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One cannot work in the Iowan Drift area and in adjacent areas of older drift without confronting the problem of the loess. During the field seasons of 1914 and 1915 while associated with Dr. Wm. C. Alden of the U. S. Geological Survey in reviewing the field evidences for and against an Iowan stage of glaciation, the writer became interested in certain phases of the loess and their interpretations. Through the kindness of his senior colleague, the writer has the privilege of briefly discussing these phases before the Iowa Academy of Science. A more complete discussion will appear in the forthcoming report of the Iowa Geological Survey in connection with the report on the investigations of the Iowan Drift, under the joint authorship of Doctor Alden and the writer.

1. *The Weathering of the Loess.*—In the various papers which have appeared on the loess, little attention has been devoted to the weathering of the loess. What will be said here will concern only that loess which is associated with the Iowan drift-sheet. From a careful examination of the exposures of the loess, it has become clear to the writer that it has been partly leached of its calcareous material and oxidized to some depth since it was deposited. The features of the average exposure where eight feet or more are shown are as follows:

		FEET
3.	Soil, black, changing below to dirty brown, no pebbles; usual thickness	½-1½
2.	Leached loess, buff to yellow, does not react to dilute hydrochloric acid, no fossils or lime concretions; thickness (in some cases as much as 12 feet)	6-8
1.	Calcareous loess, usually of lighter color than the noncalcareous except where grayish; the grayish color may not appear for several feet below the top of the calcareous zone; snail fossils commonly present, also lime concretions. This zone is usually not shown in cuts less than 8 feet deep.	

The persistency of these phenomena in cut after cut makes them of significance in reading the history recorded by the loess. The buff loess and the gray loess have heretofore been generally regarded as separate and distinct deposits, differing considerably in age. The buff loess has been thought to be of Iowan age and younger, while the gray has been held to be of approximately Kansan age, it being held that the gray probably has the same relation to the Kansan drift as the buff seems to have to the Iowan drift.

These conclusions, however, do not seem to the writer to be well based. Of the many exposures examined on the east and south sides of the Iowan area, there was not a single one which showed good evidence of an interval of time between the deposition of the gray and the buff. There is no zone of leaching at the top of the gray, such as would be expected if the two deposits belong to two different epochs, nor is there any other strong evidence of weathering effects that would differentiate the two. Indeed there is a continuance of lime carbonate particles and shells from the gray up into the buff, and in most cases there is a transition in color. It is true that in some instances rusty streaks occur at the contact, but these were found also indiscriminately at any horizon. In view of these features of gradation and the absence of any that distinctly separate the two in terms of time intervals, the writer has become convinced that the two are of the same geological age, that the mass of the loess was originally gray, and that the buff is to be regarded merely as the oxidized phase of the gray.

Another important historical point to be noted from a study of the weathering of the loess is that the leached zone records the fact that the loess has been subjected to the solvent action of ground water for a sufficient length of time for the calcareous particles and snail shells to be dissolved out to a depth of several feet. Fossils are not seen in many shallow cuts for they occur only in the zone which has not been leached. One must bear in mind, however, the possibility that the upper part of the loess was deposited as a noncalcareous clay. This may be true of some of the leached zone, but it would be an extreme view to assume that the ground water has performed no work since the loess was deposited, especially if the mass of the loess is pre-Wisconsin in age as will be shown later. But aside

from these reasonable grounds, there is good basis for thinking that the noncalcareous zone of the loess is largely due to the leaching process. There are to be found on the surface today living snails, which, according to Professor Shimek, who has made an extensive study of them, are mostly of the same species as the snails whose shells are found as fossils in the loess. If this is true, it is quite evident that if the loess has suffered no leaching, snail shells should be found in the noncalcareous zone as well as in the calcareous zone beneath. As to where present snails secure their carbonate of lime, it is quite possible that the lime may be obtained from the feldspar particles of the clay, which then may be carbonated by ground water. Another evidence that the loess has in reality suffered leaching is the fact that lime concretions are found near the top of the calcareous zone, the material of these concretions being that which was dissolved from the zone above.

These phenomena, therefore, lead to the conclusion that the mass of the loess, which is associated with the Iowan drift, was once calcareous and gray, and that it accumulated at a time when the rate of deposition was greater than the rate of leaching. This suggests strongly a special episode of deposition for this particular loess.

2. *The Source of the Loess.*—The loess associated with the Iowan area is thickest in three situations: (1) along the river valleys leading from the Iowan drift; (2) around the border of the Iowan drift; and (3) in those elliptical hills which McGee termed paha.

In some instances the buff loess is so thick along the larger valleys that the valley walls rise distinctly above the bordering upland like low ridges. This is so noticeable along the Cedar river southwest of Marion and along the Wapsipinicon river west of Oxford Junction that one is reminded of the common remark of the early geologists who studied these localities, that the streams left the plains to cut through the hills.[1] Of course, in some instances dune sand is associated. In many other places along valleys the loess is thick without forming distinct ridges. The accumulation of loess in such marked deposits along valleys is probably due to nearness to a source

[1]It is evident in such cases that the ridges came into existence after the valleys were cut.

of supply, namely the valley flats, and to the vegetation and topography favoring lodgment, all of which has been pointed out by Professor Shimek.

The notable thickness of the loess around the border of the Iowan drift is too well known to demand much further reference. The fact that it gradually diminishes in thickness and becomes finer as distance increases from the Iowan border, together with the fact that it is thick even away from valleys, indicate that the Iowan area also was a source of supply. Within the Iowan area itself the loess is generally absent or nearly so, but to this there are exceptions as would be expected. It is obvious that deposits would be made wherever there were obstructions. Some such conditions gave rise to the paha, the wind depositing dust and sand about rock projections, glacial drumlins or even sand dunes. Their persistent southeasterly trend probably is best accounted for by assuming either that the winds were prevailing northwesterlies or that the drumlins trended in that direction.

If the source of the loess was the Iowan drift and the valley flats, and if the mass of the loess was deposited in a calcareous and unoxidized condition, then it must have been blown from the Iowan drift before the drift was weathered. This thesis may now be tested by noting other evidences for the age of the loess.

3. *The Age of the Loess.*—The age of the loess can be ascertained by noting its relations to the Kansan drift, the Illinoian drift, the Iowan drift and the Wisconsin drift. In the Kansan area the loess mantles the slopes as well as the uplands. Calcareous and fossiliferous loess in many places also overlies leached, oxidized, and decomposed Kansan drift. Such evidences of an unconformity tell us that the Kansan drift was not only weathered before the loess was deposited, but that the drift-plain was quite thoroughly dissected.

The loess mantle continues into the Illinoian drift area in southeastern Iowa, where it shows the same amount of weathering as the loess about the Iowan border. Here it also occurs on the eroded surface of the Illinoian and in many places its calcareous zone rests on the weathered and decomposed Illinoian till, there being in many places an intervening development of the gumbo as in the Kansan area except that it is thin-

ner. Thus it is clear that the loess also is younger than the Illinoian drift by a considerable interval.

In the Iowan area the loess is generally so thin that the leached zone extends down through the loess into the till, but it is a striking fact that in those areas where the loess averages four to six feet in thickness the leached zone passes into the underlying till scarcely more than a few inches to one and one-half feet. Evidently the leaching process has but recently reached the till. This view is supported also by the fact that the top of the till is practically the same color as the lower part of the loess. No soil or gumbo development was found anywhere between the Iowan drift and the loess. Where the loess is absent or nearly so the drift is leached correspondingly more, but a little less than the loess where thick sections are exposed. All of these evidences bear out the interpretations made from the areal relations of the loess, its composition and characteristics, that the loess was deposited closely following the retreat of the Iowan ice-sheet.

This conclusion may at first seem incompatible with the evidence of the fossil shells which, according to Shimek, indicate much the same climatic conditions as the region possesses today. But it should be recognized that the climate at the close of a glacial epoch must be decidedly different from that at the beginning. A glacier is the product of glacial conditions. Its development and advance are preceded first by the culmination of glacial temperatures and precipitations. Its retreat occurs only after the glacial climate ceases. Probably the climate of the zone in close proximity to a retreating continental ice-sheet is affected somewhat by the presence of the ice, but yet the conditions are probably much less severe than in the case of an advancing ice-sheet. In the first case, the climate opposes the existence of the ice mass, while in the second, it is responsible for it. Is not the close of any glacial epoch in reality that time when the climate becomes permanently effective in causing glacial retreat? Granted that present temperatures probably did not prevail in the immediate vicinity of the Iowan ice-edge, it does seem likely that after the earth's climate had changed and the ice had melted back several hundred miles from its extreme limit, seasons approximating those of the present prevailed where the marginal loess occurs. Even though this

distance be increased to a thousand miles, the length of time consumed in this retreat would be brief geologically, probably not permitting of any perceptible amount of weathering. The statement, therefore, seems safe that the loess was deposited immediately after the closing stages of the Iowan glacial epoch in which case the loess should be regarded as early Peorian in age rather than Iowan.

If the loess is early Peorian in age, the relations of the loess to the Wisconsin drift should show it. In an excellent exposure made by the Chicago, Milwaukee & St. Paul Railway Company during the recent reconstruction of their line in Marshall county, at the Wisconsin margin, tangible evidence was found supporting this view. Here the loess, which is typically developed to the south of the Iowan border, passes beneath twenty-five feet of Wisconsin drift. The loess itself also is twenty-five feet thick. The larger part of the Wisconsin drift has been scarcely changed by weathering, whereas the loess is almost wholly oxidized, there being some gray left at the base, and the top of the loess in one place is leached four to five feet. Therefore, the conclusion seems warranted that the loess which is associated with the Iowan drift is chiefly early Peorian in age.

4. *Bearing of the Loess on the Problem of the Iowan Drift.* —Inasmuch as the deposition of the loess dates back to the time when the Iowan drift was yet unleached, the loess may be used for correlation purposes in determining the time relations of the Iowan drift to the Kansan and Illinoian drifts. The great unconformities between the loess and the Kansan drift, and between the loess and the Illinoian drift, which have already been described, show that the Iowan ice-sheet invaded Iowa a long time after the Kansan and Illinoian glaciations, the Kansan, of course, having much preceded the Illinoian.

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