Proceedings of the Iowa Academy of Science

Volume 60 | Annual Issue Article 53

1953

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Evolution of the Level Interfluvial Divides on the Kansan Till Plain in Iowa and Missouri*

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The purpose of this paper is to discuss and evaluate various alternative hypotheses concerning the evolution of the level interfluvial divides on the Kansan Till plain in southern Iowa and northern Missouri. About four-fifths of the plain is dissected (3), but the undissected remnants have an almost flat surface. In contrast to this the undissected portion of the much younger surfaces of the Mankato and Cary till plains have an undulating topography with numerous closed depressions and isolated low knolls.

The two contrasting landscapes are illustrated in Figures 1 and 2. The Kansan flats are loess covered, but over most of the area where undissected divides persist loess thickness varies regionally from about 4 to 10 feet and appears to have been deposited as an almost perfectly uniform blanket with no appreciable local variations in thickness.

A number of possible explanations for the flatness of the Kansan till plain have been advanced.

1. One explanation might be that the ground moraines of the Kansan glacier were deposited with almost perfectly flat surfaces. This possibility cannot be ignored. There are several rather large nearly level areas on the Iowan and Tazewell till in northwestern Iowa. These flats are the exceptions, but they do occur. As calcareous loess is described by Smith and Riecken (8) as resting directly on calcareous till on these flats, it appears that there was very little time between deglaciation and loess deposition and that the flat land surface is a depositional surface. However, most of the undissected Iowan and Tazewell surfaces are sloping, and the Cary and Mankato surfaces, are as previously mentioned, quite undulating. Hence, it seems somewhat unlikely to assume an almost level surface for all of the Illinoian and Kansan glacial plain.

2. Another explanation that has been advanced (Kay and Apfel, 3) is that the Kansan till plain was reduced to a common low level by peneplanation. This theory was advanced in connection with the development of theories concerning the formation of gumbotil. The gumbotil which represents long periods of weathering on flats,

*Journal Paper No. J-2315 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 1152.

is found at different elevations which rather strongly argues against peneplanation, and so this theory has been generally abandoned. Then, too, the topographic relationships of the various fossil soils developed on the pre-loess Kansas surface make this hypothesis appear untenable (4). This will be discussed in more detail later.

3. The divides on the Kansan till plain are so level as to suggest a lacustrine origin. It appears quite probably that portions of the plain are of lacustrine origin. Voss (10) reports peat beds on the Kansan surface in Illinois, which could indicate a shallow lake or lake margin (10). Work on two sections near Columbia, Missouri, indicate a water deposition of the so-called "gumbotil" layer (2). The sections examined in that study, however, are not typical of many gumbotil exposures, and work by Simonson (7) and others indicates that at least a portion of the buried soils of southern Iowa are formed from till.

A lake whose bed would encompass the level plain remnants that persist throughout the Kansan and Illinoian glacial area would surely have left other evidence of its existence.

4. Another postulate that appears to warrant further consideration is that the level interfluvial divides are remenants of flat colescent interfluvial surfaces that were developed as a natural gradational product during the reestablishment of drainage on the Kansan till plain and its subsequent dissection.

Processes That Might Lead To The Development of Flats

On an undissected ground moraine relief is relatively low, seldom exceeding 50 feet and is usually less locally, as for example, over a square mile. The ground moraine commonly forms undulating plains with gently sloping swells, swales, and closed depressions (1).

That such conditions probably once existed on the Kansan ground moraine are indicated by the presence of lacustrine deposits (2), of peat (10), and of soils derived from till (7), all on the level interfluvial divides over Kansan till.

It is believed that the older till plains have existed under a number of different types of climate (9). Erosion conditions can best be evaluated by considering these climates separately.

1. *Sub-humid climate.*

Under a sub-humid climate it appears reasonable to suppose that the interfluvial divides would be grass covered. Under these conditions growth of grass would be most vigorous in the swales and on the lower slopes and least vigorous on the tops of the knolls and on the steep hillsides. Thus, erosion might be essentially at a still

stand on the lower slopes while it would be proceeding quite rapidly on the upper slopes. Under these conditions the dense vegetation of the lower areas would tend to slow up the runoff waters from the higher areas, and there most of the sediment would be dropped. This would tend to build up the low areas at the same time that the higher areas are being planed down. This process alone may be sufficient to account for the leveling off of the Kansan till plain when the long period of time available is considered.

2. *Peri-glacial climate.*

The entire Kansan till plain existed within about two hundred miles of the Illinoian and Iowan glaciers and within slightly greater distances of the Tazewell, Cary and Mankato glaciers. It appears almost certain that the Kansan surface was subjected to peri-glacial conditions during the later glacial periods. Pollen studies of peat deposits between the Kansan and Illinoian glacial deposits at Quincy and Norwood, Illinois indicate a climate cooler than now (10).

The process of congeliturbation (the process whereby ground is disturbed by frost) must have been quite active during all these later glacial periods. Congeliturbation has been described—Louis Peltier, "Pleistocene terraces of the Susquehana River, Pennsylvania" (5)—as a very effective process in decreasing relief in non-glaciated areas adjacent to continental glaciers.

Direct measurements of the effect of congeliturbation are difficult to make on the Kansan surface but this is not hard to understand when the unconsolidated nature of the material and the long time intervals are considered. Congeliturbation is recognized in the field by the disruption of structure of the material in question.

3. *Warm climate.*

Throughout southern Iowa, eastern Nebraska, and northern Missouri there are numerous exposures of reddish colored fossil soils developed on Kansan till. These fossil soils are similar to the Red and Yellow Podzolic soils which are the modern soils in the southeastern part of the United States extending north only into southern Missouri. Because of this similarity it is believed that the climate under which the reddish fossil soils developed was warmer than at present (9).

The evidence of different climates is another indication of the very great age of the Kansan till plain. Although all age assignments for the older glacial deposits must be regarded as very rough estimates, all available evidence indicates a very long period of time between the retreat of the Kansan and the advance of the Illinoian

glaciers—the Yarmouth Interglacial age. The period from the retreat of the Illinoian glacier until the advance of the Iowan, the Sangamon Interglacial age, was also quite long. The estimates given by Flint (1, page 532) of approximately 300,000 years for the duration of the Yarmouth and 100,000 years for the Sangamon as compared to 50,000 years from Iowan time to the present, appear to be of the correct order of magnitude.

Based on the above discussion the development of the present Kansan plain can best be explained as follows:

(1) The Kansan glacier left a ground moraine of typical swell and swale topography with some nearly level areas and with numerous shallow depressions.

(2) Dissection of the till plain was initiated and proceeded by headward cutting from the major streams such as the Missouri and Mississippi rivers. This dissection apparently proceeded at an uneven pace, and there is soils evidence to indicate that there were long periods of slow erosion or stabilization followed by brief periods of intense erosional activity. This we believe to indicate climatic variation.

(3) Concurrently with the dissection, the higher portions of the till plain—away from drainageways—were depressed and the swales filled. Lakes were formed; filled with sediment and outlets established. Leveling proceeded differentially faster on those areas with the most depositional relief so that all areas not dissected tended to approach a common plain. This process proceeded throughout Yarmouth time—the period between Kansan and Illinoian glaciation. Because of the depth of leaching of the Kansan till buried under Illinoian till it is known that most of the time the climate was humid and that a long time interval occurred.

During or following the Illinoian glaciation some loess deposition occured over at least a portion of the Sangamon surface. Following this event there was another long period during which that portion of the Kansan plain not covered by more recent glaciation was subjected to weathering and dissection. Fossil soils that formed on slopes during this period are leached and are more red in color than the modern soils. From this it is assumed that the climate was somewhat more warm for a portion of this period than at present and was humid. The chroma of these buried "ferretto" soils are about the same as are found in modern soils in southern Missouri.

This stage was brought to a close by the advance of the Iowan glacier. During the closing stages of the Iowan glaciation loess deposition was very widespread. Because of the fairly even distribution of the loess on the Sangamon surface, being only slightly thinner on the gentle slopes than on the flats, it appears that the surface on large portions of the Kansan and Illinoian plains has

been essentially stable since the close of the Iowan glaciation. This is another indication of the relatively short interval from Iowan time to the present as compared to the duration of the Yarmouth and Sangamon Interglacial ages.

On narrow ridges, especially in regions of deep loess, slopes were steepened because of the increased relief that resulted from the loess deposition. On wider ridges, especially in regions at a distance from the loess source, where most of the wider flats on Kansan till exist, borings indicate that loess depth is essentially uniform over any small area on a flat ridge top. The effect of the loess blanket in these areas has apparently been to preserve the same slope conditions as existed on the underlying buried soil with perhaps some minor improvements in the development of flats.

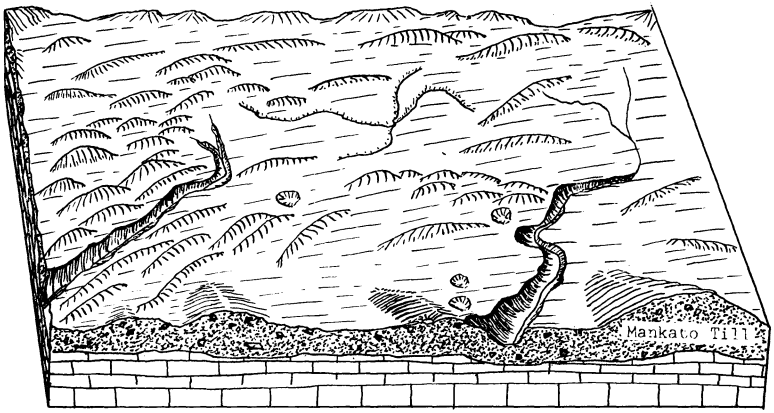

Figure 1. Typical morainal topography on young Till Plain in Northern Iowa

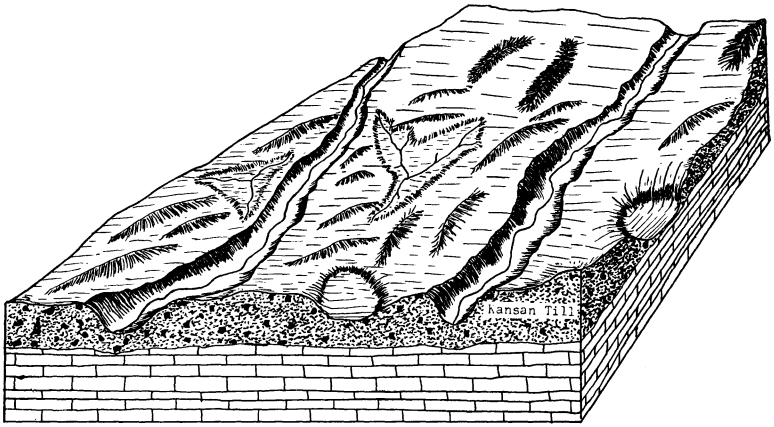

Figure 2. Typical early Sangamon land surface on the Kansan Till Plain in Southern Iowa.

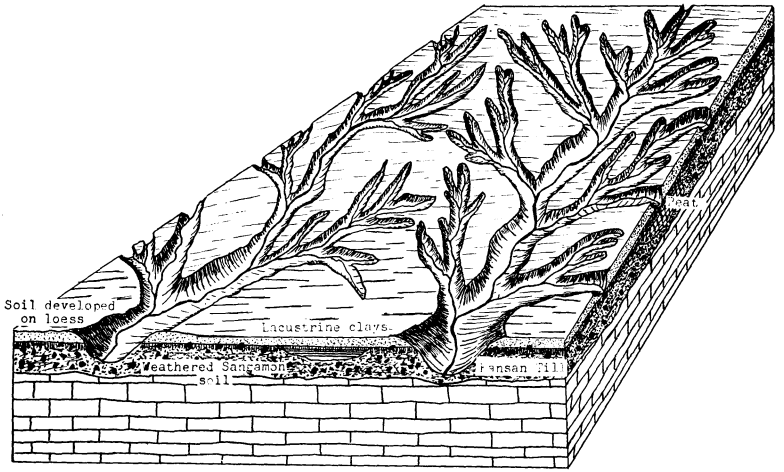

Figure 3. Typical modern land surface on the Kansan Till Plain in Southern Iowa.

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