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THE INTERPRETATION OF CERTAIN LEACHED GRAVEL DEPOSITS IN LOUISA AND WASHINGTON COUNTIES, IOWA.

W. H. SCHOEWE.

During the field season of 1917, the writer examined two exposures of stratified sands and gravels, which, in age, may probably be correlated with the close of the Nebraskan stage of glaciation and with Aftonian times.

The first of the two exposures, which are separated by about two miles, is located in Washington county in the extreme southeast corner of section 36, Iowa township. The other outcrop is found in Louisa county in the northwest quarter of the southwest quarter of section 8, Union township, Township 76 North, Range 5 West. In both cases, the exposures are in banks of streams, the first forming the north bluff of Davis creek, the second, the south wall of Goose creek. The base of the two sections lies practically at the level of Iowa river which is about one-eighth of a mile farther to the east and which, according to barometric readings, is at 620 feet above sea level.

As the two sections are very much alike, a detailed description of but one will be given, and only the points of differences of the other one will be brought out. The exposure to be described is the one in Washington county at the location cited above.

The section is as follows:

	Feet
3. Light ash-colored drift.....	10
2. Leached and oxidized sands and gravels.....	20
1. Dark bluish calcareous drift; compact, unoxidized and containing small pebbles.....	4

Towards the base of the sand and gravel deposit, the gravels predominate. The textural range of the gravels is rather high, the pebbles varying from small fragments the size of a pea to pieces several inches in diameter, the finer material, however, being in excess. The gravels are cross-bedded.

The sands which are highly oxidized and have a brownish color are fairly fine and have a low textural range. In structure they are highly contorted, dip at high angles, are cross-bedded and at places,

especially in the middle of the deposit, are more or less horizontal. A lens and pocket structure is conspicuous throughout the exposure in which occasionally leached mud or clay balls are found.

Although but ten feet of the ash-colored drift is exposed, the slope of the hill is covered by drift to a height from forty to fifty feet above the section. The exposed portion of the till contains limestone pebbles and is filled with many concretions. Higher up the slope of the hill, the drift is leached. The entire outcrop is from 150 to 250 feet long.

The other section differs but little from the one just described, except that it contains less gravel and no drift is exposed beneath the sands. However, it contains near the base several thin leached layers of till from one to two feet thick. Here and there, a well weathered limestone pebble occurs in it, nor are lime concretions entirely wanting.

On the whole, the stratification of the sands and gravels of the exposure in Louisa county is more horizontal than that of the one in Washington county. Barometric readings show that the two sections lie approximately at the same elevation: namely, from 620 to 630 feet above sea level. The length of the second outcrop is the same as that of the first and the exposure is forty feet high.

INTERPRETATIONS OF THE DEPOSITS.

The deposits above described may be interpreted in either of the following ways:

1. The sand and gravel deposits are inclusions incorporated in the Kansan drift.
2. The sands and gravels are interbedded outwash material between two drifts which are of the same age and therefore Kansan as the uppermost till is known to be of Kansan age.
3. The sand and gravel deposits lie between drifts of two different ages, the gravels and sands having been deposited in connection with the lower till, but having been weathered during interglacial times or before the deposition of the upper drift.

VIEW 1.

The sand and gravel deposits are inclusions incorporated in the Kansan drift.

Discussion.—Sand and gravel pockets incorporated in tills are familiar to all. But whether large stratified inclusions of leached and oxidized sands and gravels in fresh drift are common is very

doubtful. If the inclusions are contemporaneous with the deposition of the fresh drift, why then are the inclusions oxidized and leached?

As inclusions incorporated in the Kansan drift, these large leached and oxidized sand and gravel deposits can best be explained as pre-Kansan material which before being picked up and later being deposited by the Kansan ice sheet were frozen into a solid mass. Should this view be correct, the deposits would still be evidence of a long interglacial stage.

In any event, if there were but one exposure, one might be tempted to favor the view set forth above. However, since there are at least two exposures, separated by two miles, and having the same stratigraphic and topographic relationships, one is led to conclude that the sands and gravels are not merely large sand and gravel pockets incorporated in a till of the same age, but rather outwash deposits lying between two drifts either of the same or of two different ages.

VIEW 2.

According to the second view, the sands and gravels are but the interstratified outwash deposits between two drifts of the same age and therefore represent the following conditions:

1. An advance of the Kansan ice sheet and the deposition of the lower drift, then

2. A retreat of the ice sheet accompanied by a deposit of outwash material covering the recently deposited fresh till.

3. A readvance of the ice depositing drift over the sands and gravels which presumably were frozen into a solid mass on the last advance of the ice sheet.

4. The disappearance of the Kansan ice sheet.

Discussion.—The above view would satisfactorily explain the origin of the interbedded sands and gravels if the latter were fresh as the two drifts are, above and below. If the sands and gravels are contemporaneous with the two tills, then one would expect the interbedded deposit to be fresh also. Is it possible that the outwash material was all leached at the time of its deposition? It hardly seems conceivable that this could have been the case. Why should they have been leached when the drifts are highly calcareous?

Were the sands and gravels leached since the deposition of the overlying drift? Hardly so, for the lower part of the upper till is fresh; besides this drift acted as a protecting cover for the underlying deposit. The till above the sands and gravels is fresh, but is oxidized and leached farther up the slope of the hill.

The only other way to explain the origin of the sands and gravels in the light of their being of Kansan age is as follows:

After the outwash material had been deposited, a time elapsed sufficiently long enough during which the sands and gravels were leached before the readvance of the ice sheet. This latter view might explain the origin of the interbedded deposits. The question, however, arises at once, how much time would be required to have elapsed before the entire twenty feet were leached and oxidized? And is there any other similar case known to glacial geologists? The so-called Aftonian sands and gravels are fresh. Do they really represent interglacial times?

In the first place, it is not certain whether the twenty-foot layer of sands and gravels represents the original thickness of the deposit. Thus the leaching of these materials may not necessarily record the entire length of time that elapsed between the two oscillations of the Kansan ice sheet, as some of the leached sands and gravels may have been eroded away before and at the time of the second advance of the ice sheet. It seems, however, that a considerable time must have elapsed before the uppermost till was deposited, if we can draw conclusions from the kame and esker deposits of Wisconsin age. Inspection of such well-known deposits in Wisconsin show that little if any leaching has taken place since the time of their deposition. Furthermore, the gravel and sand deposits south of DeWitt, Iowa, which are either of Illinoian or of Iowan times are still fresh. These gravels as well as those of Wisconsin age have no protecting cover of drift and therefore have been exposed to the oxidizing and leaching processes for a considerable length of time. Are we to assign a period of at least as long a duration as all of post-Wisconsin time to the interval between the two oscillations of the Kansan ice sheet? Hardly so.

VIEW 3.

The third view regarding the sand and gravel deposits explains the deposits as Nebraskan outwash materials which were exposed for some time to the elements of weathering before the coming on of the Kansan ice sheet.

The following steps are represented:

1. An advance of the Nebraskan ice sheet and the deposition of the lower till.
2. The retreat and disappearance of the Nebraskan ice sheet accompanied by a deposit of outwash material.

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3. A long interglacial period during which the outwash material was thoroughly oxidized and leached.
4. An advance of the Kansan ice sheet and the deposition of the upper drift.
5. The disappearance of the Kansan ice sheet.

Discussion.—This view is the only one which will satisfactorily account for all the conditions as they exist in the field: namely, an upper till the top of which is oxidized and leached and whose lower portion is fresh, then an oxidized and leached stratified deposit of sand and gravel beneath which is an unoxidized fresh till. Presumably as the Kansan ice advanced over the outwash deposits, the sand and gravel were frozen into a solid mass.

OTHER EVIDENCE BEARING ON THE PROBLEM

A study of the gumbotils in close proximity to the described sections shows that there are two distinct gumbotils, one lying at an elevation of about 710 feet and the other from 620 to 640 feet above sea level. The higher lying gumbotil is the Kansan, and the lower one the Nebraskan. There never has been any doubt regarding the Kansan gumbotil, but it has just recently been established that the lower gumbotil is the Nebraskan. Now the noteworthy point is that the elevations of the sand and gravel deposits are approximately the same as those of the Nebraskan gumbotil near by. This coincidence of elevations seems to signify that the sands and gravels were lying on the same surface as that of the Nebraskan drift and that while the till was being oxidized and leached to form the Nebraskan gumbotil, the sands and gravels were also undergoing the same processes of leaching and oxidation and hence represent the same interglacial interval.

CONCLUSIONS

We have here the following facts:

1. The stratified sands and gravels are oxidized and leached.
2. These deposits lie between two fresh drifts of which the upper part of the overlying till is leached, hence presenting a section as follows:

Drift	leached
Drift	unleached
Sand and gravel deposit.....	leached
Drift	unleached

3. There are two such exposures, separated by several miles and having the same elevation as well as the same stratigraphic and topographic relationships.

4. The elevations of the sand and gravel deposits and the Nebraskan gumbotils are approximately the same.
5. View 3 best explains and accounts for all of the conditions as seen in the field.

The writer is of the opinion that the lower drift is Nebraskan, that the sand and gravel deposits are Nebraskan outwash materials, that these outwash sands and gravels were oxidized and leached contemporaneously with the formation of the Nebraskan gumbotil and that the upper till is the Kansan.

Ever since the history of the origin of the gumbotil has been worked out by Professor Kay,* the value of interbedded sand and gravel deposits between drifts has lost its significance as a criterion of interglacial times. It is only when such deposits are oxidized and leached and lie between fresh drifts that any positive value can be attached to them as recording an interglacial interval.

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*Kay, G. F., Gumbotil, A New Term in Pleistocene Geology: Science, New Series, Vol. XLIV, Nov. 3, 1916.

Kay, G. F., Pleistocene Deposits Between Manilla in Crawford county and Coon Rapids in Carroll county, Iowa: Iowa Geol. Survey, Vol. XXVI, pp. 217, 218, Ann. Rep't. for 1915.