Screenings from the Soil Research Lab

IOWA ENGINEERING EXPERIMENT STATION
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A GEOLOGICAL ISSUE -- PART ONE

Scientists are human, bless their hearts, and soil engineers frequently work with a brand of scientist called geologists.

Geologist "Ifbut" Smedly regards his engineer buddies as the pleasant fellows whose main conversational talent is to ask geologists impossible questions and expect quick, clear answers. Geologist Smedley always tries to answer with scientific accuracy, which means the plentiful use of if's and but's. Which is how Smedley got his nickname, "Ifbut."

Engineer Ferocious K. Dammaker is dissatisfied with routine scientific answers. When he asks three geologists the same question he is disturbed to get three different answers. He may deliver an opinion in special technical language called swearing. He also has a bone to pick with the geologist who goes around muttering about "pre-Cambrian porphyritic anticlines" or some other such nonsense. He thinks they should talk English.

The Point of View

The difference in viewpoint probably stems from a basic difference in training and in thought because, basically, scientists like to learn things, and engineers like to do things. A scientist may spend days, weeks, or years investigating and deliberating a problem that has no more apparent practical worth than a wood tick. The engineer says, "The hell with it; let's build our road." The geologist retorts, "All right, but it may be a hell of a road." Sometimes he's right--it isn't much of a road. This increases his stature but not his popularity.

With all this emphasis on knowledge it's understandable that a geologist almost comes apart if he doesn't understand things. A fact requires a reason, even if he has to guess. He then back-checks his guess to see if it explains things. If it does, he has a theory. If it doesn't, he guesses again. Often two or more guesses satisfactorily explain things, and one theory will appear better to one man than another theory which appeals to another. This leads to....

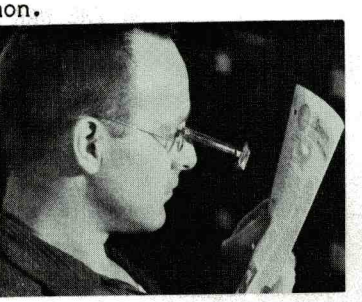
An experimental stair-step loess road cut near Magnolia in western Iowa. The ability to stand in vertical cuts is believed by some to be due to high permeability of the loess. The exposed loess never becomes water-logged enough to lose its cohesion.

Argumentism

Geologists, the most cantankarous, restless individuals imaginable, are forced to rely on the earth's clues; and these are sometimes dim. Much is left to the imagination, and geologists prefer to imagine independently. A theory must be tested, and you can't try science in a court of law.

The Dread Peril

Sometimes in the course of the arguments you see signs of Deductive Astigmatism. Sufferers of Deductive Astigmatism can't see straight. A man with a severe case of the D.A.'s becomes totally blind to all forms of contradictory evidence. The deductions have taken over his soul. Fortunately such severe cases of Deductive Astigmatism are rather rare. Mild attacks are common.



Special eyeglasses are sometimes worn in an attempt to correct Deductive Astigmatism. Otherwise eyeball distortion dims the vision when the victim is confronted with all forms of contradictory evidence.

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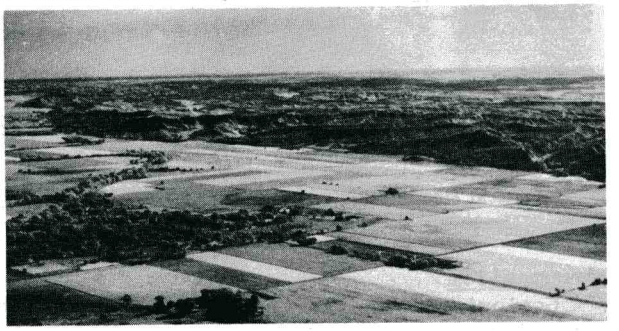
Unfortunately when a man has it he doesn't know he has it, and he automatically thinks the other guy has it, so in reality nobody knows who is afflicted. That's what makes science so interesting. You find the Deductive Astigmatism transmitted through such impersonal media as books, articles and college lectures, so nobody is safe. In fact, we suspect everybody suffers it once in a while.

On the Wierd Prevalence of Flapdoodle

Our final bit of bone rattling concerns use of technical language. One side accuses the other of using big words to sound high-falutin, and the defendants claim that big words are needed to convey the dope with accuracy.

We believe that anybody who uses technical language for the sake of the language should be shot or at least whittled up a bit. It's not hard to make something difficult, and perhaps it does give a certain satisfaction. If people can't understand a man they are likely to think he is a genius.



Loess bluffs in western Iowa. The flat area in the foreground is the Missouri River floodplain, believed to have been a major source for the loess.

Fortunately this type of man is rare; much more common is the specialist, either engineer or geologist, who resorts to technical language because after twenty years these are the only words he knows. Obviously his code is invaluable for clear thinking and brevity, but when he publishes for us slugheads he may need help. Therefore we have the technical editor.

PART TWO
THE LOESS PROBLEM, THE GREAT AMERICAN TRAGEDY, OR THE WAR BETWEEN THE STATES

The question of the origin of loess is one wide open to scientific argument. Loess is a widespread soil deposit found in our own Midwest and Far West as well as in China, Russia, Germany, Argentina, New Zealand, and a few other places like Nebraska. Also most of Iowa is mantled with loess, which increases the importance quite some little bit. The question is how it got there.

The topography in the areas of thick loess is steep and bisected by streams. It is quite hilly country.

Pronouncement

Loess is a German word, Löss, pronounced "looerss" with the "ooer" deep down in the throat like a gargle. When most people say it, it sounds like a shallow "lurss," or else they give up altogether and say "low-ess" or even "luss." Of these, Webster approves the first two; many professional men are naturally inclined to prefer the last. In Iowa we usually say "luss" to rhyme with "lust." But we bow to regional preference.

Definition

The loess battle is a very serious one because the debators aren't even agreed as to what they're talking about. Many would prefer to tie the definition of loess in with origin, but others say this is not conducive to scientific objectivity. In fact, some people have gone to the term loessoid to avoid the question of origin. Loess is so variable in different regions that a definition broad enough to cover all loess deposits, if they are deposits, and narrow enough to exclude everything else is almost impossible.

Therefore, loess is characteristically a tan, unstratified silt with a variable percentage of clay, and very little sand. The mineral composition can be almost anything but seems to remain fairly consistent over any one area. The thickness of loess varies from zero to over 150 feet, although with zero thickness it is most logically called something else. This zero is mentioned only to establish the lower limit.

Appreciation

The areas of deep loess in the United States have been eroded into topographic magnificence with a grandeur, artistry, and spectacle that easily inspire awe. Not only do we have the superbly sculptured landforms with sharply de-

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The Delta River in central Alaska is a fine example of a braided stream fed by melting glaciers.

fined drainage patterns, we see the high, almost vertical cliffs cut and standing in this friable, compacted "dirt," and the innumerable cat-steps tracing the approximate contour lines around the hills.

And then some look at our beautiful hills and say, "Students, loess is a wind deposit. Notice the dune shaped hills." This is still in some books, but most of those who should know say that the topography is erosional, which means the hills were carved by running water. Frankly we don't see how they could look dune shaped, except possibly to verify that they are a wind deposit.

Earthworms and the Outer Cosmos

By the year 1900 the guesses on origin of loess already included being washed in by the ocean, carried about by water from melting glaciers, blown in by wind, or descended from a cosmic dust cloud such as encircles Saturn. One scientist proposed that loess emerged from mud volcanoes and was then distributed by a great post-glacial flood. A favorite is the suggestion that loess deposits represent gigantic accumulations of earthworm castings, the earthworms gobbling up glacial till at the front end and leaving a trail of loess behind them.

The Wind Blew and the Silt flew

The aeolian theory is one of the oldest and is still the most popular. In the 1880's a Baron F. von Richthofen studying some of the widespread deposits of loess in China concluded that wind was responsible--that Chinese loess was an accumulation from countless dust storms flowing from the deserts of interior China. In 1897 T. C. Chamberlin applied the aeolian hypotheses of loess to the central U. S. He reasoned that this loess did not blow off the deserts but from nearby glacial outwash areas. His evidence was that the mineral composition of loess approximates that of the regional glacial deposits.

Taking in the Outwash

To understand the theory of a glacial source for dust storms one needs to know something about glaciers. A glacier is either a creeping river or a creeping flood of ice, depending on whether it is confined in a valley or not. As it creeps it incorporates gravel and other debris in the basal ice. At the margin of the glacier where the final ice melts, the melt water forms a river with a very heavy load of sediment. Because of this the river develops a braided channel with extensive sand and gravel bars. The channel continually shifts about, divides and recombines as if not sure where it's going. The river bars swept by wind form a ready source for sand and silt.

Salt and Pepper

Particles picked up by wind and carried in air ordinarily tend to settle out. The larger the particles the more rapidly they settle. Sand particles carried in air are large enough that they skip along over the ground, a mechanism called saltation and responsible for the peppering one gets in a sand storm. Saltation is a major factor in the building and migration of sand dunes, and the need for sand to bounce on something means that sand dunes gradually grow outward from the source area.

This photo was taken from a bar in the Knik River in Alaska, a source of wind-blown sand and silt. The haze is from dust, both in the air and in the camera. Note how the trees are bent with the wind. An active sand dune exists immediately adjacent to the river plain; farther away one finds silt deposited as dust on the wild Alaskan shrubbery.

Silt does not need that extra added lift from bounce, because air turbulence is enough to hold it in flight. Unlike sand, some of the silt can be carried hundreds of miles without settling. It comes down by gravitational settling or with rain.

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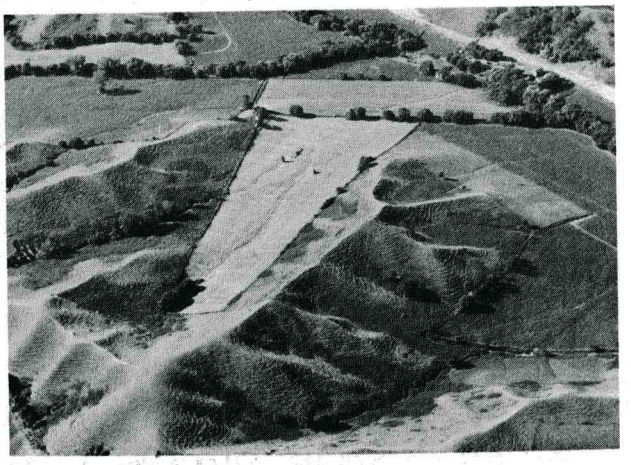
Facies Change

A favorite with aeolian theorists is that loess changes gradually with distance downwind from the source. Some say distance can not be the major controlling factor, because the rate of change is variable at different places. As a general rule loess does thin out and is finer as one travels away from a logical source. A theory is that the coarse silt settles out faster and is concentrated in deposits near the source. Farther away the amount of coarse silt in the air is depleted, and finer materials become the major constituents in the deposit.

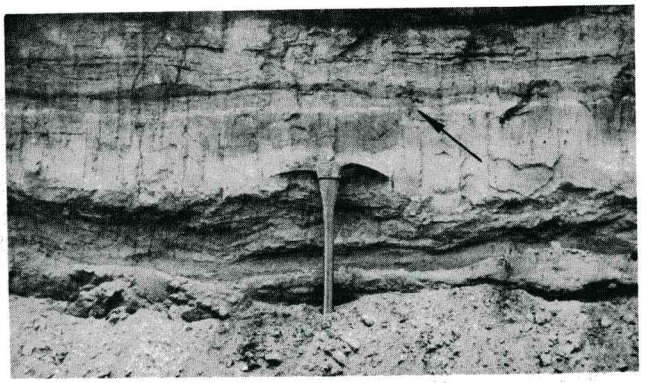
For the budding geologists such a change is called a sedimentary facies change. (This is Latin, but there's no other word for it.) The complete facies change would be from sand dunes adjacent to the source area to loess that is first a silt, then farther away a silt loam, a silty clay loam and a silty clay, as the clay content increases and the silt content decreases. If the depletion theory is correct, the rate of change is not so dependent on distance as it is on other things such as source area, wind velocity, height of blowing, etc.

Fossils, Root Tubes and Paleosols

Minor features of many loess deposits include fossil snail shells, often given in evidence that loess is a wind deposit because the snails are land snails. That is, they lived in air, not in water. Other dead things in loess include occasional mice, gophers, and broken-headed geologists who chose the wrong time to argue. Fossil animal holes, denoted by educated as paleocrotovina, (jargon) occur occasionally. Tiny vertical holes believed to be root channels infiltrate the loess, improve its vertical drainage, and act as tiny cylindrical surfaces for the deposit of carbonates and iron oxides. The resulting tubes are called "pipestems."



Seen from the air, cat-steps appear as minute wrinkles around the hills. They were once believed to be cattle trails. Now they are generally supposed to be caused by downhill slumping.



Loess in Alaska commonly contains thin pink or white layers of volcanic ash. The ash is silt-size and is carried about by wind. The origin of the ash is volcanic explosions which spray dust and lava high into the air.

Much of the recent work on loess has been to identify and correlate fossil soil profiles. Soil at the surface of the ground becomes discolored, forming a dark topsoil. Somewhat deeper in the ground it becomes clayey, forming a subsoil. Similar layers occur buried within the loess, where they are interpreted as representing weathering which took place when loess deposition temporarily halted. Material then exposed at the surface of the ground had time to weather. Later on deposition was renewed so that the soil profile was covered up. These pauses in deposition are believed related to different glacial advances. And a buried soil is called a paleosol, meaning ancient soil.

Is Loess a Soil?

Finally we can jump in on another argument, this time between engineers, geologists, and agricultural soil scientists. Let's assume for the moment that loess is a wind deposit. Is loess a soil? The engineer says "yes," because he can dig it. Some soil scientists say "yes," because it will grow things, but others emphatically say "no;" loess is the parent material for the true weathered soil profile, or solum, which forms near the ground surface. Geologists, if they believe in wind, say loess is properly called a sediment. Who's right? They're all correct, considering the uses to which they want to put it. Here is the difference between scientists and engineers; the scientist wants to know about something, but the engineer's main concern is how he can use it. Loess behaves like a soil, therefore it is a soil. For scientific value this definition is about like saying kerosene is water because you can drink

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it. If the processes of formation are different, the materials are different. Clay formed by weathering is not the same as clay laid down by a river. The latter is a sediment; the first is a soil.

LOESSIFICATION, Y'ALL

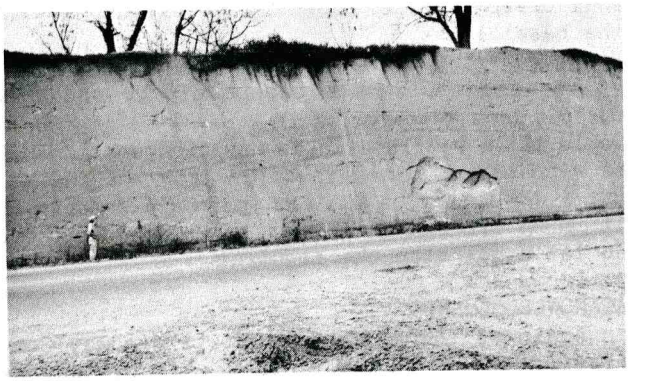
In loess as in life it's hard to buck the wind, but some people do so. Most recently Dr. R. J. Russell of Louisiana State University, after working extensively with river deposits of the Mississippi, reasoned that from its position on the hills loess could be slumped terrace deposit. Loess in the south-central United States is close to the river on terraces, although there is again some disagreement on nomenclature. Hence the theory of "loessification."

According to Russell, loess has the same particle sizes and minerals as floodwater deposits of the Mississippi called backswamp deposits. Older backswamp deposits exist higher up on river terraces that represent former floodplains. Weathering leaches the carbonates and removes much of the clay, the carbonates later being replaced when the loess sits at a lower level. Snails and gravel are incorporated into the loess as it churns and mixes during its creep downslope. A strong point in the argument is that it explains how gravel could be mixed in the basal portion of the loess. Gravel found in basal loess is a little hard to explain if you blow everything in on the wind.

Retorts and Reverberations

Gravel? replied the aeolinists--carried in by animals; and as for loessification, where did the clay go? How did all that clay get washed out? And what about the increase in loess fineness away from the river? Loessificationists replied, of course loess changes away from the river floodplain--what do you expect when it grades into the unaltered clay-rich backswamp deposits? As for those minor discolored zones, they are not "paleosols;" they are clay zones, although most of the clay was left behind when the loess moved downslope. Furthermore the loess is always thicker on the flanks than on the crests of hills--how do you explain that by wind?

On the other hand the evidence is not all in agreement. Recent work by Iowa geologist Dr. R. V. Ruhe shows that in Iowa the loess is commonly thicker on crests of divides, and gravelly basal portions are not loess but are a result of slope erosion and sedimentation prior to major loess deposition. Ruhe believes in wind.



A loess cut at Natchez, Mississippi, with faint color bands. Loess in the south-central U.S. is commonly thicker at lower elevations and is gravelly in the basal part.

Perhaps a major source of trouble lies in extending results of studies in one area to other areas. Yet wind-blown loess of the northern U. S. can be traced hill by hill into the south, and the loessified loess of the south can be traced hill by hill up north. If everyone is correct, somewhere there is a sudden shift in the mode of origin, probably at some arbitrary boundary like a state line. Geologists have a little trouble accepting this.

The Far North und der Nederland

In the U. S. we're either all wet or full of wind, but people in Alaska are full of frost action. A theory advanced by Stephen Taber, an authority on permafrost, is that the common upland loess in Alaska is nothing more than local bedrock which has been disintegrated by frost action. Most Alaskan geologists and soils men say the major evidence still points upwind, and the silts are wind-deposited loess. However, downslope movements associated with frost action account for much thickening of the deposits in the valleys. Some of these translocated valley silts are highly organic, have a rather undelicate odor and are called "muck."

A major argument in favor of Taber's theory is that the mineral composition of the silt corresponds to that of the supposed parent rock. A major argument against the theory is that the mineral compositions do not always correspond to those of bedrock. And so the story goes.

A Netherlands geologist named van Rummelen has been talking against the wind for some thirty years, his conversation somewhat resembling the words of Taber and Russell. Van Rummelen's loess, which he prefers to call "loessoid" to keep it out of the wind, is derived from weathering of Cretaceous age bedrock followed by soil creep and mixing. Most Dutch geo-

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logists and soils men still stick with the wind, but they will go along with the idea of slight soil creep incorporating gravel or boulders in the basal loess.

Majority Accuracy

If scientific questions could be reliably decided by a vote--which they can't or the world would still be flat--loess would unquestionably be wind blown, other theories notwithstanding. But a new theory is at least partly a success if it causes critical re-examination of the old ones. So let's not stop the argument.

ACKNOWLEDGEMENTS

Again we thank the Iowa State Highway Commission and the U. S. Bureau of Public Roads for picking up the tab.

Since loess is the most abundant surficial material in Iowa our soil engineering investigations naturally started with this material. The work on engineering properties of loess has been skipped over in this issue so that we might present the more fundamental question of origin. Engineering data will be presented in future issues. A separate engineering and geological investigation of Alaskan silts and glacial materials was undertaken by Engineering Experiment Station personell under the sponsorship of the Office of Naval Research.

We also gratefully acknowledge the abundant correspondence which came in reply to questionaires sent to various soils bureaus and geological surveys in other states and countries. The answers have proved very helpful and warrant a much more thorough presentation.

REPLY CARDS

With this, our fourth issue, we finally have the nerve to test our popularity. Actually we're encouraged by your letters, for which we extend a very deep and sincere thanks. Please return the enclosed card if you want to remain on our mailing list; otherwise we're afraid we may lose a customer. You'll notice we don't even buy the stamp; we're a very low budget operation, and we can't afford that plus salaries. Please note that this card is only for SCREENINGS, since our list does not coincide with other Iowa State College mailing lists. Mail the card only if you want SCREENINGS.

Finally a long overdue apology to our foreign readers because we are so slangy and sometimes unintelligible; we find that a little nonsense helps our days along. We hope we don't completely ruin yours.

IN THE NEXT ISSUE : Stabilization of soils with lime.

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