The Sand Areas of Indiana.

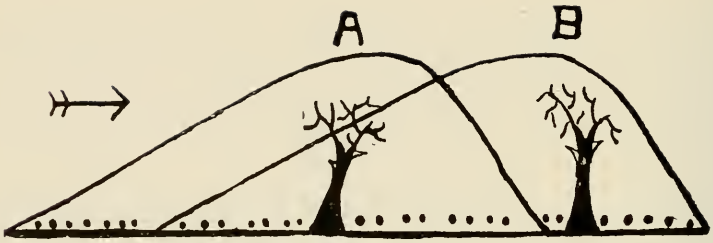
By Chas. W. Shannon.

Sand deposits may be studied from two points of view, first as to origin and structure, second as to their economic value. Dune sand is a kind of soil and at the same time is a particular kind of deposit.

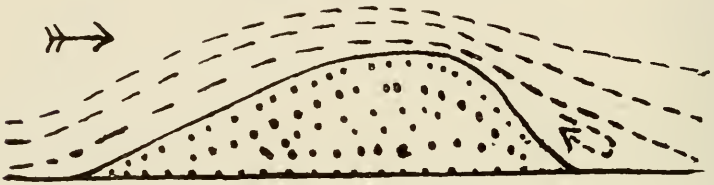
The sand areas of Indiana consist of sand-dunes, sand-hills, sand-flats or "swales" and sand prairies. The pricipal areas of the sand deposits are. (1) The dunes and ridges about the head of Lake Michigan. (2) The great expanse of the sand-hills and plains to the south of the principal dune area, extending to the southern limit of the marshy area south of the Kankakee River and east to the gravelly moraines. (3) The sand prairies of the lower Wabash Valley. (4) The deposits along the Ohio River. (5) The deposits along White River and its tributaries.

The Dune Area.—One of the marked features of the northern part of the State is the shifting dunes and ridges of sand. These great tracts of sand about the head of Lake Michigan belong wholly to beach accumulations, being sand derived from the immediate south shore, and from the erosion of the eastern and western shores and carried southward by shore currents during northern gales, and after being rolled upon the south shore it is carried inland by the winds and built up into unstable hillocks and ridges.

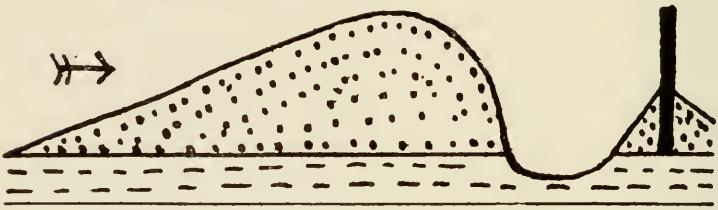
"Dune sand consists of loose, incoherent sand forming hillocks, rounded hills and ridges of various heights. Dunes are found along the shores of lakes, rivers or oceans, and in desert areas. They are usually of little value in their natural condition because of their irregular surface, the loose open nature of the material, and its low water holding capacity. Dunes are frequently unstable and drift from place to place. The control of these dunes by the use of windbreaks and binding grasses is frequently necessary, as at Cape Cod and on the coast of California, for the protection of adjoining agricultural lands. In certain regions they have been improved for agricultural purposes or employed as catchment areas in city water supplies or planted to pine forests for the protection of agricultural lands and for revenue."—U. S. Bureau Soils.



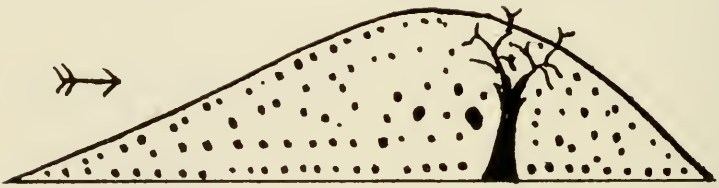
Showing Progress of Dune from "A" to "B."



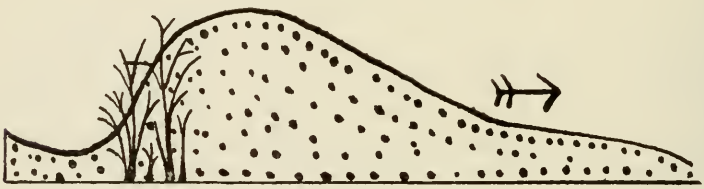
Relation of Dune Profile to the Wind.



As Affected by a Solid Object—as a Fence.



By an Inflexible Object—as a Tree.



By a Flexible Object—as Grass.

Wherever a sandy soil occurs unprotected by vegetation dunes are built up. They are usually roughly stratified, the degree of stratification and the thickness of the beds depending upon the force and direction of the wind. The sand grains become much rounded by abrasion, and in many cases become very small. Sand grains are heavier than dust particles and are not raised far above the surface by the winds; the larger grains being rolled along on the surface. The movement is very similar to that of "frozen" snow in drifting.

From Michigan City, Indiana, west for a distance of about twenty-five miles the lake beach presents a line of sand-dunes, averaging in width from one-third to one-half mile, and in places 150 to 200 feet high. Farther to the west to the State line the beach spreads out into a broad belt of low ridges running parallel and with an extreme width of about two miles. It has been estimated that after deducting the sand deposited by Lake Chicago that at least half a billion cubic yards of material have been added to the surface of Lake and Porter counties alone by the waters of the present lake. The dunes and ridges are most typically developed on a large scale about Michigan City in the great "Hoosier Slide," which has stood as the greatest and most noted of the dunes. During the past few years this dune has had its bulk greatly decreased by the hauling away of the sand by the hundreds of train-loads for various economic purposes. The sand sells for about three dollars a carload. Railroad switches are laid along the sides of the dune and steam shovels scoop out the sand and dump it into the cars. Many cars are also loaded with hand shovels and wheelbarrows. When a cavity is made in the sand the wind soon brings down a new supply from the top and renews the deposit. A sand brick and building block factory located in the southeastern part of the dune finds its supply of raw material continually replaced at its shed doors. Practically all the railroads entering Chicago have used this sand in track ballast and elevation. Great trestles have been filled and swamps and marshes along rights of way have been covered with the sand. The dunes and ridges at Dune Park, about twelve miles to the southwest of Michigan City, are very extensive and are also a source of much of the sand shipped out for numerous purposes. In addition to the use mentioned the sand is used for the filling of city lots, building sand, and many manufactured products.

The Origin and Accumulation of the Sand.—Estimates were made several years ago by Dr. Andrews to determine the amount of sand belonging to the Lake Chicago deposits and the amount belonging to the work of the present lake. It was found that the lake was encroaching upon the western border and on the eastern border along southwestern Michigan. In Indiana the lake is filling in rather than extending its borders. The estimates show that the combined bulk of the beaches formed by Lake Chicago is nearly equal to that due to the present lake. The length of time involved in the accumulation of the beach deposits was estimated by measuring the amount of sand carried southward past the piers at Chicago and Michigan City. The sand stopped by the two piers annually was found to be 129,000 cubic yards. Since the estimate shows that not more than one-fourth or one-fifth of the drifting sand is stopped by the piers, the period for the accumulation is given as less than 6,000 years, or about 3,000 for Lake Michigan. Dr. Andrews has also estimated the age of the lake from the annual amount of destruction from the bluffs.

"Dr. Andrews's estimates were based on the assumption that there is a southward-flowing current on each side of the lake, carrying sand to its present head. Investigations made by the Weather Bureau in 1892 and 1893, under the direction of Pro. Mark Harrington, led him to the conclusion that the currents on the east shore in the southern portion of the basin are northward instead of southward. He accounts for the accumulation of sand on the north side of breakwaters along this coast by the action of the surf, in storms blowing from the north which is more transient than the currents proper and would affect the southern part of Lake Michigan only when the wind was in the north. This occasional phenomenon is very efficient when it occurs. He concludes that the estimates of the time involved in the formation of beaches have less value than they would have if the accumulations were due more largely to lake currents.

"Considerable study of the movement of water in Lake Michigan has been made by the Chicago Drainage Commission, largely under the direction of Professor Cooley. As a result of these investigations, which involve not only a study of bottle papers but also a thorough canvass of the opinions of lake captains and an examination of breakwaters, Cooley has reached the conclusion that the effective work on the shores is due to waves and not to currents, and it is a matter of doubt if this lake has

Hoosier Slide as viewed across the docks at Michigan City. The entire foreground is a solid expanse of sand.

Hoosier Slide as viewed across the docks at Michigan City. Chicago–Michigan City steamer "Roosevelt" in the foreground.

such a system of currents as is indicated by Professor Harrington's charts. The movement of the water seems to depend mainly upon the wind, but is governed to some degree by the contour of the shores. If the north winds prevail for a few days, as is often the case in the spring months, the surface water appears to have a southward movement throughout the breadth of the lake, and return currents must be at some depth. On the other hand, a prevailing south wind, such as occurs for short periods during the summer, will induce a northward movement across the entire breadth of the lake. The contours of the shore seem to favor a northward movement from direct west winds in the north half and a southward movement in the south half of the lake. As the prevailing winds are often from the west, these become the most protracted of the movements of the surface water. Cooley has found that breakwaters along the shore support this interpretation. In the southern half of the lake they are largely constructed to protect the harbors from the drift on the north side, while in the northern half they are constructed to protect them from drift coming from the south. In view of this apparently changeable course of lake movements, it seems doubtful if estimates, such as Dr. Andrews attempted, have the value that some have attached to them.[1]

"Near the shore the bottom of Lake Michigan is uniformly covered with sand. At the shore line this sand is about ten feet deep and it extends out to where the water reaches a depth of about thirty-five feet. Beyond this depth of water the lake bottom is composed of a stiff, tenacious blue clay, which is said to contain partings, or pockets of sand from whence, in part, comes the supply which is constantly being carried to the shore by the waves. Much of this sand is doubtless blown from the dunes by south winds back over the lake, and, falling on its surface is again brought to land. Moreover, by storms and by ice jams in the spring all projecting points along the lake are slowly worn down and the material composing them is carried out to be again returned and built up in a new place. Thus much of the sand is in constant circulation, and the necessary new supply is not as great as it seems to be.

"Much gravel, consisting of pebbles ranging in size from the size of a hen's egg to that of a small marble, is washed up by the waves to within a foot or two of the margin of the water. In many places it is raked out

[1] U. S. G. S. Monograph XXXVIII, pp. 455-56.

Uprooting of trees on sand dunes at Dune Park Ind. Wind ripples in foreground

Uprooting of tree caused by the south side of the dune being disturbed by the building of interurban line. The sand at once began to move on and the old dune was destroyed.

by hand and carted beyond the reach of the high storm waves, and afterwards loaded and shipped by rail to Chicago, where it is used in roofing and concrete pavements. The immediate source of this gravel doubtless is the blue glacial till which forms the greater part of the floor of the lake, since the composition of the pebbles plainly show that they came originally from formations which lie far to the northwest."[1]

If a person stands upon the southern shore of the lake and observes the waves coming in, he will notice that each wave carries up a small quantity of sand, and when it is rolled up far enough to be out of the reach of other waves until it has had time to dry it is rolled farther inland by the wind and is added to the great mass of sand already accumulated, which goes to build up the dunes and the ridges. The surface of dry sand over which the wind blows for a considerable length of time is generally marked with ripples just as the sand in the bottom of a shallow stream. The ripples are small, but their shape and structure is the same as that of the larger dune of which they are a part. The long gentle slope of the dune is formed on the windward side. As the wind blows over the surface the current is turned upward, and as it passes over the crest an eddy is left on the leeward side and the grains roll over the crest and drop downward. Objects in the path of the dune influence the outline of the dune as shown in the page of diagrams. The transporting power of the wind varies as the sixth power of the velocity, i. e., if the velocity be doubled the carrying power is sixty-four times as great. Consequently any increase in velocity rapidly increases the carrying and erosive power.

The grains of sand freshly brought up from the lake from the erosion of the shores are angular pieces of quartz, but soon become rounded by abrasion. The sand of the Lake Michigan region is of a light brown color, but when viewed at a distance in the sunlight has a very white appearance.

Vegetation.—The surface of a great part of the dune area is without vegetation. The tops and sides exposed to the winds are in most cases bare, while in the swales between the ridges are shrubs and grasses of distinctly sand soil types. The bare surfaces gleam in the sunlight and give the appearance of great snowdrifts. On cloudy days the top of the ridges, the clouds and the lake in the background present a confused outline. Farther inland the vegetation gets a better hold on the sand and many of the hills are practically covered with black and barren oaks, north-

[1]Indiana State Geological Report, 1897, p. 41, Blatchley.

Sand dunes and ridges at Dune Park, Ind. Some vegetation finds a footing on the sides and in the swales.

Buildings of the Sand Brick and Building Block Co., located in the southeast corner of Hoosier Slide. Raw material is close at hand and with natural transportation renewing the supply.

ern scrub pine and white pine, but often after a tree has attained considerable size and apparently firmly rooted, the crust of the surface is broken slightly in some manner, or the grasses and other protecting plants are burned and the wind again gets free action on the bare surface and the sand is moved along and the trees uprooted. On the other hand, the sand often drifts about a tree and wholly or partly covers the tree. If the top of the living tree be found to be projecting from a dune it is a good evidence of a recently constructed dune. In most cases the trees are dead, and after the twigs and limbs become brittle or decayed, they are broken from the main branches or trunk and blown away. The wind then again begins its work, and as new parts of the tree are exposed the process continues and the sand once present has constructed new hills or ridges and the resurrected tree with only the trunk and larger branches stands as a marker of the former location of the sand.

Animal life is rare in the dune region. Vegetation is too scarce to furnish a sufficient supply of food. In the area quiet prevails but work is constantly going on, the surface is always being modified.

2. *The Sand-hills and Plains.*—This area in a very general way comprises the tract of sand to the south of the principal dune area extending to the southern limit of the Kankakee marshes, and east to the gravelly moraines. The term "sand-hill" is used to describe ridges and uneven tracts of sand not in motion, either on account of partial consolidation, or because the sands are fixed by a natural growth of vegetation.

In addition to the sand-dune and sand-hill areas, large tracts of sand are common, the surface of which is very even. Such areas occur usually in connection with the dune or hill areas, but are designated as "sand-plains" or "sand-prairies." Such areas also occur along the old flood plains of rivers. Some of the best agricultural lands, and especially for the growing of small fruit, are found in these level sand tracts. The sand usually carries a large percentage of organic matter, and retains moisture sufficiently well to insure good yields except in times of long continued drought. The dry growing season of 1911 was a severe test on such soils. Sand-plains vary in size from the low narrow swales between dunes and ridges to areas many square miles in extent.

In the area under consideration the sand ridges and hills occupy southeastern Starke, the greater part of Pulaski and the central portion of Jasper and Newton Counties; all of which lie southeast of the Kankakee

marsh; also a narrow strip of ridges on the east and south borders of the sand area in Fulton, Cass, White and Jasper Counties; and the ridges from the southern limit of the typical dunes to the flats on the north of the Kankakee. Scattering ridges and "sand-islands" are found scattering over the level portions of the sand area.

The thickness of the sand varies much because of the irregularities of the surface. Over much of the region the sand is very thin except in the ridges. Throughout much of the region wells are obtained without passing below the sand. They are shallow, having depths of ten feet or less on the level tracts and correspondingly deeper on the ridges. It would appear from all available data and estimates made that the sand is on an average about ten feet in thickness over the area. The ridges range in height from five to forty feet, but the majority are less than twenty feet. They vary in breadth from a few feet to an eighth of a mile, but in general are from two hundred to three hundred feet wide. The prevailing trend of the ridges is usually easily determined, but in places they wind about apparently without system. Mr. Leverette, Dr. Chamberlin and Professor Purdue have attempted to work out a system of the ridges and the bouldery tracts associated with the ridges. Further study of the region is contemplated to work out the system.

"Those on the east border in Pulaski County, Indiana, show a tendency to a north to south trend, while those on the south border in Cass, White and Jasper Counties trend nearly east to west. Those on the south border of the Kankakee trend about with the course of the stream, south of west in the Indiana portion, and north of west in the Illinois portion. Between the ridges bordering the Kankakee in Indiana, and those on the south and east borders of the sand area, the trend is not so easily systematized. The ridges there are arranged in groups and strips, among which there are extensive plain tracts, often boulder strewn and having only a thin sand covering."—U. S. G. S. Monograph XXXVIII, p. 332-33.

The soils of the area vary from peat and muck, with a considerable percentage of sand and high in organic content, to the loose barren sands. Much of the area is low lying and marshy, thousands of acres of which have not been reclaimed for agricultural purposes. In the undulating and rolling parts the soil is chiefly a fine sandy loam, with good natural drainage. All the ordinary crops are grown to some extent and many special crops are of great importance in the region. While much of this land has

Showing stratification lines in sand dune at Michigan City.

Markings caused by slumpings in sand dunes, Michigan City.

been considered worthless, present indications are that all will be reclaimed and made to yield good returns. The nearness to Chicago makes the region of special value for truck farming and the growing of small fruit.

3. *Sand Plains of the Wabash Valley.*—All along the course of the Wabash from its source to its mouth are found deposits of gravel and sand which are of great importance. From Parke County to the mouth of the river are extensive level stretches of sand occupying the area between the lower bottoms of the river and main tributaries and the higher uplands to the east. These sand tracts have the widest development and the most even topography through Vigo, Sullivan and Knox Counties; in the greater part of the widest expanse being from two to five miles in width and with a very even surface. This part of the area consists of a sandy loam with a high percentage of organic matter, giving the soil a very dark color and rendering it of high agricultural value. It is devoted chiefly to the growing of corn. In the region about Carlisle in Sullivan County the sand is built up into hills and ridges rising in some places to considerable height. This region is devoted chiefly to the growing of cowpeas. They make a very rank growth of a good quality. A very similar type of topography is found in the region about Emison in Knox County and in the part of the county to the south of Merom and extending southward past Decker into the region about Owensville in Gibson County. Melons are grown on all these sandy soils, but the great melon producing part of the State is in the vicinity of Decker and Owensville. The growing of melons has increased the price of the sand land in the past ten years from about $20 an acre to $100 or more.

From the neighborhood of Decker southward the sand is of a coarser quality than that farther to the north. In the coarser sands the soils are so porous and so well drained that they are poorly adapted to the general farm crops. Much of the sand strip from Hazelton to New Harmony has in many places a typical dune topography, but in general it has been somewhat modified by the reworking of the surface and by the effects of the natural growth of vegetation. Low swales are also present which are difficult or impossible to drain. These dune deposits are due either to recent agencies or represent a transitional stage between the deposits from the flood waters of the Wisconsin stage and the recent stages. The material of the dunes is a coarse quartz sand which in some places shows

some degree of stratification. The sand varies in thickness from a thin coating to 100 feet or more.

To the south of New Harmony the same type occurs, but in many places it appears a true sandy loam. In addition to the areas of sand mentioned above, many areas of small extent and varying quality occur in the lower bottoms along the river.

4. *The Deposits Along the Ohio River.*—Great bars and deposits of sand occur in the bends of the Ohio River all along its course, but no valley deposits of importance occur until below Rockport. From this point to the junction of the Ohio and the Wabash there is a continuous deposit of sand except where broken by the bluffs coming down to the river, as at Rockport. The most characteristic occurrence of the sand is in a narrow, persistent ridge lying only a short distance back from the river. The slope on the river side is rather abrupt while inland the slope is long and gentle. This ridge seems to have been formed before the river cut its channel down to the present level. During times of overflow the coarser materials were deposited near the channel and the finer grades carried farther inland, thus forming a natural levee along the river.

5. *The Deposits Along White River and Its Tributaries.*—Both forks of White River have considerable deposits of sand and gravel along their courses and have contributed much to road material, building sand, etc. Along the east fork large quantities of sand occur in the bed of the river at Brownstown, and south of Bedford old stream deposits furnish much sand for ballast and other purposes. Here on the south side of the river the sand is built up into dune-like hillocks. At West Shoals considerable sand occurs in the present valley, and also on the top of the bluff is a deposit made by the stream in its early history. Again to the west at Portersville river sand occurs on the bluff. From this point to Petersburg the sand continues in an irregular line, and from there to Hazleton the area widens and becomes a part of the line of the Wabash deposits. Through Greene and Daviess Counties considerable sand occurs along the west fork, but in most places where it occurs it becomes a sandy loam. To the northwest of Bloomfield some magnetite is found in the sand, and similar deposits of less extent occur at other points to the north along the main stream and its tributaries.

Ancient Pipes.

Andrew J. Bigney.

The customs of ancient peoples are always interesting and instructive. Several pipes of rare occurrence have come into the possession of the museum of Moores Hill College. Some brief notes are here presented.

No. I is a very large pipe measuring nine inches long and the bowl end four inches, and $2\frac{1}{2}$ inches in width. It is made of soapstone. Its place of occurrence is not known.

No. II is a pipe of the mound builders. The place where it was found is not known.

No. III is an unfinished mound builder's pipe. This is particularly interesting because it is unfinished.

No. IV is a very old pipe showing the rude drawings on it of some prehistoric people.

No. V is probably a more recent pipe. It no doubt was used by the early Indians.