
International collaboration in Geomorphology
A discussion on ways in which national organisations might work more closely together and on the need for wider geomorphological co-operation.

Friday 20th, September:
Geomorphology and development
A full discussion on the practical applications of geomorphology and closing session.

All plenary sessions will take place at Owens Park, University of Manchester at 20.00 hrs.

Paper Presentations

Papers will be presented in a number of parallel sessions devoted to specific themes, Each day from Monday 16th to Friday 20th September will see several paper presentation sessions in each lecture theatre being used for the themes of that day. Speakers normally will be allowed 20 minutes to present their papers, with a few being allowed longer. In each session three papers will be presented with a total of 15 minutes for

SECONDE CIRCULAIRE Janvier 1984

Plus de 600 personnes de 65 pays ont répondu à la première circulaire, dont des exemplaires restent disponible à l'adresse ci-dessus. Un programme scientifique rigoureux de communications écrites, de discussions et de présentation de posters a été élaboré, auquel il est prévu que participeront des géomorphologues de pointe de tous les continents, d'organismes privés, d'administrations et d'institutions universitaires.

Cette circulaire comprend un formulaire de réservation, un appel aux communications sous réserve de l'envoi d'un résumé. Les participants sont priés de prendre bonne note des dates limites précisées dans cette circulaire. Le congrès a deux langues officielles: l'anglais et le français. Les résumés et les communications doivent être fournis dans une de les deux langues, les organisateurs du congrès ne pouvant se charger de la traduction.

Programme du Congrès

Sessions pleinières du soir

Dimanche 15 septembre:
Session d'ouverture et conférence d'introduction sur le thème: développement
Géomorphologie, resources, milieu naturel et pays en voie de développement

Mardi 17 septembre:
Forum sur le développement futur de la géomorphologie

Mercredi 18 septembre:
Discussions sur les collaborations internationales en géomorphologie

Vendredi 20 septembre:
Discussion sur Géomorphologie et Développement: Séance de cloture

Toutes les sessions pleinières auront lieu à Owens Park, Université de Manchester, à 20 heures.

Présentation des communications

Les communications seront présentées lors de sessions qui se dérouleront parallèlement, selon les thèmes. Chaque jour de lundi 16 septembre à vendredi 20 septembre verra plusieurs séances de communications dans chaque salle de conférence consacrées au thème du jour. Les conférenciés disposeront de vingt minutes de parole pour présenter leur communications, quelques uns disposeront de plus de temps. Dans chaque séance trois communications seront présentées avec un total de quinze minutes pour la discussion. Les séances seront organ-

FROM

Title Name Forenames

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Hotel I wish to reserve ☐ a single room ☐ a twin room (two persons)
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or a deposit of £10 per person ☐
☐ I wish to have a double room (same price per person)
Or ☐ I wish to reserve accommodation at Owens Park (University residence) for the period .....to .....September 1985 (.....nights) for .....persons and enclose **either** the full fee of **£16 per night** per person
or a deposit of £10 per person ☐

Pre-Conference Excursions
I would like to reserve .....places on the pre-Conference excursion to
(You may number 1,2,3 in order of preference in case excursions are fully booked)
and enclose a non-returnable deposit of £5 per place
£.....

Please number
Northern Ireland ☐
Scotland ☐
Wales ☐
Lake District ☐
Peak District ☐

Post-Conference Activities
(Please indicate your first choice as 1 and an alternative as 2)

Please number
Excursion to south and south west England ☐
Excursion to English Midlands ☐
Workshop on soil stability and erodibility ☐
Workshop on catchment instrumentation ☐
Workshop in sediment analysis ☐
Workshop in geomagnetic monitoring ☐
Workshop in remote sensing ☐
Workshop in simulation and computer modelling ☐

Places booked on excursion/workshop/symposium persons ☐

I enclose a non-returnable deposit of £5 per place
£.....

Accompanying Persons Programme
I would like to reserve places on the following tours and enclose a non-returnable deposit of £2.50 per place

Tour	Number of places
Z1	☐
Z2	☐
Z3	☐
Z4	☐
Z5	☐
Z6	☐
Z7	☐

Total deposits £.....

TOTAL FEE AND DEPOSITS ☐

Payment must be made by Bank Certified Cheque in Pounds Sterling and made payable to "First International Geomorphology Conference".

Please return the form by September 30th. 1984. if at all possible.

LL11: April 1984: Contents

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