LOESS LETTER 37

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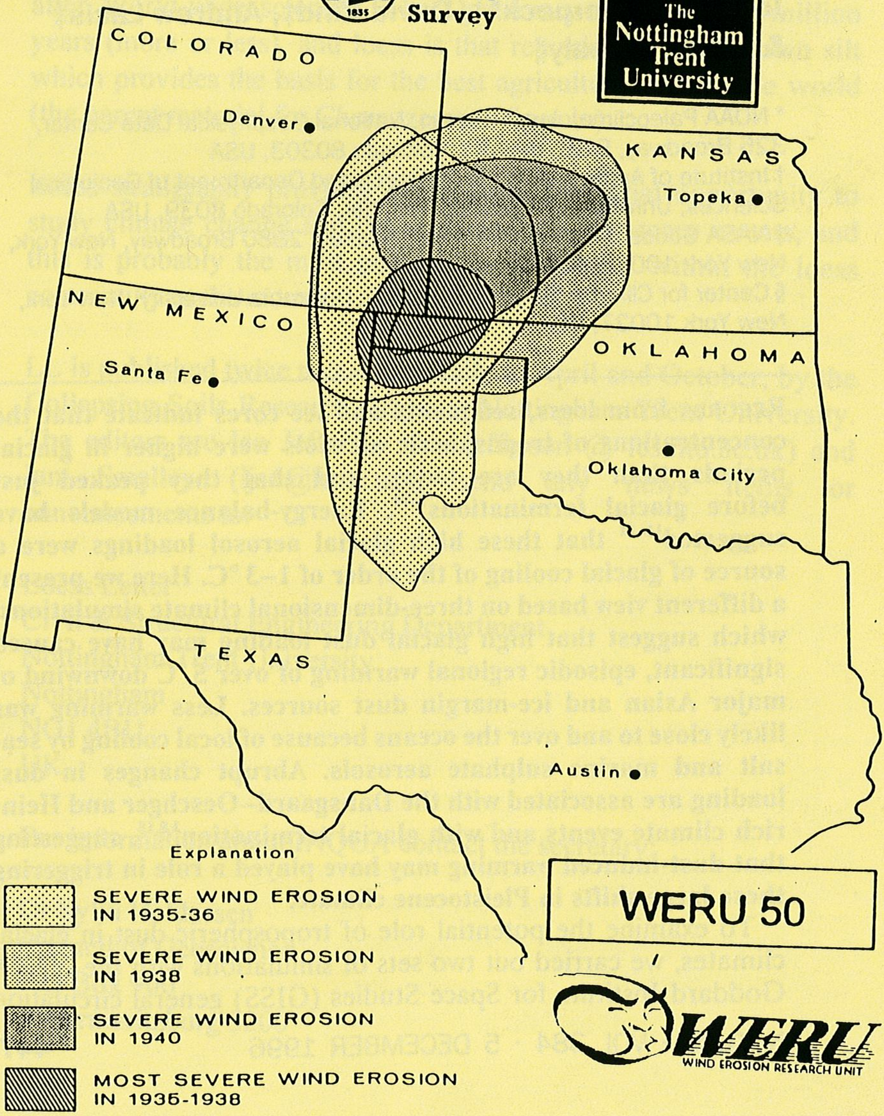
WINDY DAY 1997

British Geological Survey

The Nottingham Trent University



WERU 50

WERU
WIND EROSION RESEARCH UNIT

Possible role of dust-induced regional warming in abrupt climate change during the last glacial period

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RECORDS from loess, sediments and ice cores indicate that the concentrations of tropospheric aerosols were higher in glacial periods than they are today, and that they peaked just before glacial terminations[1-10]. Energy-balance models have suggested[11-14] that these high glacial aerosol loadings were a source of glacial cooling of the order of 1–3 °C. Here we present a different view based on three-dimensional climate simulations, which suggest that high glacial dust loading may have caused significant, episodic regional warming of over 5 °C downwind of major Asian and ice-margin dust sources. Less warming was likely close to and over the oceans because of local cooling by sea-salt and marine sulphate aerosols. Abrupt changes in dust loading are associated with the Dansgaard–Oeschger and Heinrich climate events and with glacial termination[3,8,15], suggesting that dust-induced warming may have played a role in triggering these large shifts in Pleistocene climate.

To examine the potential role of tropospheric dust in glacial climates, we carried out two sets of simulations with the NASA Goddard Institute for Space Studies (GISS) general circulation

Loess Letter 37: April 1997

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

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

LL is published twice a year, normally in April and October, by the Collapsing Soils Research Group at Nottingham Trent University. The editors are Ian Jefferson (Ian.Jefferson @ fes.ntu.ac.uk) and Ian Smalley (ijs4@le.ac.uk): send any news items or announcements to:

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

LL37. A special issue to celebrate the 50th anniversary of the USDA Wind Erosion Research Unit at Manhattan, Kansas; and also to complement the "Windy Day" meeting at Nottingham Trent University on 2 April 1997. The 50th anniversary of WERU is being celebrated by a conference at the KSU campus 3-5 June 1997. LL sends greetings to delegates at the WERU conference, and to participants the Windy Day discussions. Contact WERU at http://weru.ksu.edu, Internet registration for the conference is possible. LL circulation lists are being revised and updated - a good moment to make sure that we have your correct address.

Cover. A map from "Dust Bowl" by Donald Worster (OUP 1979). This is a classic study of the areas worst affected by the wind erosion problems of the 1930s. In addition to the general map on the cover we reproduce maps of Haskell County in Kansas and Cimarron County in Oklahoma. The shaded parts of the state maps show where the worst erosion occurred. The cover picture has appeared in LL before, when the Worster book was reviewed in LL5.

LL13. We republish the front of LL13, published in April 1985. This was the last time that LL had a major wind erosion issue. LL13 supported the meeting of the South Central Cell of the Friends of the Pleistocene which was held in Baton Range and neighborhood in April 1985. By a fantastic coincidence one of the days of the meeting, April 14 1985 was exactly (to the day) 50 years after Black Sunday April 14 1935. And - April 14 1985 was also a Sunday. Most of the FOP group woke up that morning in the Ramada Inn on top of the loess bluffs at Natchez. Travelling past a wall of loess near Vicksburg we noticed that some wit had incised the words "Pink Floyd" into it. Pink Floyd and the Wall of Loess. LL13 comes from the Canadian period of LL - hence the bi-lingual title. To keep up with our bi-lingual traditions LL37 publishes some extracts from Genevieve Coude Gaussens 1991 book on Saharan dust - Les Poussières Sahariennes. The "Great American Desert" turned out to be not a desert at all, but there are no doubts about the Sahara. This is a great and windy desert and soil erosion causes problems for the communities on the periphery.

Chepil & Woodruff 1963. Another in the LL series on classic literature. Obviously with LL37 having a wind erosion theme we select a wind erosion classic. "The physics of wind erosion and its control" by W S Chepil and N P Woodruff, published in Advances in Agronomy no.15, pp 211-302, 1963. Very suitable for LL37 since it originates from USDA, Manhattan, Kansas. An important and much cited review and a critical document in the literature of wind erosion. We reproduce some choice parts - read and reflect.

Soil Physics. T J Marshall & J W Holmes 1988. A view from Australia, M & H have a small section on wind erosion - which we reproduce. Note that the key reference is Chepil & Woodruff (1963) and also that the section is a bit short on detail and discussion. It suggests that from the soil physics viewpoint wind erosion is not a particularly relevant problem - perhaps the soil physicists see the solution more in term of soil engineering, of wind breaks and shelter belts. But the real wind erosion problem can be investigated at the soil physics level, at the particle nature, soil structure, interparticles bond level. In the soil erosion equation

$$E = f(I,C,K,L,V)$$

The factor I, soil erodibility, is the key factor - if we are interested in studying the actual processes of soil erosion. This functional equation is a practical equation (see the Chepil & Woodruff extract); we need to probe to a deeper, more fundamental level, to look at the factors that influence erodibility.

$$I = f\text{ (bond strength, particle size, water content, particle packing, soil structure, etc)}$$

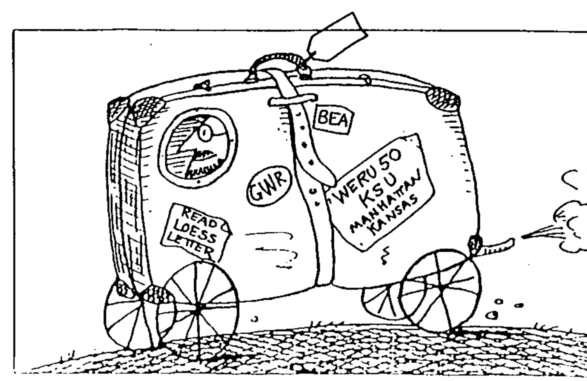
These are the factors - related to soil physics - that we need to investigate.

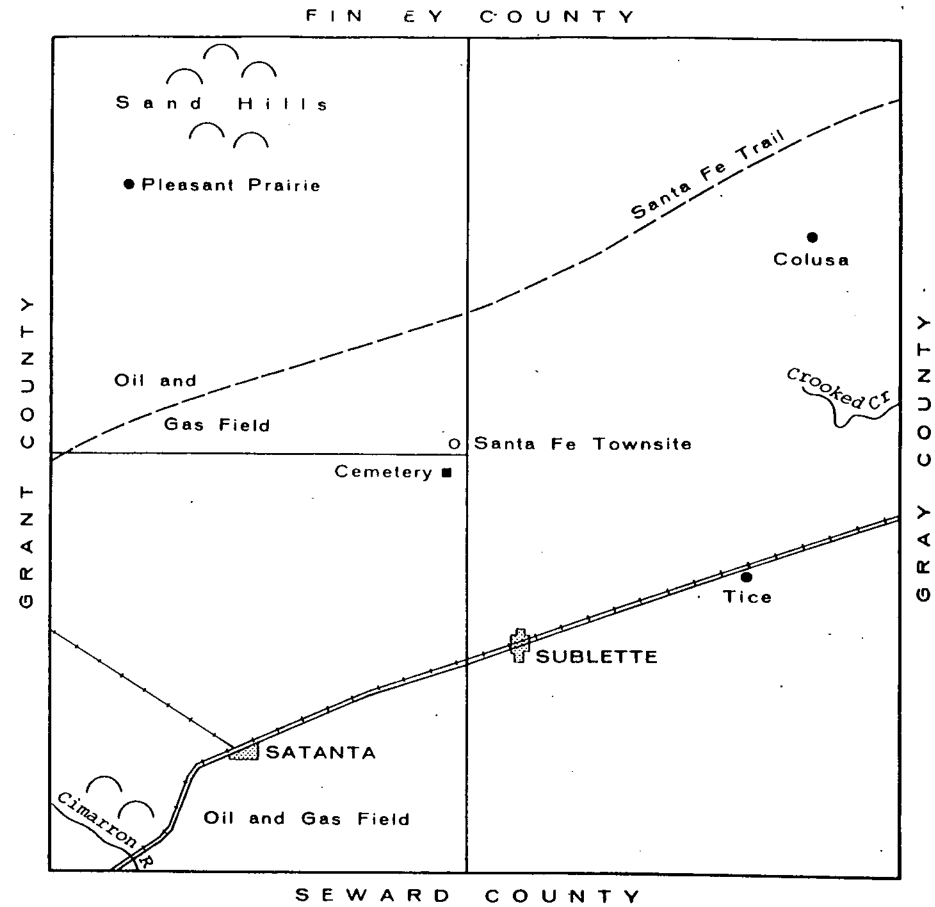
We focus on the search engine "Nlight N" (http://nln 5001.nlightn.com). On 2 December 1996 it registered 1255 hits when asked to search for "Loess". We like the idea that news about loess is available in the "News Briefing Index" and commend this service to LL readers. We reproduce a page of NlightN material to offer a taste of what is available.

Hot Bot performed well on "Soil erosion by wind" achieving 7712 hits. It popped up the wind erosion poster from Alberta, the piece by Cheryl Neuman from Trent University, and various lists and interesting things from WERU. We reproduce a selection. We would welcome any thoughts and comments from LL readers on the use of the various search engines to examine the loess data on the Internet. Also remember to send your news items to "loess-info@ univ-rennes1.fr) for display on the 'loess infor' new service.

LLate News.

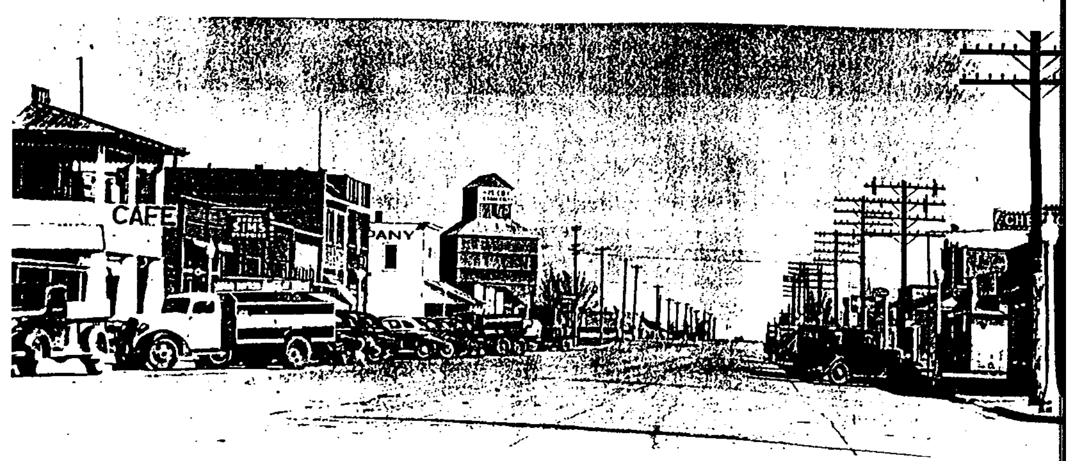
A new joint project has been launched by the Engineering Geology Group of the British Geological Survey and the Geotechnical Research Group at Nottingham Trent University. The project title is 'Nature, Formation, Distribution and Geotechnical Properties of the Brickearth in Britain'. The aim is to provide the first total overview of the loessic brickearth in Britain. John Catt at Rothansted Experimental Station has blazed an inspiring trail round the UK loess. This joint project helps to continue his work, adding a geotechinical dimension.



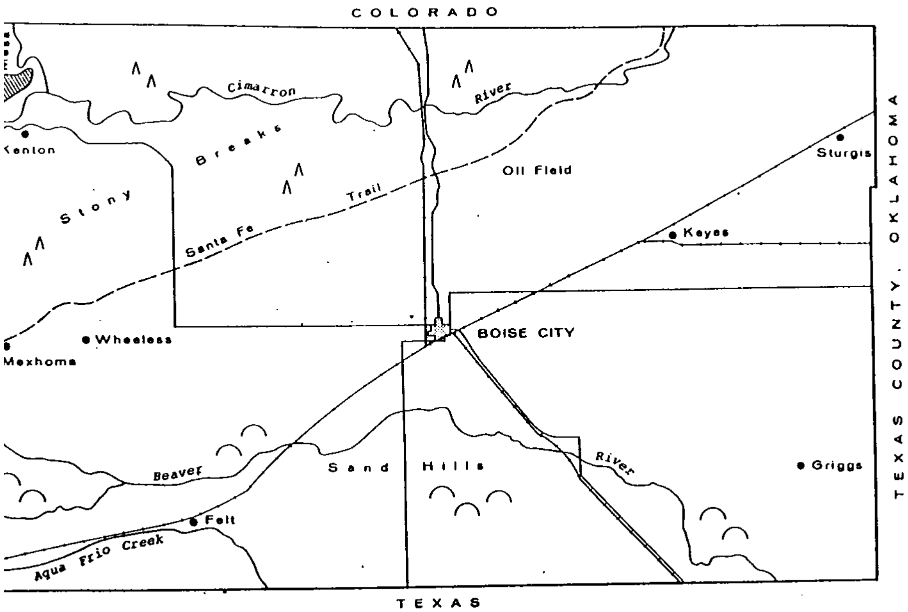


HASKELL COUNTY, KANSAS

1935



The main street of Sublette, Kansas, in 1941. (*Irving Rusinow, National Archives*)



CIMARRON COUNTY, OKLAHOMA

1935

Symposium

1947-1997

50th Anniversary

US Dept. of Agriculture
Agricultural Research Service
Wind Erosion Research
at Kansas State University

LES POUSSIÈRES SAHARIENNES

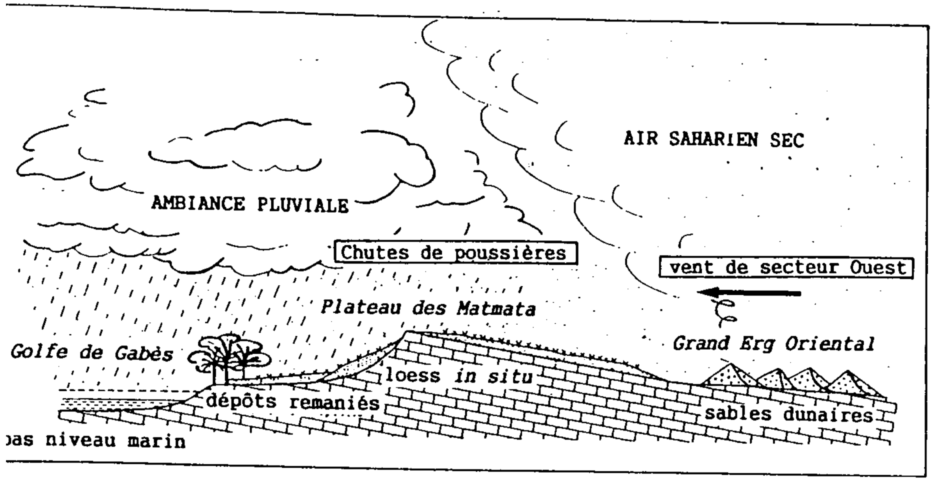
Geneviève Coudé-Gaussen

John Libbey EUROTEXT

Comme dans la plupart des déserts, il y a au Sahara deux manifestations importantes de la dynamique éolienne : les sables désertiques et les poussières. Mais, par opposition aux sables désertiques qui constituent des étendues dunaires considérables, géographiquement bien circonscrites, pérennes à l'échelle historique et que l'homme a appris à éviter ou à traverser, le phénomène des poussières éoliennes a un caractère moins bien défini dans l'espace, plus imprévisible dans le temps, moins bien compris et anciennement redouté. Au Sahara, les poussières ont longtemps inquiété les nomades qui voyaient dans leurs tourbillons la manifestation de génies maléfiques. De même, au-delà des mers, en Europe ou au Moyen-Orient, les pluies de sang ont eu depuis toujours la signification de très mauvais présages... Cette inquiétude a été l'expression populaire d'une longue méconnaissance du phénomène. Pendant longtemps, on n'a pas compris la nature des poussières, on ignorait leur provenance, leur mode de déplacement et les raisons de leur chute.

Fondamentalement, le «phénomène poussières» n'existe que par la convergence de deux facteurs : la présence d'un stock de particules très fines potentiellement mobilisables et celle d'un vent suffisamment fort pour les mobiliser. L'environnement désertique est particulièrement propice à cette convergence mais, d'une part, tous les substrats ne sont pas également aptes à libérer ces particules fines et, d'autre part, le vent n'y montre pas partout la même compétence. Le premier problème concernant les poussières sahariennes est donc de localiser leurs zones-sources, d'en apprécier la productivité et de s'interroger sur les processus de libération des particules. Une fois mobilisées, les poussières se déplacent en suspension plus ou moins loin vers les marges du Sahara et au-delà. Les trajectoires des lithométéores sont diverses mais s'inscrivent néanmoins dans la logique de situations météorologiques-types. Les caractères sédimentologiques du matériel varient ou non pendant ce transport, jusqu'à la chute des poussières.

Il existe donc un *cycle actuel des poussières sahariennes* dont l'étude s'avère indispensable à la compréhension du rôle que les poussières ont joué, par le passé, dans les sédimentations désertiques et péridésertiques.



gure 151. – Le modèle sédimentaire des loess péridésertiques dans le paléoenvironnement pluvial du ;istocène supérieur des Matmata.

Conformément à la reconstitution paléoclimatique proposée par Rognon [8, 9, 10, ., 12, 13], la trajectoire des dépressions polaires s'est déplacée sur l'Afrique du Nord et le émont saharien de l'Atlas, occasionnant des pluies orographiques et développant sur les arges sahariennes des *conditions pluviales* au Pléistocène supérieur. Balayant largement le ihara septentrional, en particulier le Grand Erg Oriental à l'Ouest des Matmata, des vents : large secteur Ouest ont mobilisé les poussières désertiques, d'autant plus facilement que *rétrécissement du gradient climatique zonal* sur ces latitudes provoquait de fortes turbulences 4]. Pour les mêmes raisons de rétrécissement zonal, le *gradient d'humidité devait être brutal* r ces marges désertiques et entraîner des pluies sur les reliefs. De plus, l'orientation Nord-Sud ı plateau des Matmata faisait obstacle aux perturbations d'Ouest et son dispositif en revers cuesta favorisait les premières pluies orographiques. Dans ces conditions de *rabattement mide*, l'atmosphère chargée de poussières était lavée : d'une part, la fraction grossière quart-use précipitait particulièrement, comme on l'a vu dans de telles conditions pour les poussières tuelles; d'autre part, la fraction fine, carbonatée et argileuse, précipitait aussi dans ce contexte *ıvio-éolien* propice au lessivage complet (*scavenging*) de l'atmosphère. Ces conditions d'hu-dité sont donc à l'origine de chutes massives de poussières, étant entendu qu'il faut limiter sa juste mesure ce caractère «pluvial» du climat pléistocène sud-tunisien, en insistant sur degré d'humidité seulement légèrement supérieur à l'actuel. On note, et on y reviendra, e les périodes de léger accroissement d'humidité, contemporaines de la formation des pa-ısols, se sont nécessairement signalées par une vraisemblable augmentation des chutes de ussières, d'ailleurs plus grossières si l'on en croit certains des caractères granulométriques evés dans les paléosols.

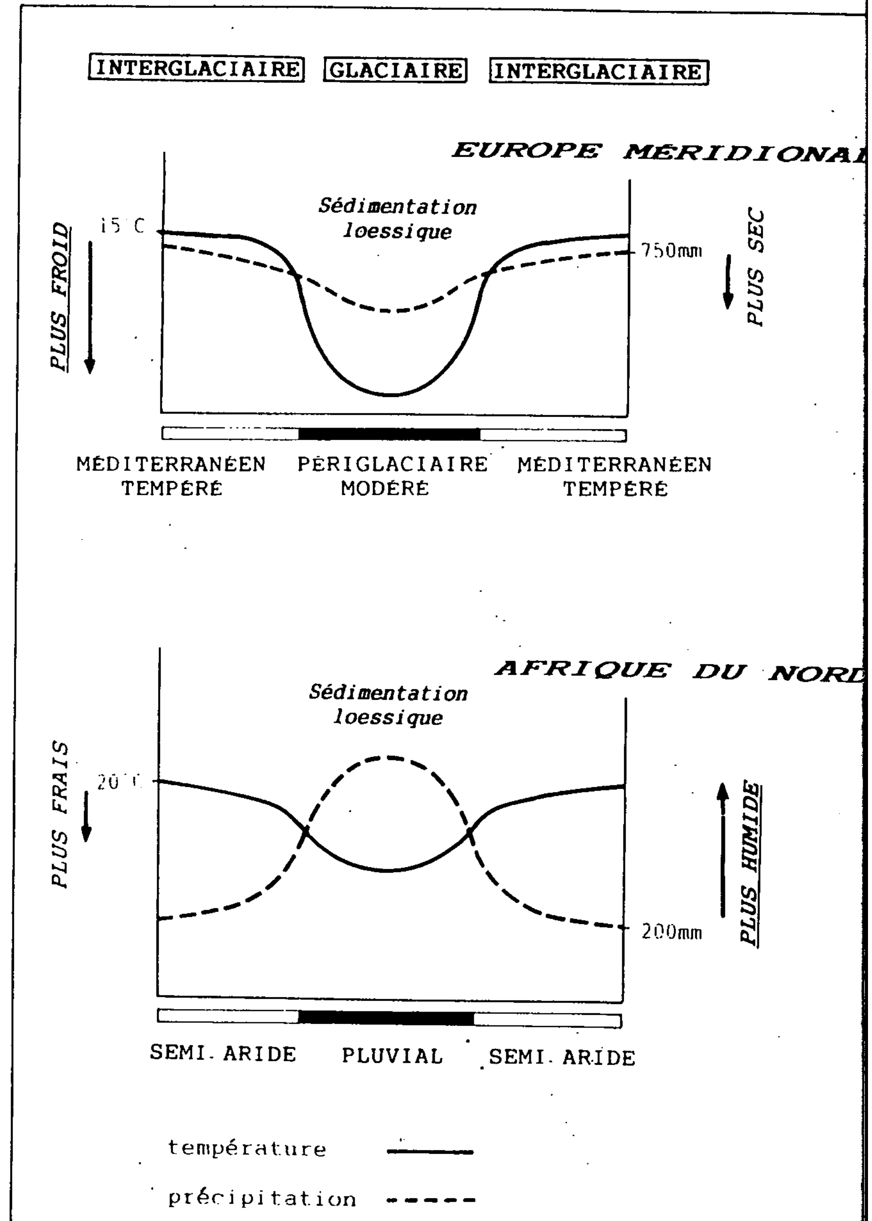


Figure 154. – Comparaison des conditions paléoclimatiques des sédimentations loessiques en méridionale et en Afrique du Nord pendant un cycle théorique glaciaire/interglaciaire.

Wind erosion

The development of our understanding of wind erosion was in a large part due to Bagnold, working in England and northern Africa on desert sands, and to Chepil, working in Saskatchewan, Canada, and Kansas, USA, on eroding soils. Bagnold (1941) showed erosion to be basically due to grains being moved up from the surface of a sand bed and then accelerated horizontally by wind before dropping back to the bed. The impact of these grains hitting the bed at an angle of 10° or less forces other grains upward. Rising more or less vertically, these go through the same bounding movement and the number participating increases as the process intensifies downwind. This movement was called 'saltation' by Bagnold, the term already employed for the bounding movement of sand under running water.

Grains in saltation are responsible for two other kinds of movement. One of these is the creep of larger grains pushed along the surface by impacts and the other is the suspension of small grains disturbed by impact and carried up by eddies in the turbulent flow of air. This material is removed by the wind as dust. While the height of saltation is restricted to about a metre and is usually less than 30 cm, dust is carried up to heights of several kilometres in dust storms. The sizes of grains moved by creep, saltation and suspension overlap, but as a rough guide they can be considered to be, respectively, in the ranges 2 to 0.5, 0.5 to 0.1 and <0.1 mm in diameter. Dust sampled close to the source by Delaney and Zenchelsky (1976) and hundreds of kilometres from it by Walker and Costin (1971) had a relatively high content of organic matter. This is in part attributable to fragments of plant material which are readily carried off because of their low density.

The threshold velocity, v_t, of air at height, z, required to start the chain reaction of saltation by moving exposed grains of diameter, d, and density, ρ, is given by Bagnold (1941, p. 101) as

$$v_t = 5.75a\left(\frac{\rho-\rho_a}{\rho_a}gd\right)^{1/2}\log(zk^{-1}) \qquad (9.12)$$

where ρ_a is the density of air (1.2 kg m^{-3}), k is a length representing the roughness of the surface, g is the acceleration due to gravity and a is a constant for an erodible material. The value of a is increased considerably if the roughness is contributed to by projections and barriers of non-erodible material, as discussed by Chepil and Woodruff (1963, p. 244). Movement of a grain results, at or above the threshold velocity, from a higher pressure on the upwind than on the downwind side and a relatively low pressure on the upper part of the particle due to the Bernoulli effect from the speeding up of the air flowing over the top of the grain. Bisal and Nielsen (1962), observed microscopically that grains 0.1 to 0.5 mm in diameter can be lifted directly from a bed without having first to roll along the surface.

Wind erosion can be controlled by keeping soil covered with plants or plant residues that reduce the velocity of the wind at the soil surface, by maintaining it in a cloddy condition if tilled so as to expose aggregates too large to be moved by the wind, or by tilling it in strips across the direction of the prevailing erosive wind so as to restrict the distance over which saltation can build up. The protection afforded by aggregates larger than 1 mm in diameter and by cover is illustrated in Fig. 9.14 by the increased wind velocity required to initiate erosion in a wind tunnel when aggregates and cover were increased. Here the plant cover was stubble 15 cm high. Plant residues can be retained by using stubble mulching machinery that leaves trash anchored but not buried, by minimum tillage, or by retiring the land from cropping. It may be noted that wind velocity for Fig. 9.14 was measured at a height of 30 cm, and since the velocity increases with height it is accordingly greater than the velocity needed to move the grains.

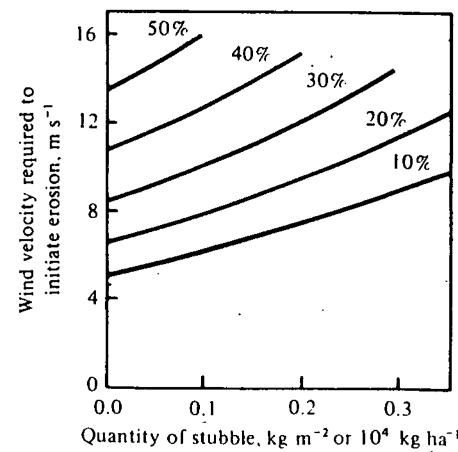


Fig. 9.14. Velocity of wind measured at a height of 0.3 m required to initiate erosion of the surface beneath a standing stubble. The curves are distinguished as the percentage of the soil in aggregates >0.1 mm diameter (Bisal and Ferguson, 1970).

The strength as well as the size of the aggregates has to be considered, because to remain large the aggregates have to be both strong enough to withstand abrasion when dry and sufficiently stable to avoid collapse if wetted by rain. Aggregates of sandy soils are not as strong nor as water stable as those of soils with higher clay content and are consequently more easily eroded. Rain can confer some resistance to wind erosion by means of the crust that remains after the soil has dried, but abrasion by grains in saltation can break this down. The strength conferred on grain and aggregate clusters by water films makes soils immune to wind erosion so long as they remain moist and this confines the problem mainly to low rainfall areas. Chepil and Woodruff (1963) cover the contributions of Chepil in this field of research. Chepil used repeated dry sieving with a rotary sieve to measure abrasion and modulus of rupture to measure strength. For clusters too weak to be handled in a modulus of rupture test, Smalley (1970) concluded that erodibility decreases with increasing tensile strength, which for weakly cohering grains was inversely proportional to the cube of the diameter of the grains forming the cluster.

The amount of soil lost by wind erosion under specified conditions and conversely the conditions required to restrict erosion to a limited amount are given by a wind erosion equation developed by Chepil and described by Chepil and Woodruff (1963) and Woodruff and Siddoway (1965). The mass of soil lost per unit area per year is expressed as

$$E = f(I, C, K, L, V) \tag{9.13}$$

where I is the erodibility of the soil, C is a climatic index, K represents the roughness of the surface, L is the length of the field in the direction of the prevailing erosive wind and V is an index of the vegetation cover. I is determined as mass per unit area per year from an inverse relation of erodibility to the percentage of the soil in particles or aggregates >0.84 mm as measured on a rotary sieve. K is based on an average height of ridges and clods that trap abrading particles. In L, allowance is made for the protection extending a distance $10h$ from a windbreak of height, h. V covers the quantity, kind and row orientation of plants and residues. E is assessed with the aid of charts and tables and a computer program is also available (Skidmore, Fisher and Woodruff, 1970).

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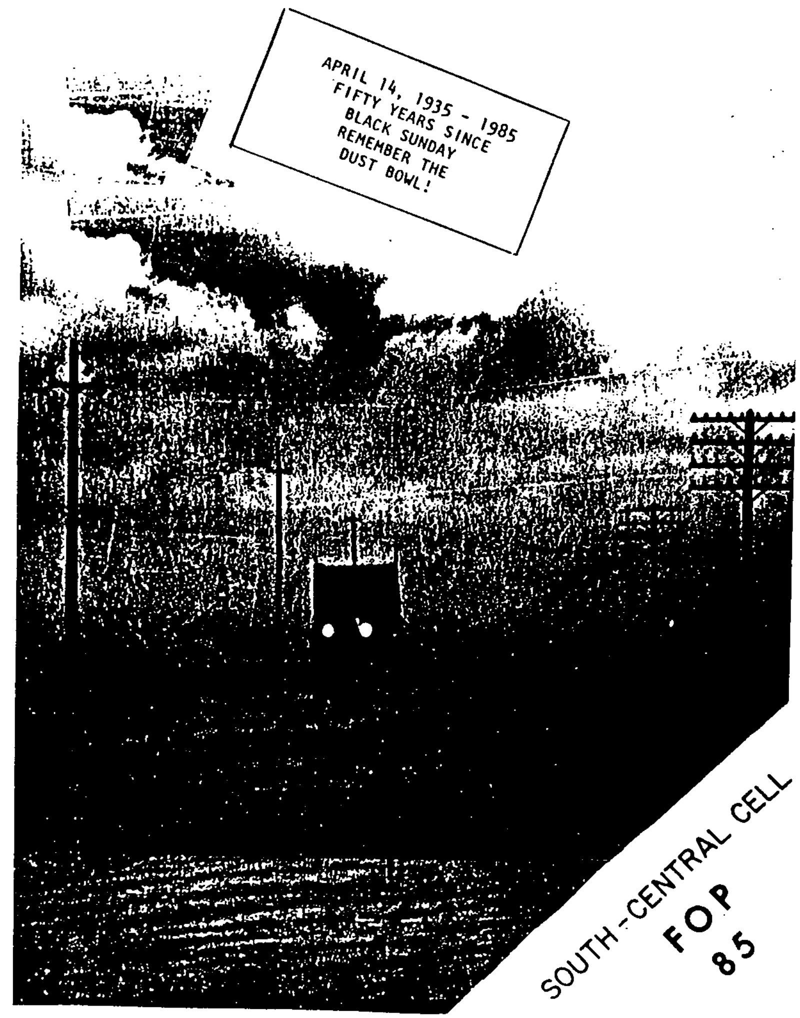
La LETTRE du LOESS

LOESS LETTER 13



THE PHYSICS OF WIND EROSION AND ITS CONTROL[1]

W. S. Chepil and N. P. Woodruff

United States Department of Agriculture, Manhattan, Kansas

I. Introduction

In many countries throughout the world, wind erosion has depleted the fertility of the soil, and in some it has transformed the fertile soils into sandy deserts. Substantial portions of central Asia, the Middle East, and North Africa were once fertile lands supporting prosperous populations, but through improper land use and soil exhaustion they changed to their present barren state. The downfall of ancient civilizations such as those of Greece and Rome is a story of depletion of grasslands and forests, soil erosion, and soil ruin.

In North America, relatively little wind erosion occurred while land was under natural vegetation. It accelerated after man began to overgraze and overcultivate the land. It became worse in the Great Plains, the semiarid and subhumid area that extends almost from the Mississippi River to the Rocky Mountains and from the Gulf of Mexico into the Prairie Provinces of Canada.

The first, and probably the last, serious wind erosion in the Great Plains occurred during the 1930's. The general realization of the great economic losses caused by wind erosion during that period helped to stimulate serious attention to its basic causes, effects, and remedies. Soil surveys of the Great Plains were initiated to aid in stabilizing agriculture in that area. Emergency wind erosion control programs were established and administered by the various States and by Federal agencies. Special wind tunnels were developed and used to study the wind erosion problem continually, not just when it occurred in the field. Numerous papers and bulletins were published on wind erosion and control. The publications on the subject, though voluminous, have been fragmentary and somewhat lost in the literature of agriculture and related fields. This review is the first attempt to bring the research information together into an analysis of the subject as a whole.

[1] Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, USDA, with Kansas Agricultural Experiment Station cooperating. Department of Agronomy Contribution No. 795.

The subject deals with movement and abrasion of soil by wind. Movement is initiated when the pressure of the wind against the surface soil grains overcomes the force of gravity on the grains. The grains are moved along the surface of the ground in a series of jumps known as saltation. The higher the grains jump, the more energy they derive from the wind. The concentration (number per unit volume) of saltating grains increases with distance downwind till, if the eroding field is large enough, it becomes the maximum that a wind of a particular velocity can sustain. The impacts of the saltating grains initiate movement of larger and denser grains and of smaller dust particles. The saltating grains collide against massive materials and other grains and cause disintegration of all involved. The disintegrated units exhibit different degrees of mobility and sort into different erosion products, such as lag sands, lag gravels, dunes, and deposited dust (loess).

Wind erosion occurs only when soil grains capable of being moved in saltation are present in the soil. Comparatively few saltating grains jump higher than a few feet above the ground. Over 90 per cent generally do not rise higher than 1 foot. Therefore, wind erosion is essentially a surface phenomenon extending to saltation height. Dust clouds are merely the result of movement in saltation.

The above-mentioned processes and products of wind erosion constitute only part of the physics of wind erosion and its control. The subject includes the intricate processes and conditions that cause erosion and the counteracting processes and conditions that suppress it. The severity of wind erosion depends on equilibrium conditions between soil, vegetation, and climate. Wind erosion is accelerated by processes that cause surface soil structural disintegration and depletion of vegetative cover. Conversely, wind erosion is hindered by stabilization processes such as soil consolidation and aggregation and by vegetation and vegetative residue developing on the surface. The speed or intensity of all the processes fluctuates considerably with vagaries of the weather and with various land uses.

The subject includes causes, effects, and remedies of wind erosion. Processes of soil destabilization, soil erosion, and soil stabilization must be understood to design effective and lasting methods of wind erosion control.

To design suitable methods of wind erosion control, soil conservationists must know the conditions that influence wind erosion and how to evaluate the relative significance of each condition. Procedures have been developed to supply them with the so-called wind erosion equation which can be used to estimate the potential amount of wind erosion from measured conditions of the field. Conversely, the equation may be used to estimate the conditions needed to reduce wind erosion to any degree. The procedures are outlined briefly in Section VII of this review.

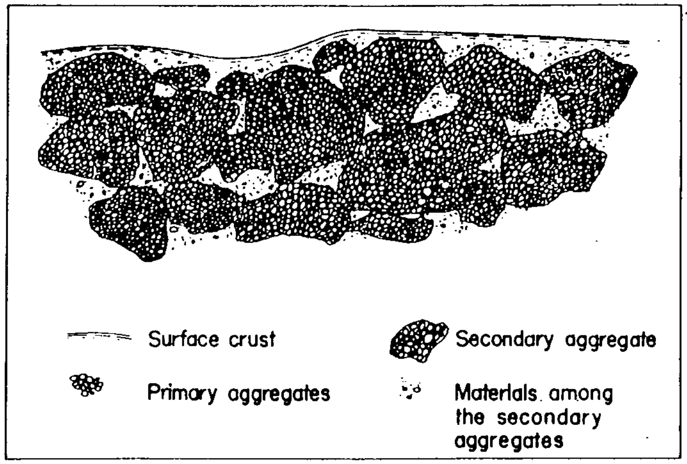


FIG. 13. Diagrammatic representation of structure of cultivated soil after wetting by rain and drying (Chepil, 1953b).

VII. The Wind Erosion Equation

A. General Framework

A wind erosion equation, with all its accompanying charts and tables, has been developed to indicate the relationships between the amount of wind erosion and the various field and climatic factors that influence erosion (Agricultural Research Service, 1961; Chepil, 1962a). The equation is being modified continually as new data become available. It is designed to serve a twofold purpose:

(1) As a tool for determining the potential amount of wind erosion on any field under existing local climatic conditions.

(2) As a guide for determining the conditions of surface roughness, soil cloddiness, vegetative cover, sheltering, or width and orientation of field necessary to reduce the potential wind erosion to an insignificant amount.

The equation embodies the major primary factors that govern wind erodibility of land surfaces. These primary factors influence wind erosion directly. They have been recognized during the course of many years of accumulation of experimental data on the problem. Some of them may be grouped or converted for convenience into equivalent factors, or may be disregarded, as follows:

Individual Primary Factors	*Equivalent Factors*
Per cent soil fractions > 0.84 mm. as determined by standard dry sieving, A	Soil erodibility, I
Mechanical stability of the surface crust, F_s	Transient, and therefore generally disregarded
Average wind velocity, v; Average moisture of soil surface, M	Local climatic factor, C
Soil surface roughness, K	Same
Distance (along prevailing wind erosion direction across field, D_f); Distance (along prevailing wind erosion direction protected by barrier, D_b)	Equivalent width of field, L
Quantity of vegetative cover, R; Kind of vegetative cover, S; Orientation of vegetative cover, K_o	Equivalent quantity of vegetative cover, V

The percentage of nonerodible dry soil fractions > 0.84 mm., A, as determined by standard dry sieving is an equivalent of their true percentage and of their stability against breakdown by tillage and abrasion from wind erosion. Sieving breaks a portion of the nonerodible clods to smaller, erodible ones. The problem is to sieve the soil with such vigor or for such period of time to neither overemphasize nor underemphasize the influence of one of these factors in relation to the other. Therefore, the method of dry sieving is standardized (Chepil, 1962a). The percentage of nonerodible dry soil fractions > 0.84 mm. in diameter as determined by standard method of dry sieving is directly related to *soil erodibility I*. This relation was derived from three major studies:

(1) Wind tunnel experiments on the relation between soil cloddiness and wind erodibility (Chepil, 1950b; Chepil and Woodruff, 1954, 1959).

(2) Field measurements in the vicinity of Garden City, Kansas, during 1954-1956 on the relation between wind tunnel erodibility and natural field erodibility (Chepil, 1960b).

(3) Analysis of intensity-frequency of occurrence of climatic conditions in the vicinity of Garden City, Kansas, during 1954-1956 (Chepil *et al.*, 1962).

The mechanical stability of the surface crust, F_s, if the crust is present, is of little consequence in the long run. It is disintegrated readily under the action of abrasion after wind erosion has started. It is a transitory condition and has some significance only if we desire to determine erodibility of the field at the moment the estimation is made. If we are interested in average erodibility for the entire soil-drifting season or year, as we ordinarily are, this condition should be disregarded.

The rate of soil movement by wind varies directly as the cube of wind velocity, v, and inversely as the cube of average soil surface moisture M. It is convenient to consider these two factors together as a *local wind erosion climatic factor*, C. A map has been prepared indicating the approximate value of this factor for any location in the United States and the agricultural areas of Canada (Chepil *et al.*, 1962).

The *soil surface roughness*, K, is expressed in terms of height of standard soil ridges (the same as ridge roughness equivalent of Zingg and Woodruff, 1951) and means that the surface, other factors being equal, will resist the wind as much as the standard soil ridges in which nonerodible clods do not exceed ¼ inch in diameter and which have a height-spacing ratio of 1:4. For example, a ridge roughness equivalent of 2 inches for a given soil surface means that the wind drag against the surface will be as great as against the surface composed of standard ridges 2 inches high and 8 inches apart running at right angles to wind direction, composed of the same proportion of erodible and nonerodible fractions as the soil, and exposed to the same drag velocity of the wind as the soil.

Width of field or field strip alone does not determine how erodible it is unless the prevailing wind direction and the presence or absence of adjoining wind barriers are taken into account too. No matter how narrow the field strip might be, if wind direction is parallel to its length, the strip would be almost as erodible as a large field of a width equal to the length of the strip. Furthermore, if any barrier is present on the windward side of the field, the distance D_b (along the prevailing wind erosion direction) which it fully shelters from the wind must be subtracted from the total distance D_f (along the prevailing wind erosion direction) across the field to determine the unsheltered distance across

the field along the prevailing wind erosion direction. This is the distance L that directly determines the quantity of erosion. It may be termed the *equivalent width of field.*

The quantity R, kind S, and orientation K_o of vegetation or vegetative cover can be expressed together in terms of equivalent pounds per acre. The equivalent vegetative material is small grain stubble to which S has been assigned the value of 1. The equivalent orientation is the absolutely flat, small-grain stubble with straw aligned parallel with wind direction, for which K_o has been assigned the value of 1. The *kind of vegetative cover factor*, S, denotes the total cross-sectional surface area of the vegetative material. The finer the material, the greater its surface area, the more it slows down the wind velocity, and the more it reduces wind erosion. The *orientation of vegetative cover factor*, K_o, is in effect the vegetative surface roughness factor and the two terms mean the same thing. The more erect the vegetative matter, the higher it stands above the ground, the more it slows down the wind velocity near the ground, and the lower the rate of erosion. The factors R, S, and K_o are multiplied together to give what is termed the *equivalent quantity of vegetative cover*, V (Chepil, 1962a). The wind erosion equation then may be expressed as

$$E = f\,(I,C,K,L,V) \tag{27}$$

which says that the potential average annual quantity of erosion, or soil loss, E, expressed in tons per acre is a function of the following factors:

I = soil erodibility,
C = local wind erosion climatic factor,
K = soil surface roughness,
L = equivalent width of field (the maximum unsheltered distance across the field along the prevailing wind erosion direction),
V = equivalent quantity of vegetative cover.

The mathematical relationships among the factors in the wind erosion equation are complicated, but charts and tables have been prepared from which the quantity of erosion (soil loss), as influenced by each of these factors, can be read at a glance (Chepil, 1962a). Moreover, the charts and tables can be used in reverse to determine what conditions are necessary to reduce wind erosion to any degree. Space is too limited here to include these charts and tables and to indicate how they can be used to estimate the potential soil loss of a field or the conditions needed to reduce the soil loss to an insignificant amount.

B. Data Needed to Estimate Potential Soil Loss

Each of the individual primary factors that influence wind erosion must be determined before the potential soil loss can be estimated. They are as follows:

Datum 1. *Soil erodibility I* in tons per acre per annum, determined from percentage of nonerodible soil fractions > 0.84 mm. in diameter. The percentage of nonerodible fractions is determined by standard dry sieving (Chepil, 1962b) or from reference tables of known average cloddiness of different soils during the wind erosion season.

Datum 2. *Local wind erosion climatic factor C*, in per cent, estimated for a particular geographic location from the wind erosion climatic map (Chepil *et al.*, 1962).

Datum 3. *Soil surface ridge roughness equivalent, K*, in inches. Usually *K* is equal to the average height of clods or ridges of which the soil surface is composed (Zingg and Woodruff, 1951; Chepil, 1962a). Several measurements can be made with a ruler and averaged. Widely spaced ridges, such as those used in emergency tillage for wind erosion control, have a ridge roughness equivalent less than their height. Usually, if the distance between them is increased beyond the 1:4 ratio, their ridge roughness equivalent is decreased proportionately. Thus, if the ridges are 6 inches high and the distance between them, measured along the prevailing wind erosion direction, is 48 inches, their height spacing ratio is 1:8, as compared to 1:4 for standard ridges, so that their ridge roughness equivalent is 4/8 of 6 inches, or 3 inches, if soil cloddiness remains the same as for standard ridges.

Datum 4. *Distance* D_f, in feet across the field (along prevailing wind erosion direction). This distance can be measured or computed from the width of field if the prevailing wind erosion direction is known (Chepil, 1959a). No adequate published data on the prevailing wind erosion direction at various geographic locations are available at present (1962).

Datum 5. *Distance* D_b, in feet (along prevailing wind erosion direction) of full protection from wind erosion afforded by a barrier, if any, adjoining the field. This distance for standard pervious continuous barrier is about 10 times the height of the barrier (Woodruff and Zingg, 1952). Data on the effectiveness of different kinds of barriers in shielding the soil surface from erosion are meager. If height of barrier is no greater than normal height of stubble, the influence is negligible and no evaluation is made.

Datum 6. *Quantity of vegetative cover, R*, above the ground in pounds per acre. This is estimated by sampling, cleaning, drying, weighing, and computing on a pounds per acre basis in accordance with standard procedure (Chepil and Woodruff, 1959). For some types of standing stubble, such as sorghum or corn, the quantity can be estimated roughly from height of stubble and number of stalks per unit area. Unpublished supplementary charts and tables are available to facilitate this type of estimation. All quantities of *R* presented in this review are based on washed, oven-dry material multiplied by 1.20. This represents approximately the average thoroughly cleaned, air-dry weights.

Datum 7. *Kind of vegetative cover factor, S* (dimensionless), obtainable from supplementary tables (Chepil, 1962a).

Datum 8. *Orientation of vegetative cover factor,* K_o (dimensionless), obtainable from supplementary charts (Chepil, 1962a).

VIII. Needed Research

Field and supplemental wind tunnel studies on the basic causes, effects, and remedies of wind erosion began in the severe dust storm period of the 1930's. Data have been collected and recorded continuously till the present time. The first attempt to apply some of this information as part of the wind erosion equation was published by Chepil and Woodruff in 1954. From then, general wind erosion research and research as applied to the wind erosion equation have been continued simultaneously. One is not and could not be separated from the other.

Considerable information still is required on air flow, temperature, evaporation, and crop yields in the vicinity of windbreaks and other types of surface barriers such as snowfences, hedges, crop strips, crop rows, ridges, and soil clods. Part of this study is expected to be applied to classification standards for shelterbelts presently in existence in the Great Plains. Ultimately it is hoped that greater clarification may be made of the principles governing air flow patterns and soil erodibility in the vicinity of barriers ranging from the size of clods to field shelterbelts. Experiments on models in a wind tunnel are being initiated to speed up attainment of basic information on this subject.

Much damage to soils and crops could be avoided if severe wind erosion conditions could be predicted a few months to a year ahead of their occurrence. Such predictions might be possible in view of the fact that severe wind erosion conditions tend to occur in cycles. A prediction of severe conditions one growth season ahead of their occurrence should give farmers ample opportunity to establish special tillage and cropping practices that would be effective.

Although it is known at present what soil structure approaches an ideal condition for resisting wind, little information is available on how best to create such a condition and at the same time permit the soil to absorb water freely and serve as a good medium for crop growth. None of the present cropping systems, including grasses, are entirely suitable, and some are detrimental. Studies are needed on new techniques of developing a suitable soil structure. More information is needed on the influence of moisture on soil structure as influenced by different types of tillage action. Possibilities of finding new methods and materials to develop desirable sizes of stable soil aggregates should be explored further.

It is recognized that vegetative covers, alive or dead, offer one of the most effective conditions for controlling wind and water erosion. However, better implements and probably more extensive education on how best to use the present implements are needed to maintain protective crop residues on the surface, to control wind and water erosion, runoff, and evaporation, and to maintain high level of crop yields.

One of the problems associated with present methods of maintaining vegetative covers is that they tend to leave the surface soil loose, fine, and highly erodible by wind. When drought occurs and vegetative covers become depleted, serious erosion sometimes occurs. Implements that improve structure of the surface soil and at the same time maintain vegetative residues on the surface need to be improved. Information on how to preserve vegetative matter above the ground or how to develop vegetative matter resistant to decomposition also is needed. Recognition, selection, and development of plant species suited for reclaiming eroding sand dune land is needed urgently.

The general framework of the wind erosion equation has been developed, but many details are still lacking. These details may be filled with accessory charts and tables as more research information becomes available.

Information is needed on the average soil surface roughness K for soil surfaces tilled with different implements on different soil classes, with different soil moisture contents. This information is important to determine the nature of the implements and methods of tillage that might be more suited than the present ones for permanent and emergency tillage programs for wind erosion control.

Information is needed on the average distance D_b of full protection from wind erosion afforded by barriers of various degrees of air penetrability in various geographic regions and for various soils. This type of information for windbreaks and other barriers is presently almost completely lacking.

Information is needed on the prevailing wind erosion direction for various locations. Available data needed to determine the prevailing wind erosion direction include: (a) average hourly wind velocity from each of the 16 points of the compass, and (b) per cent duration of wind from each of the 16 points of the compass. The prevailing wind erosion direction needs to be computed from the above data. A map then can be prepared for estimating the prevailing wind erosion direction on individual farms. This type of information would be valuable in determining factors D_f and D_b and, inversely, in determining how wide crop strips running in a certain direction should be to control wind erosion in various regions.

Soil erodibility I, based on standard dry sieving procedure, needs to be determined for various soil types wherever wind erosion is a problem.

Information on the values of kind of vegetative cover factor S and orientation of vegetative cover factor K_o is needed for cultivated and grass crops other than those already investigated.

It is expected that the wind erosion equation will become more useful as more specific information on the influence of the major primary factors I, C, K, D_f, D_b, R, S, and K_o becomes available.

IX. Conclusion

This review has been devoted to discussion of progress made in obtaining new information on wind erosion and its control. However, the solution of the problem is dependent on the overall progress made in research, testing, and extension.

It is beyond the scope of this review to discuss the overall progress made in the solution of the wind erosion problem. Substantial progress apparently has been made. Probably the best evidence of this is the fact that the severity of dust storms in the Great Plains during the 1950's was considerably less than during a period of similar climatic conditions in the 1930's (Chepil and Woodruff, 1957; Chepil *et al.*, 1962; unpublished data by Chepil *et al.*) This difference is believed to be due to better techniques, more favorable financial resources, and more earnest desire on the part of everyone to conserve the soil.

H.-P. Blume & S.M. Berkowicz (Editors)

Arid Ecosystems

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Most continents of the Earth have arid and semi-arid regions. These regions in sum contain 20% of the world's population and comprise over 30% of the world's total land area. Many developing countries are composed of extensive arid and/or semi-arid areas, where the needs of the rapidly increasing population have often led to misuse of the land. In recent years the consequences of such misuse have been compounded by drought, initiating a severe desertification process. Desert eco-systems are so delicately balanced and fragile such that once disturbed they may require a length period of time to recover.

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K. Auerswald, H. Stanjek & J.M. Bigham

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Soils play an important role in the function of both natural and managed ecosystems. Understanding the impact of environmental factors on these ecosystems requires a knowledge of soil processes ranging from molecular to landscape in scale. The properties and spatial distribution of soils and their mineral constituents are especially useful as indicators of both present and past environmental conditions. Soils and soil minerals form or transform in direct response to biogeochemical factors that are driven by local, regional or global processes. Through a series of case studies, this text demonstrates that linkages can be made between measurable soil and mineral properties and the processes that shape the weathering environment. Examples include layer silicates, carbonates, sulfides, and both iron and aluminium oxides. Several papers also emphasize the role of biotic factors in soil systems, the sensitivity of these factors to management practices, and the frequently overlooked interactions that exist between organic and inorganic compartments of soils and surface waters. Finally, this text recognizes that spatial and temporal variability are inherent attributes of soils and landscapes that must be quantified and properly managed if ecological and environmental harmony are to be maintained. The buffering function of soils and the importance of this function to the release and flux of nutrients in terrestrial ecosystems are given special consideration.

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Loess. **[Publisher occurs 2 times]**
LOESS **[Subject occurs 343 times]**
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Loess a partial bibliography / by Ian James Smalley. **[Title occurs 2 times]**
■ ***Loess* Accumulation and Soil Formation in Central Kansas, United States, During the Past 400000 Years** **[Title with Citation published in 1994 in British Library Document Supply Centre Inside Information from British Library. Purchase this Base Record for $0.10]**
Loess Addresses, essays, lectures. **[Subject occurs 3 times]**
■ ***Loess*, aeolian deposits, and related Palaeosols in the Mediterranean region** **[Title with Citation published in 1990 in Earth and Environment from American Geological Institute (AGI). Purchase this Base Record for $0.10]**
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Here are the 6 occurrences of LOESS in the News Briefing Index:

Oct 27, 1996

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TAIYUAN (Oct. 27) XINHUA - An attempt to turn the eroded *loess* plateau in north China's Shanxi Province into a "green land" has paid off, thanks to increased input from the central and local governments. A report...

Oct 21, 1996

North China Infrastructure Development
TAIYUAN (Oct. 21) XINHUA - Shanxi Province is trying to develop infrastructure to put an end to its backwardness, with about 22 billion workdays involved in water conservation work in the past three years. During...

Oct 16, 1996

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Oct 15, 1996

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ZHENGZHOU (Oct. 15) XINHUA - Effective soil and water conservation in northwest China's *Loess* Plateau has reduced the volume of silt in the Yellow River by about 300 million tons a year. Latest surveys show that the...

SWCS ALBERTA

Wind Erosion Prevention Poster

Wind erosion happens when the soil is left unprotected from the strong winds. The loss of topsoil lowers the quality of the soil. This makes it more expensive and harder to grow good crops. The blowing soil can also plug ditches, make driving more difficult, plug ventilation equipment and so on. Country and city people should both be concerned with wind erosion. Strong winds will always be around but we can do certain things that will protect the soil from blowing away.

Photo Credit SWCS (Alberta Chapter)

- A. Too much tillage of the soil breaks down the clumps of soil into smaller particles which are more easily carried away by the wind. Straw and other plant pieces left on the ground are also broken up and worked under when the land is tilled over and over. The soil is no longer protected and can blow away.
- B. One way to slow down the wind and keep the soil in place is by planting shelterbelts. The rows of trees that make up a shelterbelt are carefully arranged so that wind does not blow across open fields. Shelterbelts prevent wind erosion in the summer and winter. In the winter, snow is trapped by the trees and melts in the spring providing more moisture for crops. Shelterbelts not only help to stop wind erosion but also provide a home for wildlife such as deer, rabbits and birds.
- C. Planting crops in narrow strips is another way to prevent wind erosion. This is called "strip cropping'. These narrow strips have stubble left on the surface and do not allow the wind to pick up soil particles. The summerfallow strips between the stubble are not wide enough for the winds to start the soil blowing.
- D. Keeping plant residue (straw, dead plants) on the surface is very important in preventing

wind erosion. One way is by seeding the crops directly into the stubble without tilling the first. This means that soil particles are kept covered and will not blow away.

- E. When the land is not tilled as often, certain weeds may start to grow and create problems. Selective weed killers can be sprayed when weeds are a problem instead of cultivating to kill them. This keeps more plant residue on the soil and prevents wind erosion.

This is one of a series of interpretive posters produced by SWCS to promote education in the conservation of our soil and water resources. Funding was provided in part by the Canada-Alberta Soil Conservation Initiative.

Surficial and Boundary Layer Controls of Wind Erosion

Cheryl McKenna Neuman, Ph.D.

Descripiton of Research:

Dissatisfaction with the performance of empirically based wind erosi development of soil loss models based on the physics of sediment transport. These require detailed input on a multitude of complex interactions between trans port and controlling variables pertaining to the surface and boundary layer. A multifaceted project involving theoretical and wind tunnel simulation is in progress to evaluate the dual and inter-related influences of soil moisture and texture on soil ero sion. Model assessment is based upon comparison of predicted outcomes with relevant data collected in ongoing field studies.

Recent Publications:

- 1994; W.G.Nickling & C.McKenna Neuman; Development of deflation lag surfaces; ***Sedimentology***, (In press).
- 1994; C.McKenna Neuman & W.G.Nickling; Aeolian sediment flux decay: Non-linear behaviour on developing deflation lag surfaces; ***Earth Surface Processes and Landforms***, (In press).
- 1994; C. Maxwell and C. McKenna Neuman; Photoautotrophs and the microaggregation of sand in a freshwater beach-dune complex: Implications for sediment transport by wind; ***Soil Biology & Biochemistry***. 26:2:221-233.
- 1994; C. McKenna Neuman and W.G. Nickling; Momentum extraction with saltation; Implications for experimental evaluation of wind profile parameters; ***Boundary-Layer Meteorology*** 68:35-50.
- 1993; C. McKenna Neuman; A review of aeolian transport processes in cold environments; ***Progress in Physical Geography***, 17: 99-117.
- 1990; C. McKenna Neuman; Observations of winter aeolian transport and niveo-aeolian deposition at Crater Lake, Pangnirtung Pass, N.W.T., Canada. ***Permafrost and Periglacial Processes*** 1:235-247.
- 1990; C. McKenna Neuman; Role of sublimation in particle supply for aeolian transport in cold environments; ***Geografiska Annaler*** 72a:329-335.
- 1989; C. McKenna Neuman; Kinetic energy transfer through impact and its role in entrainment by wind of particles from frozen surfaces; ***Sedimentology*** 36:1007-1015.
- 1989; C. McKenna Neuman and W.G. Nickling; A theoretical and wind tunnel investigation of the effect of capillary water on the entrainment of sediment by wind; ***Canadian Journal of Soil Science*** 69:79-96.

WERU WIND EROSION RESEARCH UNIT

The Wind Erosion Discussion List

Ted Zobeck of the USDA, ARS has a discussion list on wind erosion. This list will be unmoderated. We encourage discussion of any aspect of wind erosion science including but not limited to modeling, climatic influences, soils, agricultural and non-agricultural aspects of wind erosion, physics, economics, environmental impacts, etc.

To subscribe, send the following message to listproc@unicorn.acs.ttu.edu:

`subscribe wind_erosion` *your name*

You will receive a confirmation of your subscription and will be issued a password. Please reset your password as instructed in the return message.

NOTE: The underscore between the words 'wind' and 'erosion' must be present.

Correspondence to the list must be sent to:

`wind_erosion@unicorn.acs.ttu.edu`

Further information may be obtained from Dr. Ted M. Zobeck at

`tzobeck@lubbock.ars.ag.gov`

Wind Erosion List Archives

Other related and interesting discussion lists include:

- A **soil erosion** discussion list. Subscribe to:
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  To get more information about this listserver, send a message containing the line:
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- A **general soils** discussion list. Subscribe to:
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- The **GEOMORPHLIST** is a moderated list for geomorphologists and those working in related fields. The moderator is Jeff Lee (adgjl@ttacs.ttu.edu) at Texas Tech University. To join the list , contact the moderator and request to subscribe and provide the following information for their directory:
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a few keywords to identify your interests in geomorphology.

- A **sustainable agriculture** discussion list. Subscribe to:
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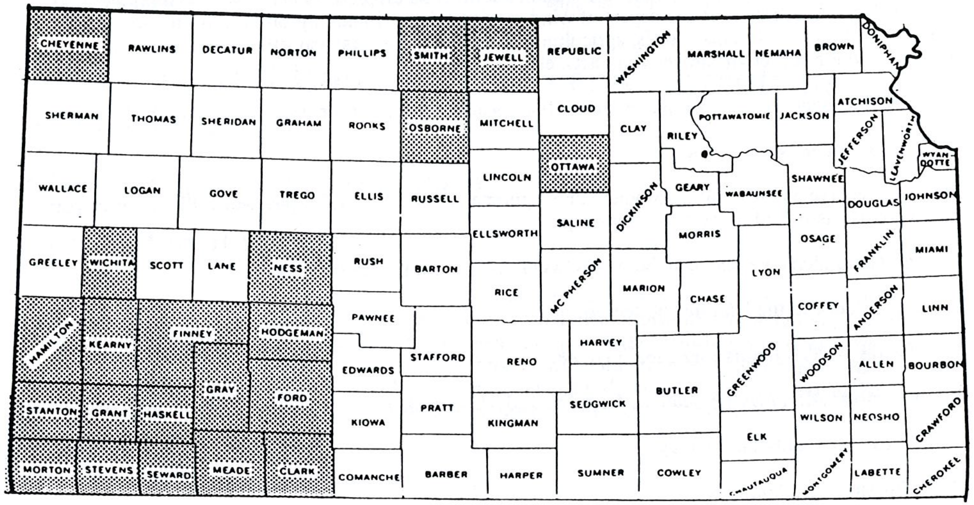

WELCOME TO THE XV INQUA CONGRESS HOMEPAGE

INTERNATIONAL UNION FOR QUATERNARY RESEARCH (INQUA)

XV INTERNATIONAL CONGRESS
3rd - 12th August 1999
International Congress Centre (ICC), Durban, South Africa

THEME: **"The environmental background to hominid evolution in Africa"**

CONTENTS

http://inqua.geoscience.org.za/

XV INTERNATIONAL INQUA CONGRESS

INTRODUCTION

XV INQUA CONGRESS IN 1999 TO BE HELD IN DURBAN, SOUTH AFRICA

At the XIV INQUA Congress in Berlin the International Council of INQUA decided to award the XV INQUA Congress to South Africa. The relatively small (150) but active Quaternary community of South Africa is grateful for this vote of confidence and is also mindful of the considerable responsibility which this will place on its members. Since a great deal of current Quaternary research is sub-continental in its scope, and since several of the proposed excursions traverse neighbouring countries, the help of colleagues form several other southern African states will be enlisted. The South African Government has already pledged its support, both financial and moral. A local Organizing Committee chaired by Tim Partridge, who was elected a Vice-President of INQUA in Berlin, has already been established under the aegis of the South African National Committee for INQUA.

Since the early years of this century the study of the Quaternary of southern Africa has vouchsafed results of major importance to the international scientific community. Some of these relate to the unique treasure-house fossil remains, not only of our earliest hominid ancestors, but of some of the world's oldest representatives of anatomically modern man. Others document, in detail, changes in terrestrial palaeo-environments in the mid-latitudes of the southern hemisphere during the Middle and Upper Pleistocene and Holocene, and strive to explain the mechanisms which underlie research techniques to the large-scale exploitation of Quaternary deposits for diamonds, titanium and a host of industrial minerals. A community of scientists has grown up around these endeavours under the umbrella of the Southern African Society for Quaternary Research (SASQUA).

The Congress will take place from 4-12 August 1999 in the superb new International Convention Centre (ICC) currently under construction in Durban. This city is a major port with a well developed commercial and recreational infrastructure, situated on the south-eastern coast of South Africa. At the time proposed for the Congress the climate is mild (average daily temperature in the range 20 - 25 grade Celsius with cool nights). The sea temperature is suitable for bathing as a result of the influence of the warm Agulhas Current. Little or no rain can be expected. Durban is a university city with many first-rate hotels and is well served by flights both from Johannesburg and international destinations (e.g. London).

The environs of Durban are varied and attractive and will permit the organization of a stimulating social programme which will include visits to an indigenous Zulu village and displays of tribal dancing. Many important Quaternary sites, both in South Africa and in neighbouring countries, at which research has been carried out over recent decades have been incorporated in the list of excursions which can be offered to delegates. The routes for these excursions have been selected so as to encompass a variety of deposits and of scenery within the succession of contrasting climatic belts which span the sub-continent form east to west.

The theme selected for the XV INQUA Congress is "THE ENVIRONMENTAL BACKGROUND TO HOMINID EVOLUTION IN AFRICA", and a special symposium on this topic will open the proceedings. Other symposia and workshops will address key topics in Quaternary research, with emphasis on Africa, the Gondwana continents and the southern oceans.

(Home) (Feedback)

For more information contact : eaukamp@geoscience.org.za

Preliminary Announcement

INTERNATIONAL SYMPOSIUM ON PROBLEMATIC SOILS
October 1998

IS-TOHOKU'98

THE JAPANESE GEOTECHNICAL SOCIETY

INTRODUCTION

The international symposium on problematic soils, IS-Tohoku'98,will be held in Sendai Japan,October1998.The purpose of this symposium is to provide an authoritative forum for engineers and scientists to discuss,exchange their experiences and recent findings in the understanding and handling of problematic soils.

CONFERENCE THEME

1.Basic and engineering properties of problematic soils around the world

a) Peat and Organic soils

b) Volcanic soils
Volcanic cohesive soil
Volcanic sandy soil
Volcanic black soil(Andosol)

c) Expansive and Collapsible soils

d) Decomposed soils

e) Others

2.Engineering classifications of problematic soils

3.Foundation engineering and earthworks related to problematic soils.

4.Countermeasures or solutions from case histories of problematic soils

PROGRAM

The three-day program will include;
Special Lectures
Keynote Lectures
Oral Presentations and Discussions
Poster Presentations

CALL FOR PAPERS

Interested authors are requested to submit the paper title with a 1-page abstract(about 300 words in English on A4 size sheet)to the address indicated below.

TIME SCHEDULE

Submission of abstracts……July,1997
Acceptance of abstracts……October,1997
Submission of papers………January,1998
Final acceptamce……………February,1998

OFFICIAL LANGUAGE

The official language of the symposium will be English.

ORGANIZING COMMITTEE

Chairman
Prof. E.Yanagisawa
Secretary General
Prof. N.Moroto
Division heads
Prof. T.Mitachi
Prof. Y.Kishino

FURTHER INFORMATION

Further information on the details of the call for papers,symposium program,registration procedures and accommodation will appear in the forthcoming bulletins.Bulletin No.1 will appear in Autumn 1996. Correspondence should be directed to:

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