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THE WEATHERED ZONE (SANGAMON) BETWEEN THE IOWAN LOESS AND ILLINOIAN TILL SHEET.

BY FRANK LEVERETT, DENMARK, IOWA.

PRELIMINARY STATEMENT.

Extent of Illinoian Till Sheet.—The Illinoian till sheet here discussed was formed by the Illinois glacial lobe in connection with the maximum extension of that lobe. It seems quite well established that a lobe on the east, which covered southeastern Indiana and southwestern Ohio, and extended a short distance into Kentucky, also had its culmination at the Illinoian stage of glaciation. Farther east the Wisconsin sheet in many places reaches the glacial boundary, but there are small tracts of drift older than the Wisconsin, lying outside its limits in eastern Ohio, northwestern and northeastern Pennsylvania, and northern New Jersey, which may prove to be of Illinoian age, though this is as yet, not established.

To the west of the Illinois glacial lobe there is a large area covering northern Missouri, southern Iowa, northeastern Kansas and eastern Nebraska, in which the upper sheet of till is older than the Illinoian, and is now referred to the Kansan stage of glaciation. The lobe which formed it is here referred to as the western lobe for it has as yet received no more definite name. The Illinoian sheet has not been recognized farther west than the limits of the Illinois glacial lobe. It seems probable, however, that it may be found in this western region, and possibly it occurs as far south as northern Iowa.

The Illinois glacial lobe at its maximum extension to the southwest, crossed the Mississippi and encroached a few miles on Iowa, in the district between Clinton and Ft. Madison. But farther north and south it appears to have terminated east of the Mississippi, except perhaps, for a few miles near St. Louis, Mo. The southern border of this lobe apparently reached to

the glacial boundary from St. Louis eastward as indicated above. It is the southwestern border which claims our attention at this time, since the Illinois lobe there overrode to some extent the sheet of Kansan drift, formed by the western lobe, which covered much of Iowa, and portions of neighboring states.

The southwestern limits of the Illinoian drift is usually marked by a definite marginal ridge, or by chains of knolly and slightly ridged drift. Beginning at the south in Jersey county, Illinois, a few miles north of St. Louis, and tracing northward, the drift margin is found to follow the east side of the Illinois river in Jersey and Greene counties, and to carry only occasional knolls and low ridges. It crosses the Illinois in southeastern Pike county, and takes a northwest course coming to the Mississippi bluff near the line of Pike and Adams counties. It there enters a district which had been covered by the western lobe at the Kansan invasion. The Illinoian border takes a northward course along or near the east bluff of the Mississippi, through Adams and Hancock counties. A definite ridge twenty to forty feet high, is developed along much of the Illinoian margin in Pike and Adams counties, and as far north in Hancock county as a point opposite Keokuk, Iowa.

For a few miles above Keokuk the Mississippi river apparently follows nearly the border of the Illinoian till sheet and no definite ridges are found. At the bend of the Mississippi below Ft. Madison, the Illinoian border crosses into Iowa. Its marginal ridge can be traced without difficulty from the vicinity of the Mississippi river bluff, south of West Point, Iowa, northward through Lee, southeastern Henry, northwestern Des Moines, and western Louisa counties, to the Iowa river at Columbus Junction. Its course there changes to the northeast and it can be traced diagonally across Muscatine county from its southwest to its northeast corner. It is traced with difficulty farther to the northeast because of concealment by a heavy sheet of loess which borders the Iowan till in Scott county, Iowa. It is known to extend as far north as Scott county, for the Illinoian till sheet has been observed in southern Scott county as far east as Davenport. The concealment by the Iowan loess is very great, not only in northern Scott county, Iowa, but also in Rock Island, Whiteside and Carroll counties, Ill. It becomes a difficult matter, therefore, to decide upon the posi-

tion of the margin of the Illinoian drift in any of these counties. It is also not fully decided whether it reaches to the border of the driftless area in Jo Daviess and northwestern Carroll counties, Ill., and in southwestern Wisconsin. The balance of probabilities, however, seem to favor its extending to the Driftless area.

The Illinoian till sheet overlaps, a few miles, the Kansan till sheet of the western lobe from the latitude of Hannibal, Mo., northward to the vicinity of the southern point of the Driftless area. In this region of overlap a weathered zone is developed between the Illinoian and Kansan till sheets at the level of the outlying Kansan surface as indicated below.

Introduction of the name Illinoian.—The tracing of this southwestern border of the Illinois lobe was begun by the writer in the autumn of 1892 and carried as far north as Hancock county, Illinois, that season. No opportunity to continue the study was offered until the spring of 1894, when the mapping of the border was carried from Lee county, Iowa, northward to Scott county. The greater part of the data presented in this paper, and conclusive evidence of a long interval between the deposition of the till sheets now known as the Kansan and Illinoian, and also the evidence that the Illinoian is much older than the Iowan had been obtained as early as June, 1894. The writer then began to use the name Illinoian in correspondence, but it seemed best to defer its introduction into literature until opportunity had been afforded other geologists to examine it. In August, 1896, Prof. T. C. Chamberlin and Mr. H. F. Bain were conducted by the writer to some of the exposures in southeastern Iowa, which show the soil above and below the sheet formed by the Illinois lobe and each recognized the need for a distinctive name for this drift sheet. The name was accordingly soon introduced into geological literature by Professor Chamberlin (1).

Other Interpretations.—At the ninth annual meeting of this academy, held in December, 1894, Mr. F. M. Fultz read a paper (2) in which the interpretation was presented that the ice lobes alternated in the occupancy of the district south of the Driftless area and that the latest occupancy was by the western lobe. The extension of the eastern lobe into Iowa had been inferred by him through the discovery of a boulder of red jasper con-

(1) See editorial, *Journal of Geology*, October-November, 1896, pp. 872-876.

(2) *Proceedings Iowa Academy of Sciences*, Vol. II, 1895, pp. 209-212.

glomerate near Augusta, Iowa, which was apparently brought from north of Lake Huron. The evidence of an extension of the western lobe over the same district was found in eastward bearing striæ along the brow of the Mississippi bluff at points farther east than the site of this boulder. Mr Fultz argued that if the striæ are not the product of the latest invasion they would not have been preserved in such an exposed situation. He also referred to some boulder-strewn terraces in the Mississippi valley, at and above Keokuk as moraines, and correlated them with striæ as the product of the last ice invasion. The following summer Mr. Fultz and the writer, while examining some rock outcrops in Burlington, found a striated surface in which the bearing is westward. This was evidently produced by the Illinois lobe, and as it is in a section about as exposed to obliteration by a subsequent invasion as those cited by Mr. Fultz in his paper, it became necessary to readjust the views set forth in that paper. This was done at the tenth meeting of the academy, in December, 1895, and the question of the relation of the two invasions was there left somewhat in doubt(1). The bowldery terrace interpreted by Mr. Fultz to be a terminal moraine has been examined by Prof. T. C. Chamberlin and Dr. H. F. Bain, as well as by myself, and to each of us it seems best explained as a residue of coarse material formed by stream excavation along the Mississippi valley subsequent to the last ice invasion. The evidence that the Illinois lobe was last on this ground seems conclusively shown in the relation of its till sheet to that of the sheet formed by the western lobe. The latter can be traced under the Illinoian sheet as indicated below. In addition to this evidence there is found an abandoned river channel in the district immediately west of the limits of the Illinoian drift which carried southward the drainage outside the Illinois ice lobe. The banks of this channel are well defined and the channel evidently has not been filled by the drift of any subsequent invasion.

Extent of the Iowan Loess.—By the term Iowan loess is meant that sheet of loess which connects at the north with the Iowan till sheet. A till sheet of Iowan age has been found in northern Illinois as well as in eastern Iowa, and it probably covers the greater part of the northern half of Illinois. It is, however, covered by the Wisconsin till sheet from Bureau county, Illinois, east and south. How much of Indiana and Ohio was covered

(1) Proceedings Iowa Acad. of Sciences, Vol. III, 1896, pp. 60-62.

by the Iowan ice invasion has not been determined. The Iowan till certainly does not extend as far south as the Wisconsin in those states. The loess forms a heavy deposit along the border of the Mississippi and Illinois valleys, but is comparatively thin in the region east of the Illinois, its average thickness being scarcely 10 feet. A silt tentatively correlated with the loess covers the Illinoian till sheet, wherever exposed outside the Wisconsin, from the Illinois river eastward to central Ohio. The Sangamon weathered zone between the loess and the Illinoian till sheet is found from central Ohio westward to southeastern Iowa, *i. e.*, to the limits of the Illinoian till sheet. The Iowan loess extends also over the Kansan till sheet of southern Iowa and adjacent portions of Missouri, Kansas and Nebraska, but this loess is separated from the underlying till by a much longer interval than that between the loess and the Illinoian till sheet, an interval comprising two interglacial stages and one glacial stage.

Application of Buchanan.—At the tenth annual meeting of this Academy Prof. Samuel Calvin, after describing certain gravel deposits in northeastern Iowa, introduced the term Buchanan as a name for an interglacial stage following the Kansan (1), and made the following statement concerning the origin and age of the deposits:

“As to their origin the Buchanan gravels are made up of materials derived from the Kansan drift. As to age they must have been laid down in a body of water immediately behind the retreating edge of the Kansan ice.”

Manifestly the deposition of the Buchanan gravels covers but a small part of the time between the Kansan retreat and the Iowan advance. Unless, therefore, the deposition and subsequent weathering both be included under this name it does not fill an interglacial stage. Were there no Illinoian glacial stage to break the continuity of interglacial conditions from the Kansan to the Iowan stage of glaciation it would not seem necessary to look for other terms. But in view of this glacial interruption there seems need for names which will stand for the weathered zones above and below the Illinoian till sheet. It is for this reason that the name Sangamon is here suggested for a weathered zone separating the Illinoian till from the overlying loess. In an accompanying paper the name Yarmouth is introduced for the weathered zone between the Illinoian and

(1) Proc. Iowa Acad. of Sciences, Vol. III, 1896, pp. 58-60.

Kansan till sheets. The name Buchanan may still have the significance given it by Professor Calvin; and if weathering be included may, perhaps, be used to cover the time involved in the two interglacial stages with the intervening glacial stage.

THE SANGAMON WEATHERED ZONE.

Earliest Recognition.—Apparently the first recognition of the occurrence of a definite soil horizon between the Iowan loess and the Illinoian till sheet is that reported by Prof. A. H. Worthen, in the Geology of Illinois (*). In his report on Sangamon county, Illinois, made in 1873, Professor Worthen called attention to a soil found at the base of the loess in Sangamon and neighboring counties. The soil apparently was first noted by Mr. Joseph Mitchell, in the excavation of wells in the north-west part of the county, and in neighboring portions of Menard county. Mr. Mitchell furnished for publication in the Geology of Illinois the following section of the beds usually penetrated:

	FEET.
Soil.....	1 to 2½
Yellow clay.....	3
Whitish jointed clay with shells.....	5 to 8
Black muck with fragments of wood.....	3 to 8
Bluish colored boulder clay.....	8 to 10
Gray hardpan, very hard.....	2
Soft blue clay without boulders.....	- 20 to 40

Professor Worthen states that the bed overlying the black muck is undoubtedly loess, also that the black muck indicates conditions suitable for the growth of arboreal vegetation in the interval between the deposition of the boulder clay and the overlying loess. The name Sangamon is taken from this locality where the soil was first reported.

General prevalence of a weathered zone at the base of the Iowan Loess.—In the locality just mentioned there appears to be only a bed of muck to indicate the interval between the deposition of the boulder clay and that of the overlying loess, for the clay immediately below the muck is described as of a blue color, a feature which suggests that there was not much oxidation and leaching or else there was subsequent deoxidation. The more common phase is a reddish-brown till surface for which Dr. H. F. Bain has proposed the Italian name “ferretto” (†)

(*) Geol. of Illinois, Vol. V, 1873, pp. 306 to 319.

(†) See. Proc. Iowa Acad. of Sciences, Vol. V, 1898, p. 91.

which may or may not be accompanied by a black soil. This reddish-brown surface appears to have been developed in all places where there was fairly good drainage. But in places where the drainage was imperfect a black muck of considerable depth accumulated and the reddened zone was imperfectly or not at all developed. In western Illinois the exposures of a black soil at the base of the loess are relatively few, but the reddened till surface is a common feature in every township. In much of the white clay district of southern Illinois and in portions of the Sangamon drainage basin a black soil is well developed. A black soil is also well developed in southeastern Iowa. Where the black soil is best developed leaching is found to have extended in places only 1 to 2 feet into the underlying till, but it often extends to a depth of six feet or more. Where the black soil is absent the leaching generally extends to a depth of six feet below the base of the loess. The variations in depth of leaching appear to depend on the conditions for percolation of water, being greatest where percolation is most rapid.

Noteworthy exposures of the Sangamon soil.—A few instances of the exposures of this soil are selected which will illustrate the variability in its character. The first section, at Ashland, Ill., is near the place where Professor Worthen reported its occurrence.

The following series of drift beds was penetrated by a coal shaft at Ashland, the identifications being made by the writer from samples of the material preserved at the engine house:

	FEET.
Soil	1½
Yellow loess, fossiliferous	9
Blue loess fossiliferous	2
Peat with black sandy slush	22
Bluish gummy clay with few pebbles	20
Yellow till	30
	<hr/>
Total drift	85

At the air shaft sand was found in the place of blue gummy clay beneath the peaty slush. A similar thick bed of peat has been noted at several other points in that region, one of the most conspicuous being in a well at Virginia City made by Mr. Oldridge. The peat was entered at the base of the loess at about fifteen feet and continued to a depth of twenty-eight

feet, beneath which a blue gummy clay was found. The drift at Virginia City has a depth of 187 feet, as shown by the coal shaft. This shaft passed through a lower black soil between till sheets at sixty-seven to seventy feet.

In the south part of the Sangamon basin, in the vicinity of Taylorville, Ill., the loess, which has a thickness of ten to fifteen feet, is underlaid by beds of sand and gravel carrying thin peat beds in their midst as well as at the junction of the loess and the sand. At the Taylorville coal shaft the uppermost peat-bed was found at thirteen to fifteen feet, and the lowest at forty to forty-four feet. Numerous exposures of this peaty material, alternating with sand beds, may be seen in ravines in that vicinity.

In October, 1896, Professor Chamberlin and the writer examined together numerous exposures of the Sangamon soil in the portion of eastern Illinois south of the limits of the Wisconsin drift, chiefly in Cumberland, Coles and Shelby counties. North of Greenup there are exposures where the subsoil beneath the Sangamon soil is traversed by branching root-like tubes one-half inch in diameter, which were easily traced ten to twelve inches below the soil proper. These tubes are filled with the black soil which apparently settled into them upon the decay of tree roots. There seems to us little question that the Sangamon soil here supported a forest. The till below this soil in these counties shows leaching to a depth of several feet. It also presents weathered cracks and seams extending down a depth of twenty feet or more. Similar leaching and weathering below the Sangamon soil has been observed by the writer in several other counties in southeastern Illinois, and in Vigo, Clay and Sullivan counties in southwestern Indiana, thus extending it to the southeast border of the Illinois lobe.

Returning to western Illinois excellent exposures of black soil and leached subsoil are found along the Santa Fe railway in eastern Knox county, of which views are here presented (see Plate iv). The soil shown in these views may be seen distinctly at a distance of nearly one-fourth mile. It is of a deep black color, resembling the surface muck found in flat portions of the uplands. The till beneath it has been leached to a depth of about four feet. The loess has a thickness of twelve feet and is slightly calcareous in the lower portion. The entire leaching of the till may confidently be referred to a date earlier than the loess deposition.

At Galva, Ill., a black soil at the base of the loess is well exposed in a clay pit at the brickyards east of the city. A large log was found imbedded in this soil which here has a depth of two feet. The overlying loess is fifteen feet in depth. A well at the brickyards penetrated forty feet of till below the buried soil, of which the upper thirty feet has a yellow color and the remainder a blue-gray color.

In southwestern Carroll county, Ill., there are extensive exposures of a soil at the base of the loess, made by the Chicago, Burlington & Northern Railway company, the loess having been removed to make a fill across the valley of Johnson creek. Probably a half acre of the buried soil is here exposed to view. It has a deep black color to a depth of ten or twelve inches, beneath which it assumes a greenish-yellow color, such as is presented by sub-soils beneath poorly drained regions. This sub-soil is leached as far down as exposed, a depth of three feet. This locality was visited last November by Professors Calvin, Udden, Bain and myself, and each recognized the clear indications of a long interval prior to the loess deposition. It may be noted in this connection that Judge James Shaw mentioned a soil in Carroll county in his report in the *Geology of Illinois* which apparently has the same horizon as the one just described. It was found at a depth of fifteen feet and a deposit of wood two or three feet in thickness was associated with it. (*)

On the portion of the Illinoian sheet in southeastern Iowa many excellent exposures of the Sangamon soil are found. An exposure similar to that in Carroll county, Ill., has been made at West Point, Iowa, where the Chicago, Ft. Madison & Des Moines Railway company has excavated to obtain filling for its tracks. The loess has been removed over an area several rods square, leaving the buried soil at the base of the excavation. Although the exposure is on the crest of the ridge which marks the western limits of the Illinoian drift, the soil is of a deep black color and has a depth of several inches. This exposure was visited by Professor Chamberlin, Mr. Bain and myself in August, 1896, as were also several roadside exposures between West Point and Denmark, and between Denmark and Ft. Madison.

Exposures in other portions of southeastern Iowa are given in connection with the discussion of the Yarmouth weathered zone.

(*) *Geology of Illinois*, Vol. V, p. 80.

Valley Excavation during the Sangamon Interglacial Stage—The large streams in western Illinois and southeastern Iowa are characterized by high, level terraces. The valleys of which these terraces are the bottoms have been formed in the Illinoian till sheet and are covered by the Iowan loess. The excavations may, therefore, be referred to the Sangamon interglacial stage. They are broad and shallow. On Skunk river, along the borders of Lee and Des Moines counties, Iowa, the terrace is only thirty to forty feet below the level of the uplands, but the valley is nearly two miles in average breadth. The valley cut below the level of the terrace is more than 100 feet in depth, but is only one-half mile in average breadth. These features indicate that during the Sangamon interglacial stage the stream had a lower gradient than at subsequent stages. On the neighboring portion of the Mississippi the valley formed at the Sangamon stage was shallow, as on Skunk river, but was not much wider than the inner valley. The large volume of water flowing through the valley at the time when it constituted an outlet for the glacial Lake Agassiz and the glacial lake in the Superior basin is perhaps the cause for the relatively great erosion subsequent to the Sangamon interglacial stage.

In southern Illinois and southwestern Indiana the main streams usually flow in broad shallow valleys, in some cases several miles in width, which were apparently built up by the glacial and fluvioglacial deposits of Illinoian age. It is seldom that sufficient deepening of streams has occurred to produce well defined terraces; and it is not an easy matter to determine the amount of work accomplished during the Sangamon interglacial stage. On the borders of these lowlands the Iowan loess rises above the level of the modern streams, and at such places occasional exposures were found in which the junction of Iowan loess and Illinoian till is marked by a thin bed of material more pebbly than the typical till; a feature which is thought to indicate moderate stream action prior to the deposition of the loess. A similar feature has been noted on the borders of many of the small valleys in western Illinois and southeastern Iowa.

EXPLANATION OF PLATE IV.

Iowan loess and Sangamon soil exposed in a cutting on the Santa Fe railway west of Williamsfield, Knox county, Ill. Thickness of loess twelve feet. The shaded band below the loess is the Sangamon soil. It has a depth of one and one-half to two feet. The Illinoian till beneath is leached and deeply oxidized for about four feet. View taken by Frank Leverett, May, 1892. (Above.)
Iowan loess and Sangamon soil near Williamsfield, Ill., near preceding but at much closer range. View obtained by Frank Leverett, May, 1893. (Below)

