ART. XLVII.—*The Silveria Formation*; by OSCAR H. HERSHEY, Freeport, Ill.

IN a recent number of the *American Geologist*,* the writer discussed, under the name of "Kansan Buried Loess," a small series of blue and brown laminated silts, exposed in a ravine one and one-half miles south of the city of Freeport, Stephenson county, Illinois. At the time, this one very limited exposure furnished the only definite information of this formation which had been secured. Subsequent studies, however—carried on chiefly through the examination of well-sections—have shown this formation to be an unusually important one, not only from its bulk, but also from the light which it throws on the relative altitude of northwestern Illinois during the earlier portion of the Kansan epoch. It has, therefore, been thought advisable to again place the subject before the geologic public, and this paper may be considered as a preliminary description and definition of the formation.

The fact is, of course, known to the writer that buried silts, nearly identical in lithologic constitution and stratigraphical position, have been discovered in several counties in northern Illinois, and also in that portion of Iowa which closely adjoins this area. But as there is always more or less uncertainty connected with the correlation of buried silts in different areas when their direct continuity has not been traced, and as this formation appears to be best developed in Stephenson county, Illinois, I will confine my remarks to that section of country exclusively.

The *Silveria* formation is a thick bed of stratified silt of a nearly uniformly dark bluish-gray color, and which occupies and nearly fills the deep-buried portion of the Pecatonica valley and its tributary valleys in northwestern Illinois. It is penetrated by nearly all the wells in the vicinity of the present streams, and is popularly known as "blue clay." It is, however, not a true clay as it does not contain the necessary percentage of exceedingly fine particles. This statement leads us directly to the manner of discriminating it from blue till or boulder clay, which is sometimes penetrated by wells in this same district. The blue till is lighter in color, more calcareous and finer-grained, presents no evidences of stratification, and contains irregularly disseminated and comparatively abundant pebbles and small boulders largely of foreign rock species. The blue silt differs from it chiefly in the following particu-

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lars: Besides its usually very dark blue gray or blue brown color, there are bands several feet in thickness which are of a lighter tint. These are encountered in contiguous well-sections at about the same depth, indicating apparently horizontal stratification. Microscopically, the deposit is a very fine-grained sand or silt, with many of the particles angular and sub-angular (one of the distinguishing characteristics of a *loess*). It usually contains a few sparsely disseminated rock fragments of small size, and they have so far, except in the extreme lower portion of the formation, proven to be *exclusively of angular white chert*. Near the base, in the deeper valleys, there are, interstratified with the blue silt, thin strata of fine gravel, composed mostly of the angular chert fragments with a few Canadian pebbles. The blue color dominates this formation so completely that even this gravel is stained with a blue tint, thereby enabling us to readily discriminate it from another gravel formation buried in the valleys, but which is of a bright red and reddish-brown color. Certain thin layers of the blue silt are, also, thickly packed with sharply angular white chert fragments which probably reached their present position through the agency of floating ice. Not only is this great preponderance of angular fragments of white chert, and almost total absence of the ordinary drift pebbles, of the greatest aid in distinguishing the presence of this formation in the material brought up by the sand pump, but it is believed also to indicate that the area in which the deposit occurs had not previously been glaciated. The white chert is of local derivation, being contained abundantly in the residual material over the Galena and Niagara limestones, the terranes chiefly exposed in northwestern Illinois.

At the single surface exposure in this county, so far as at present known (described in the paper already mentioned), the *Silveria* formation, besides displaying all the characteristics discovered in well-sections, is laminated in the irregular manner commonly known as "ripple marking." The upper two feet are false-bedded, ferruginous, light-brown, fine sand and silt, and appear to represent the shore deposit of the ancient lake in which this formation was laid down. It is here sparingly fossiliferous. There are, uniformly disseminated and apparently largely responsible for the blue color, minute particles of carbon. In addition, also, the fossil flora is represented by very diminutive fragments of black semi-decayed wood. But the only interesting portion of the fossil contents consists of several species of small shells. These occur pretty generally distributed through the exposed portion of the deposit in the proportion of several hundreds to every cubic foot of silt. But in the upper division, described above as representing

apparently a shore or just off-shore deposit, they increase in proportionate numbers. This division of the formation had not been exposed previous to a heavy flood which occurred during this spring, and the fossil contents of the formation had not been professionally studied at the time of the preparation of the previous paper on the subject. Lately, however, several collections from this horizon have been made and submitted to Mr. W. H. Dall, whose report is as follows:

"No. 1 is probably a variety of *Pyramidula striatella* Auth. It is larger, better-developed, and less rugose below than the recent specimens with which I have compared it. No. 2 appears to be *Pupa blandi* Morse, though a young shell mixed with the others may be *Vertigo ovata* Say. No. 3 is *Succinea avara* Say; a fragment of a *Helix*, like *H. tridentata* Say, was intermingled. There is nothing depauperate about the specimens."

The three species undoubtedly present are represented by about the following proportionate numbers of individuals: *S. avara*, 50, *P. blandi*, 5, and *P. striatella*, 2. They are practically a portion of the ancient terrestrial fauna of the neighborhood, and with this fact in mind the significance of their increase in numbers in the apparent shore deposit becomes readily apparent. The number of species is too limited to warrant our drawing very definite conclusions from them as to the nature of the climate of that time. Their rather robust development would seem to negative the idea of a cold climate, but the presence of the ice-sheet in Illinois necessary to the supply of material for the formation of this deposit, undoubtedly introduced a cooler climate than the present. I have previously held to the position that the comparative scarcity of the faunal and floral remains enclosed within this deposit, which was peculiarly favorable for their preservation, may be considered as indicating the relative severity of the climate.

The position of the Silveria formation in the county of Stephenson may be briefly described as follows: Just previous to the opening of the Kansan epoch, the streams of northern Illinois flowed at the bottom of narrow, steep-sided cañons, trenched from 300 to 400 feet below the general upland surface. The first important effect of the approach of the advancing Kansan ice-sheet was to depress this area and cause a silting up of the deep valleys. In Stephenson county the cañon valleys were about half filled with fine gravel and blue silt. This has since suffered great erosion and has been buried deeply under later formations. It is now quite frequently penetrated by wells along the valley sides, but at heights which never exceed 20 feet above the present river level at Freeport. Nearer the

center of the valleys it is almost invariably reached at about 20 feet under the present stream level. Being a stiff, clay-like silt, but slowly pervious to water, all wells upon encountering it must go to the bottom, where a supply of water may be obtained from the basal gravel or from fissures in the solid rock below. In thickness it usually varies at present between 40 and 60 feet, but is occasionally penetrated to the depth of 100 feet. Over the abandoned valley of Yellow Creek about 3 miles S.W. of Freeport, there is a low ridge of drift. A well beginning on this ridge was sunk 183 feet without reaching the solid rock at the bottom of the valley. The deposits passed through were first, brown loam, followed by drift, beneath which "blue clay" was reported to have been penetrated to the thickness of 150 feet. This "blue clay" represents the Silveria formation, which fills up the abandoned valley of Yellow Creek to above the present stream level.

The frequency with which the blue silt is encountered at the height of 20 feet above the present stream level, along the sides of the valleys, shows that, were the later formations stripped from the region, they would be found to have rested upon narrow terraces, bounding on either hand trough-shaped valleys about 40 feet in depth. The horizontal banding, the horizontality of the stratification at the exposure near Freeport and other phenomena connected with the formation, have been considered to indicate that the buried terraces represent the nearly level surface of the deposit when completed. In those portions of northwestern Illinois which are outside of the Pecatonica basin, the deposition of the buried blue silt was probably due solely to subsidence of the land, but in Stephenson county we can explain its unusual development only under the supposition that the Pecatonica valley was closed on the east by a glacier, thus raising the water level considerably above that which the mere subsidence of the region would have done. The probable existence of this extra-glacial lake somewhat complicates the subject, but still it is believed that the valleys in the surface of the silt are valleys of erosion. Not only do these valleys show erosion forms, but they are in proportionate size to the present streams, and are never accidentally partially closed by a strong development of the blue silt. Moreover, erosion is clearly indicated in the exposure near Freeport. In short, the evidence is sufficiently strong to warrant my assumption of their origin as valleys of erosion. Therefore, I shall consider the formation to have originally extended over the central portions of the valleys to practically the same height which it now attains on their sides.

If the importance of the formation be judged by its bulk it will be seen to compare favorably with all the others of the

district. It underlaid one-seventh of the county with an average original thickness of 100 feet. This spread out over the entire county would make a uniform layer of 14+ feet. For the purpose of comparison I will introduce a table in which all the other Quaternary formations of the county have been treated in the same manner.

	Thickness if spread over entire county.
1. Silveria formation	14+ feet.
2. Lake Pecatonica formation	1 foot.
3. Till	4 feet.
4. Stratified drift gravel	2 feet.
5. Angular limestone gravel (drift)	1 foot.
6. Florencia formation	6 inches.
7. Valley <i>loess</i>	2 feet.
8. Upland <i>loess</i>	7 feet.
9. Modern alluvium	10+ inches.
Superficial deposits of Stephenson County, Ill. Total 32 feet, 4 inches.	

Its mass is thus seen to be twice as great as the drift series proper (Nos. 3, 4 and 5) and about one and one-half times as great as the combined mass of the Iowan *loess* series of the region (Nos. 6, 7 and 8.)

The determination of the exact age of the Silveria formation depends on several factors, the precise value of which cannot at present be positively demonstrated. The first is the positive identification of the drift sheet which overlies this formation with that which is exposed in Kansas, and therefore known as the Kansan drift sheet. For reasons which it is hardly necessary to mention here, the oldest drift sheet of northwestern Illinois, southwestern Wisconsin and northeastern Iowa, has been considered as Kansan in age. Moreover, it is supposed to represent the culminating stage or time of maximum advance of the great Kansan ice-sheet. As this correlation is probably correct, I shall assume that the drift sheet of Stephenson County, Illinois, is Kansan in age. Now this drift-sheet rests upon the Silveria formation. Therefore, the age of the latter is not later than the Kansan epoch. Following the usual custom of correlating all formations which are inter-glacial in position, with the inter-glacial epochs, I should pronounce this deposit as a pre-glacial formation. But its evident derivation from material formed during glacial action and (presumably at least) the known position of the glacial front during its deposition, connect it with some stage of glaciation. Therefore, it is neither properly pre-glacial nor inter-glacial in age.

The second factor which creates a difficulty in placing this formation in the geologic time scale, is the exact significance of the eroded valleys in the surface of the blue silt. The drift sheet in the deeper valleys has been mostly removed by subsequent erosion (Aftonian mainly). But locally we find the drift in situations which indicate that the erosion of the valleys in the blue silt was accomplished mainly before the completion of the Kansan epoch. The question remains, however, as to whether this erosion was sub-aerial or glacial in nature. In the exposure near Freeport it is settled in favor of the former hypothesis, for here we find an erosion unconformity with a slightly developed soil and remains of vegetation at its surface, overlain by another extra-glacial lake deposit which itself preceded the arrival of the ice in that vicinity. Strong presumptive evidence that the erosion of all the valleys in the surface of the blue silt was mainly sub-aerial and antedated the arrival at Freeport of the ice-sheet, is furnished by the regularity of the valleys, their nearly uniform depth, and the absence from the till west of Freeport of any large amount of material which could have been derived from this formation. Therefore, we can say that if these valleys are truly valleys of erosion as they appear to be, their excavation was accomplished mainly by sub-aerial agencies, and antedated the glaciation of the region.

It has been assumed, as before stated, that the unusual development and relatively great height which the Silveria formation attains in Stephenson County, was due to obstruction of the valley by the advancing ice-sheet. The sub-aerial erosion within the limits of the former lake area, above partially demonstrated, requires the disappearance of the ice from the lower portion of the valley to give free drainage through the ancient Rock-Illinois valley, then occupied by the ancestor of the present Rock river. The relative importance of this fluctuation in the border portions of the ice-sheet depends largely on the length of the erosion interval above indicated. While the amount of material removed from the immediate vicinity of the streams during this post-Silveria erosion interval was apparently greater than the erosion which has been accomplished in the same position since the Iowan loess series was deposited, I do not think that any very long period was required. Although the completion of the work within 500 years would have converted the ancient Pecatonica river into a stream of "liquid mud," the somewhat increased precipitation of the glacial period, and otherwise more favorable conditions of erosion, may have enabled its accomplishment.*

*The length of time required to deposit the Silveria formation in Stephenson County can only of course be conjectured. If we assume the annual amount of sediment deposited to have had a thickness of one inch, and the average original

The post-Silveria erosion interval has no epochal value, as it was too short, there is no evidence of a marked change of climate, and the ice-sheet probably lay close to the Rock-Illinois valley during the entire time. I should divide the Kansan epoch into a number of sub-epochs or stages of which the time of deposition of the Silveria formation would constitute one stage, the post-Silveria erosion interval another, and the time of glaciation of northwestern Illinois still another. Therefore, the Silveria formation in Stephenson County, Illinois, may be chronologically correlated with an early stage of the Kansan epoch.

The post-Silveria stage of erosion has some bearing on the question of the relative altitude of the region at that time. All the deposits in the valleys of Stephenson County, under the drift sheet and its associated Lake Pecatonica clays, except the Red Gravel before referred to, appear to be genetically connected so that they may be considered as one formation, made up of gravel, sand, and mainly of blue silt—the Silveria formation. Just previous to the beginning of deposition of this formation, the streams flowed from 100 to 200 feet lower than at present. Therefore, the land stood relatively higher. During the post-Silveria stage of sub-aerial erosion, when free drainage was again restored in the Pecatonica basin, the streams flowed about 20 feet under the present water level or over 100 feet above the pre-Silveria stream level. The comparatively great width of the post-Silveria valleys indicates that the interval of erosion was sufficiently prolonged to enable the streams to cut to at least a local base level. Therefore, the land stood relatively lower at the close than it did at the beginning of the Silveria sub-epoch. In other words, the early stages of the Kansan epoch were characterized by a slow subsidence of the land which had returned nearly to its present relative altitude before the maximum extension of the ice-sheet.

The name which I have proposed for the formation discussed in this paper, is derived from that portion of Stephenson county, where it is, so far as at present known, best developed, and in which its only surface outcrop in the Pecatonica basin, occurs. If the deposit in this county should be correlated with some formation already discriminated and specifically designated in other districts, the name of the latter would, of course, have precedence, but the term *Silveria* would still be of some value as a local denomination of the conditions peculiar to the Pecatonica basin, namely as *Lake Silveria*.

Freeport, Ill., July 13, 1896.

thickness of the formation to have been 100 feet, 1,200 years would be required. This estimate probably falls rather below than above the actual time.