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INTERLOESSIAL TILL NEAR SIOUX CITY, IOWA.

BY J. E. TODD AND H. FOSTER BAIN.

Till and loess are well known deposits and need not be defined. It is a peculiar and anomalous relation between the two which it is proposed to describe in this paper. It is well known that the till almost universally occupies a position below the loess wherever the two are found in the same section. A few cases only have been noted where the reverse is true. Such an instance was described by McGee and Call* in an account of the loess near Des Moines. Similar occurrences have been reported by other observers from central and eastern Iowa. These may all be readily explained by an advance of the ice sheet over the loess already deposited around its margin.

The senior author of this paper has, during several years of observation, noted only three or four instances which could by any use of language be mentioned as illustrations of the subject; of these the one illustrated in the plate 1 is the only clear case.

The first instance of interloessial till noted was in 1889 at Riverside Park, near Sioux City. This may still be seen in a gravel pit facing the Big Sioux river near its mouth. The notes taken at that time are as follows:

4. Loess, thickening back from bluff — to 100 feet or more; above a few fresh water shells, including *Lymnea* and *Cyclas*; below one or two specimens of *Helix hirsuta*.

3. Till, brownish; with northern pebbles; disappearing a few rods farther north; containing fine sand blending with the loess.

2. Compact, whitish, silt-like loess, containing *Succinea* similar to shells still living on the bluff above. The upper portion containing carbonaceous streaks and marks, suggesting marsh grass.

1. Gravel, coarse; obliquely stratified, with occasional northern boulders.

The most probable explanation of this occurrence seemed to be that number 1 marks a stage when the river was larger and

*Am. Jour. Sci., (3), XXIV, 202-223, 1882.

flowed at a level probably twenty feet higher than at present. Number 2 is probably a silt capping which originated in a manner analogous to that of ordinary bottom land. The Succinas were probably introduced accidentally, as similar shells may now be found at the base of the bluffs. Number 3 seems to be a slide or wash of till from a higher original level farther back. The drift clays lie thirty or forty feet higher a few rods away. Number 4 is probably the body of a terrace similar to that found south of Sioux City. It is true its upper surface is more eroded near Riverside, and not clearly distinct from the older loess farther north, but the hill-tops of loess do not rise as high as farther north and east.

Somewhat similar deposits occur at Kansas City. Near the foot of Lydia street, under many feet of loess are irregular sheets and strips of limestone fragments, northern pebbles, granite, red quartzite and other rocks. These have a slight intermixture of clay, interstratified with layers of loess. The top of the exposure of the pebble beds is about sixty feet above the Missouri river near by. It is clearly in the base of a high terrace covered with loess. The explanation suggested for the Riverside section is quite confidently applied here with the modification that the wash is not so clearly till, and the under layers of loess are not so regularly deposited.

The best and clearest example of interloessial till is that discovered and examined by both the authors within the past field season, near Sioux City. North and east of Riverside Park there are a number of openings from which sand and gravel has been taken. These usually expose in regular order, loess, brown clay, a thin gravel bed and sand. In one of them, however, a bed of till was found interstratified with the loess. This exposure is about one mile northeast of the Brugier bridge, over the Big Sioux river, and is about 150 feet above that stream. It is as high as any drift exposure in the vicinity. The till is typical boulder clay, consisting of dark brown clay, through which is disseminated pebbles and boulders of northern rocks, such as are found lying at lower levels in the drift of the vicinity. Among the rocks identified is the Sioux quartzite, which is indicated by a hammer at the left of the plate. The bed of till is of variable thickness, being a little over six feet at the left of the pit and tapering from that toward the right to a feather edge. While the whole width of the bed is not exposed the outline seen seems to indicate a lense-shaped body, quite

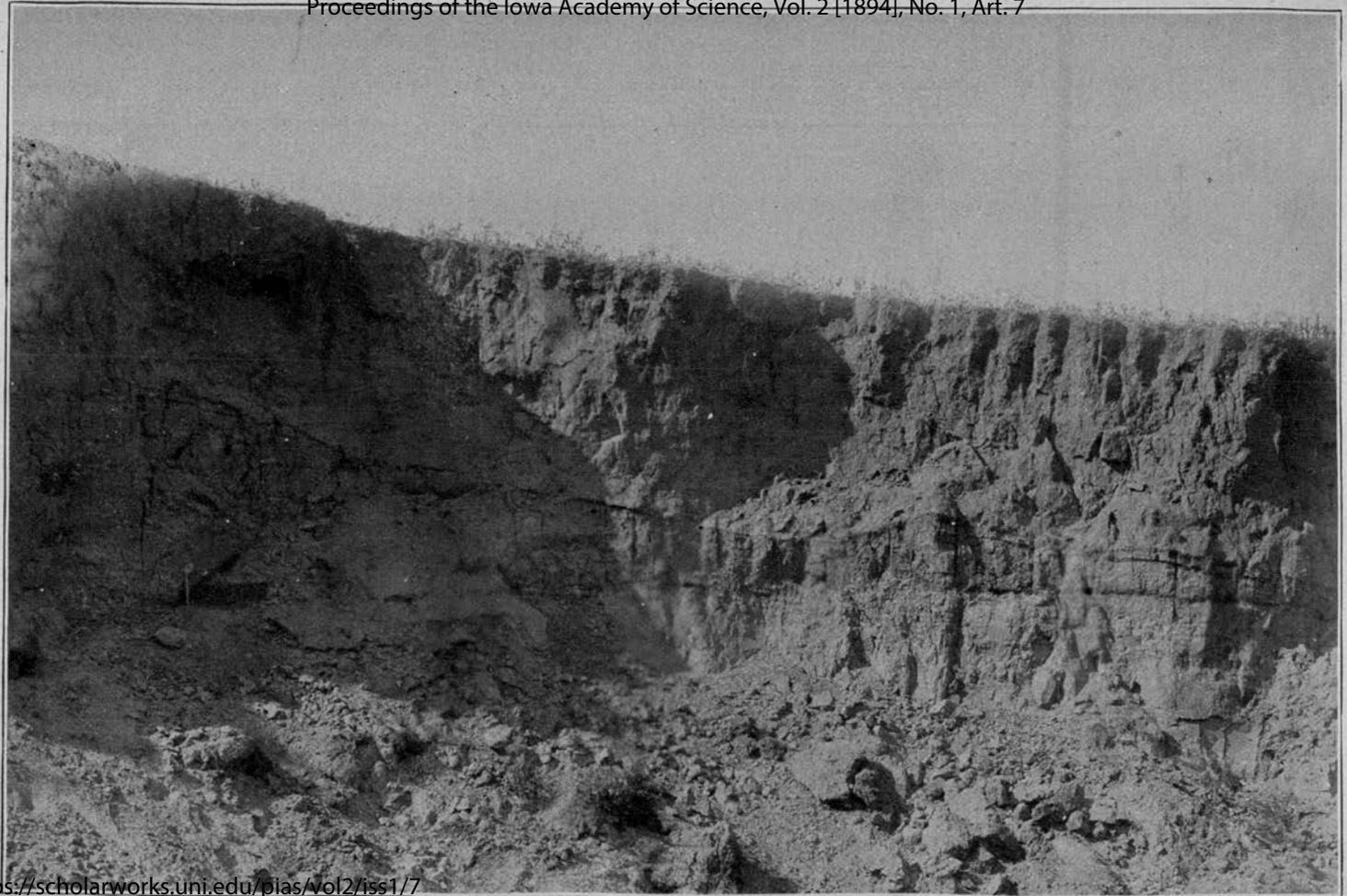
thin relative to its aerial dimensions. The loess is well exposed, both above and below the till bed, and is in each case of a character indistinguishable from that so frequently seen in the city street cuttings and other excavations. The surface above shows the usual flowing lines which so well characterize the topography of a loess covered land.

The intermixture of till and loess seen at this locality cannot be explained by the theories mentioned in the other cases. The till found here is many feet above any known drift found in the vicinity, and is well up in the loess. The most rational theory seems to be that, while the loess was being deposited, a mass of floating ice laden with debris from the adjacent ice sheet, stranded and gradually unloaded its burden or upset as it was floating and dumped into the water the material carried.

Such an explanation for certain tile deposits has been suggested, but there seems hitherto to have been no such clear case observed.

It remains to consider the bearing of this fact upon some general problems concerning the drift. The relation of these deposits to the outer or Altamont moraine is of interest. This moraine, as it has been traced, presents a gap about nine miles wide, in the northern part of Clay county, S. D., about thirty miles northwest. It is also known that through this gap an ice tongue nearly that breadth (nine miles) extended down the valley occupied by the Vermillion river on the west and Brush creek on the east. This came within, perhaps, twenty miles of the typical exposure just described. The next gap of the moraine north of the one just described, is where the Big Sioux comes through, south of Canton, near Fairview. The drift in western Plymouth county, Iowa, near which the exposure described is situated, is thin and patchy, being usually not over fifteen feet in thickness. That the region has not been covered by the heavy land ice would seem to be indicated, not only by this, but also by the general presence of beds of fine sand and clay under the drift, and showing no signs of disturbance.

The deposition of till in the loess indicates their contemporaneous origin, and therefore throws light upon the age of both. It indicates that some of the till outside the moraine is as late as the loess, and argues strongly in favor of all being not long antecedent and of probable similar origin.



The similarity of the higher exposure and the one near the river indicates the probable common origin of both. If this be so it indicates that the trough of the Missouri was excavated much as now, and yet that the water surmounted the Cretaceous bluffs with sufficient depth to float small icebergs. This conception will also explain why the boulder clay is so thin over the uplands; also, why it should be distributed so far down the Missouri, while it is so thin near the moraine.

Such a thickness of the drift as is found in southwestern Iowa and northern Missouri could seem, perhaps, to have been derived in a similar manner from the Des Moines ice lobe.

PREGLACIAL ELEVATION OF IOWA.

BY H. FOSTER BAIN.

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The long period intervening between the deposit of the Cretaceous rocks of Iowa and the advent of the glaciers has left in this state no record in deposits. Its history must be gathered entirely from the land forms then created, and from inferences drawn from orographic changes known to have taken place in other regions.

Over the greater portion of Iowa the land surface of post-Cretaceous time is now covered by a thick mantle of drift. It is only in the northeastern corner of the state that it is exposed, and it is in this region mainly that the history of the period has been read. It is, however, possible to find in other portions of the state much which confirms the results obtained from a study of the driftless region.

Throughout Iowa the records of well borings show the presence of numerous buried drainage channels, some of which can be traced with a measurable degree of accuracy for a considerable distance. In the course of recent detailed work in connection with the Geological Survey a number of these have been noted. One of the best examples is what may perhaps be called the Washington Channel, as it has been studied most in that county.