favors the digestion of starch and the translocation of carbohydrates, and especially that it increases the activity of the starch-digesting enzyme. Wortmann disagreed with this, but Stahl, in his researches with variegated leaves, found a satisfactory explanation of the favorable influence of the red pigment on the process of the translocation of materials. The formation of red pigment in leaves in spring and fall, and in high mountains, in summer, is associated with low temperatures which retard the translocation of the photosynthate, and thus decrease the activity of photosynthesis. Stahl's thermoelectric investigations with red-spotted leaves demonstrated an increased absorption of heat in those parts of the leaves containing anthocyan. On the basis of these results, Stahl modified Pick's thesis as follows:

> In the heat-absorbing red coloring matter of leaves the plant possesses a medium for accelerating the transformation of matter and energy.

Contrary to the light-shield theory, which holds that the anthocyan is a protection against the destructive effect of a too intensive light on the chlorophyll, Stahl's theory, especially in view of the favoring of the process of translocation, has the advantage of either giving biological significance to the red pigment in autumn leaves, or of pointing the way to investigations of the metabolism in autumn-red leaves.

It remains to be proved whether the favoring influence of the red pigment on the translocation of material may actually be demonstrated by comparative chemical analyses, or, in other words, whether and in how far red leaves, under the same conditions, suffer a more thorough emptying out than do other leaves on the same plant which have not formed the red pigment. Swartz's analyses of green, yellow and red leaves of *Parottia persica,* with reference to nitrogenous contents showed that, before leaf-fall, the red leaves are more thoroughly emptied than the yellow ones.

If a leaf is dropped from the branch shortly after its color has turned (be the color either yellow, red or white) the cells still remain alive, except in a few cases where *pari passu* with the loss of chlorophyll a brown pigment spreads over the leaf-surface. The outer appearance and also the microscopical characters indicate that the cells by no means contain merely disorganized matter, but maintain their complete vital functions until the appearance of the brown and black color, which indicates the death of the leaf. Thus, with Tswett, Swart concludes that the color change of leaves is not a postmortem decomposition, but a physiological process, and that we have to distinguish two phases in the change of color, viz., the *necrobiotic,* with its yellow, red and white tints, and the postmortem, characterized by the appearance of brown and black color.

But Swart holds that the theory of translocation does not stand and fall with the question as to whether the leaf during yellowing becomes dead or not, for, as he has shown in the investigations here recorded, the translocation of material still takes place from the portions of leaves that have already entered upon change in color. Nevertheless, Swart adds, the theory, in consideration of certain cases, must suffer a certain limitation.

A chapter on final considerations (pp. 97–117) concludes the book.

C. Stuart Gager

SPECIAL ARTICLES

ON THE ORIGIN OF THE LOESS OF SOUTHWESTERN INDIANA [1]

The gallant defenders of the grand old aqueous theory of loess deposition seem to be retreating southward, though their rear-guard vigorously contests every district yielded. Just now they seem to be crossing the Ohio River. Rumor has it that a strip on the north side of the river in southwestern Ohio is still being claimed; southwestern Indiana[2] has been in their undisputed possession for 10 years; and the latest publications on the geology of western Kentucky and southeastern Missouri contain such words as "the writer may state his

[1] Published by permission of the Director of the United States Geological Survey.

[2] *Bull. Geol. Soc. Am.,* Vol. 14, pp. 153–176 and the Patoka folio U. S. Geol. Survey.

belief that the loess of the region under consideration is of fluviatile and not of eolian origin,"[3] and "the submergence during the deposition of the loess."[4]

However, changing the figure, there is reason for suspecting that some have secret longings for a geological statute of limitations which would remove responsibility for statements expressed a few years ago.

Fortunately for the sake of long and interesting debate, it seems impossible to say the last word on the origin of the loess. Nevertheless, some, perhaps weary of the controversy, or perhaps for novelty, have seemed ready to compromise and admit that some loess may have had one origin and some another. Such an interpretation was placed on the loess of southwestern Indiana in the reports just referred to, and the principal object of the present communication is to suggest that another view concerning this material may be tenable.[5] The suggestion is perhaps somewhat tardy, but it has received several years of careful consideration.

The correct interpretation of loess like that of other geologic phenomena depends much on the study of extensive areas. The writer's first-hand knowledge of the loess comes from most of the area of its occurrence in the United States from Nebraska to Ohio, and from Minnesota to Louisiana and also from a part of that in Europe, but it has been particularly in the survey of the Quaternary geology and physiography of a dozen quadrangles in southern Illinois that he has been impressed with the idea that the conclusions set forth with regard to the loess of the Patoka quadrangle are not widely applicable. Naturally, the attempt was made to correlate the work in Illinois with that done in nearby districts, and for this purpose the Patoka area has been visited a half dozen times in as many different years. The object of the later visits was to review the work done in previous years and to make sure that none of the critical places had been missed, though a complete survey was not undertaken.

Some quotations from the Patoka folio will indicate the view there set forth.

Previous to the present survey of the region no attempt had been made to differentiate the silts, but evidence is now at hand for separating them into two types: (1) thick, yellowish, calcareous, and frequently stratified silts along the immediate borders of the Wabash Valley, which are designated *marl-loess,* and (2) the more clayey, oxidized and structureless silts designated as *common loess,* forming the general mantle over the surface more remote from the river. The first is believed to be of aqueous and the second of eolian derivation.

The marl-loess

occurs at all altitudes from the flood plain to the 500-foot level (120 feet above the river), at which altitude it frequently forms broad terraces and flats . . . burying a rugged rock or till topography. The thickness of the marl-loess in these terraces and flats is sometimes 40 feet or more, but thicknesses of 10 to 200 feet are more common.

The marl-loess is characterized by a high calcareous content and frequently by a sandy texture. Calcareous concretions are exceedingly abundant. In many instances it is delicately stratified and in some cases is interbedded with sands or fine gravels, or even carries scattering pebbles itself.

The perfection of their stratification, their interbedding with sand and gravel, the presence of pebbles in them, their terraced form, and their limitations to the borders of the Wabash point to water as the most probable agent in the accumulation of the marl-loess deposits, the deposition probably being in a fluvio-lacustrine body occupying the lower Wabash Valley, into which the silt was brought from the Iowan ice sheet by the Wabash River.

The view expressed in the *Bulletin of the Geological Society of America,* however, seems, to be that the "marl-loess" is partly eolian and the "common-loess" partly aqueous. To the present writer it does not appear likely that any of the loess of southwestern Indiana

[3] Water Supply paper No. 164 U. S. Geol. Survey, p. 46.

[4] "The Physiographic Development of the Lowlands of Southeast Missouri," p. 30.

[5] The loess is not the only surficial material of the Patoka quadrangle concerning which the writer is inclined to a different view from that set forth in the folio, but it is perhaps the most important.

is water deposited or has any stratification except in certain places where it has a very obscure banding roughly parallel to the present surface such as loess commonly displays.

However, some of the material included under the head of "marl-loess" has a very distinct and approximately horizontal stratification. Most such material is sand of fairly uniform grain, but layers and lenses of gravelly sand, calcareous sand, and also clay and silt are common. The lime is especially abundant in the lower ends of tributary valleys. But, so far as the writer could find, this material is not present at a greater altitude than 440 feet or about fifty feet above the flood plain, and it appears to him to be a part of a widely developed system of valley fillings, remnants of which he has traced through nine states in the upper Mississippi Basin. The tops of the remnants are generally 40–60 feet above the present flood plains. The valley fillings seem to have grown as units notwithstanding the fact that some streams are greatly overloaded and others not at all. It thus happened that some tributaries were ponded by the filling in the main valleys into which they discharged, and the deposits laid down in such comparatively quiet water are fine-grained and calcareous, the lime being largely in the form of small irregular masses differing somewhat from loess kindchen and possibly secreted by plants.

Whatever the origin of the stratified material, surely it is not correct to call it loess, for it differs markedly in several respects from the material known by that name elsewhere, particularly at the type locality in Germany. The principal respects are that it is heterogeneous, being made up of material of all degrees of fineness from clay to gravel, whereas loess is very homogeneous; (2) that it is coextensive with the valley fillings above referred to. Thus the "good sections of a very siliceous form of the marl-loess . . . in the bluffs at Mt. Carmel," the writer would call good exposures of waterlaid terrace sand, having no relation whatever to the true loess.

It seems, further, that some wind-blown sand has been included in the "marl-loess." The valley filling along the Wabash has been the source of much dune sand. Most of the dunes are near the valley bottom, but some of the sand has been carried up on the valley side and some even to the top of the bluff and neighboring divides. This seems to have happened in at least two different epochs, and there appear to have been two or more epochs of loess accumulation, though one is most important. As a result the sand and loess finger into each other in places, but in no section are there more than 2 or 3 layers of each.

It therefore seems to the writer that the "marl-loess" includes

1. Ordinary bluff loess (the principal part).
2. Glacial outwash.
3. Deposits laid down in ponded tributaries.
4. Wind-blown sand.

The stratified and sandy material of classes 2, 3 and 4 are markedly different from true loess.

The division of the loess of the Patoka quadrangle into marl-loess and common-loess appears to have a relation to the fact that on the bluffs near very large streams loess is generally coarser (or at least more free from extremely fine particles) and thicker and more calcareous than at a distance of several miles. The greater part of the material mapped as marl-loess seems to be loess of the ordinary bluff phase. That is to say, it is buff colored, soft, massive, unstratified, homogeneous, calcareous, earth. The particles are mostly angular quartz grains, too small to be classed as sand but some of them are clay. It commonly contains shells of air breathing animals and is characterized further by a tendency to develop and retain vertical cliffs.

The fact that both the bluff-loess and the clay-loess are best developed on the east side of the valley seems more reasonably accounted for by the prevailing westerly winds than by postulating that "the main current hugged the western shore," especially since throughout the Mississippi Basin the loess is more extensive on the east side of the few main streams than on the west.

The writer confesses an inability to see the "terrace form of the marl-loess" as described, the top being said to have a position 500 feet above sea. As mapped, it lies at all altitudes between 380 and 500, and there are somewhat flattish areas at all altitudes, but especially at 440–450 the altitude of the top of the valley filling in this region. Since divides generally have a rounded profile, and those of this area stand about 500 feet above sea, probably more of the surface here is near that altitude than any other, but the fact is scarcely evident from the topographic maps.

Also the loess does not seem to the writer to show a marked change in character at the 500-foot contour. In color, texture and other physical and chemical characters, including those brought out by mechanical analyses, acid tests and the microscope, the material seems to be a single deposit. In a very rough way the altitude of the surface increases with distance from the river and for this reason the highest "marl-loess" may be, on the whole, a little more like the clayey phase ordinarily found at some distance from larger streams than the average bluff loess, but the difference is slight and there seems to be no noticeable change at the 500 contour.

The statement that the range of fossils "is coextensive with that of the marl-loess, none being found above the 500-foot level" is not in accord with the writer's observations. One rather large collection was made at an altitude of 555 feet, two miles north of the center of Patoka and another at 525, one fourth of a mile northwest of that point. Another collection was made two miles north and one and one half miles west of Owensville at an altitude of 535 feet. At the first named locality the following species, all of which are land shells, were collected: *Pyramidula alternata* Say, *Succinea* sp. (young), *Helicodiscus multilineatus* Say, *Euconulus trochiformis* Montague, *Polygyra monodon* Rock, *P. hirsuta* Say, *Pupa muscorum* L., *Helicina occulta* Say.

The maximum thickness of the "marl-loess" is only about 40 feet, and yet it is continuous except where it has been subjected to severe erosion, as on the steeper valley sides. If the "marl-loess" were water deposited—a valley filling now dissected—one might reasonably expect to find remnants of triangular cross section and limited extent located where the meandering streams had chanced to leave them, instead of an almost continuous layer covering valley sides. The "marl-loess" as mapped has a vertical range of 120 feet or more, but the maximum thickness is scarcely a third as much. Like true loess, it appears to mantle hill and valley alike, in places obliterating minor irregularities, but nowhere greatly modifying the major features.

The writer found no pebbles in place in the material which he would class as loess, and none in any of the material described as marl-loess at a greater altitude than 440 or at most 450 feet. Pebbles are, to be sure, pretty good evidence that a deposit is not eolian, providing they are certainly in place. But there are so many ways in which pebbles are scattered that unless they were certainly in place or very nearly in place, it would seem unsafe to regard them as evidence of water deposition.

The relation of the true loess to the general form of the surface of southern Illinois throws a rather important sidelight on the problem. The Mississippi and Ohio are bordered by high rough country and the general surface slope is not toward these two principal streams but away from them. The loess, however, here as elsewhere, is thick, porous, calcareous and fossiliferous on the high hills near the rivers and gradually becomes thin and clayey toward the low country at some distance from them. If the part below 500 feet were water deposited, thousands of square miles of the interior lowland must have been submerged and this area should presumably have a considerable deposit if not a thicker one than the higher country, but the deposit is thin or wanting in the lowland. It thickens gradually toward the rivers and is thickest on the hills where the water must have been most shallow, along the Ohio and Mississippi. The bluff loess certainly appears to be a single deposit from the bases of the hills at 375 or 400 feet to their crests at 700 or 800 feet where it is thickest. The distribution of the loess is very different from that of material known to be waterlaid valley filling.

Briefly, the writer believes that the so-called marl loess of southwestern Indiana consists of wind deposited true loess, stream laid valley filling, and dune sand, and that the true loess part of it together with the "common loess" corresponds to the well-known loess of other parts of the Mississippi basin.

Eugene Wesley Shaw

SOCIETIES AND ACADEMIES

ST. LOUIS ACADEMY OF SCIENCES

At a meeting of the Academy of Sciences of St. Louis, held October 19, Professor Nipher gave an account of his work during the summer of 1914, at his summer place in Hessel, Mich., on "Magnetic Disturbances in the Earth's Field due to Dynamite Explosions, Burning Black Powder and the Fog-horn of a Steamer."

The magnetic needle was mounted on a frame of timber, the vertical posts of which were set two feet into the ground. The frame and the boxes containing the control magnets were loaded with half a ton of rocks. The boxes containing the control magnets were also clamped to the frame with large wooden clamps. The base of the air-tight vessel containing the magnetic needle was also clamped to the frame. The torsion head was braced by means of wooden bars. Four cords at right angles to each other were attached to the torsion head. They passed outward and downward through holes in the table, and upon them were hung two bars of wood at right angles to each other. These bars were also loaded with rock. The apparatus was protected from heat effects by a series of blankets within the tent, having air-spaces between.

No difficulty was found in producing marked local disturbances in the earth's field by means of dynamite suspended in air to the east and to the north of the tent. The needle being at right angles to the magnetic meridian, this disturbance indicated a variation in the horizontal intensity.

The amount of dynamite exploded varied from half a stick six or eight feet from the tent, to thirty sticks distant 275 feet. In the larger explosions, the sticks were placed end to end on bars of wood having a cross section $1 \times 1\frac{1}{2}$ inch. Each stick of dynamite was securely held in place upon the bar by means of a winding of heavy cord. The ends of the bar suffered no appreciable injury. Those parts in contact with the dynamite vanished in dust so fine that it was difficult to find any trace of it. The changes in the position of the needle in explosions of this character amounted to ten or fifteen minutes of arc.

Much more marked effects were produced by distributing half a stick of dynamite into a column about 15 feet in length. It was packed closely into the angle of a little trough of wood, which rested upon a heavy beam of wood. The trough was held in position by means of masses of rock hung on cords. The column of dynamite was in line with the needle and either above or below the level of the needle. In this way deflections of about one degree of arc were produced. The direction of deflection was reversed by reversing the direction in which the explosion traversed the column. The end of the column nearest the needle was distant from it about ten feet.

This seems to indicate that a magnetic field is created around this exploding column, like that which exists around a wire conductor carrying a current of electricity. In most of the experiments of this character only a small part of the column exploded. It is believed that the conditions which will cause an explosion of the entire column with equal violence throughout have been finally attained, and this work will be continued.

The black powder was spread over a platform having an area of 25 square feet, placed a few feet from the west side of the tent. The amount of powder spread over the platform was from 25 to 50 pounds. The flame shot upward to a height of 15 to 30 feet. The lines of the earth's field were deflected around the region filled by this flame. The intensity of field within the tent was momentarily increased. The deflection of the needle amounted to from 25 to 50 minutes of arc.

At the request of Professor Nipher, the captains of the steamers of the Arnold Transit Co. were instructed by the president, Mr. Geo. T. Arnold, to blow a loud and prolonged blast on their fog-horns when at the nearest point to the observing station. This distance was about half a mile. Appreciable effects were thus produced when the air was quiet, the sky was clear and the intensity of the field had reached a high value. The result in every case was to decrease the intensity of the earth's field.

In two cases the blast from the 5 o'clock boat was at once followed by a premature appearance of the sunset disturbance. Rhythmical vibrations over from 10 to 20 degrees of arc at once followed, and continued for four or five minutes. This result needs further examination under more favorable conditions.

C. H. Darforth,
Recording Secretary