

GEOLOGY OF KANSAS.

PART FIRST.

GENERAL PRINCIPLES.

The area of the State of Kansas is 78,418 square miles, or ten times that of Massachusetts, one-sixth larger than Missouri, and about one-third larger than England. The settled portions of the State, embraced within the organized counties, cover 25,000 square miles.

The labors of the first year of a geological survey, under a small appropriation, and over one-third of so large a territory, could be but little more than a general reconnaissance. This allowed so short time to each county that no detailed report of any could be given. On the other hand, the remarkable uniformity of the geological formations, extending even to single stratification, enables us to give the development of each county with sufficient precision to delineate its general geology. No marked disarrangement of the strata has been seen, and from the Coal Measures to the Cretaceous, there is apparently no unconformability. This absence of any geological disturbance accounts, mainly, for the rolling features of the prairies and the almost entire absence of either lakes, ponds or swamps. The few lakes are really but the old beds which the rivers have deserted in forming new channels. Sibley and Silver lakes are examples of this feature. It gives such excellent drainage that we have never seen a swamp which compared with those of the Eastern States, deserved the name. Even the low river bottoms

are uncomfortably wet only during the rainy periods. There are no mountains in the State, and no hills that rise very high above the valleys.

The general slope of the country is east, with a slight inclination toward the south. This is seen by the course of the rivers. The mouth of the Kansas river is about 850 feet above the ocean. The rise of the land due west to Manhattan, 107 miles, is very uniform and gradual, and is a little over two feet to the mile;* thence westerly, the rise is similar and but little more rapid. This is shown by the current of the Smoky Hill river, which rises in the western part of the State and flows quietly nearly due east, without any important rapids and but one fall, and that only a few feet.

COAL MEASURES.

The lowest geological formation known in Kansas is represented by the upper portion of the Coal Measures. It is a continuation of the coal field which covers the northeastern part of Missouri, and the southern part of Iowa, and also extends into the Indian Territory south of this State. Like the deposits of those States, the dip of the strata here is to the northwest, passing at a low angle of inclination under the Permian, Triassic and other later stratifications. The Coal Measures cover a larger area of the State than any other formation, being nearly one-third of the whole. The fossils of this epoch are formed over all of the eastern part of Kansas, and exist as far west as Fort Riley.

The line which separates the Coal Measures from the Permian runs rather irregularly in a northeasterly and southwesterly direction. Considering Fort Riley as on the line of average extent westerly, we shall have, (in the width of the State,) the territory of the coal lands 208 miles in length by 107 in average breadth, which gives an area of 22,256 square miles. The extent of the coal regions, in the settled part of the United States, is estimated to embrace about 140,000 square miles. In our calculations we include only the Coal Measures proper, and not the Permian, although the latter belongs to the Carboniferous Age.

* See Appendix.

It will thus appear that Kansas contains one-seventh part of all the coal lands of the United States. We do not, however, intend to be understood that the State contains one-seventh part of the coal, for Pennsylvania has more numerous and thicker working beds. But we shall show, under the head of coal, in *Economical Geology*, that we have one seam, which, for all practical purposes, is inexhaustible. The question of the area of distribution becomes more important than the quantity to each square mile, when the latter is sufficient for all our wants.

The Coal Measures here have undergone little change, and lie nearly in their natural position. They dip on the average, as before stated, slightly to the northwest. In some parts of the State this inclination cannot be seen, and in some instances there is an anticlinal ridge or dip in the opposite direction. Thus, in Wyandotte county, the strata are nearly level, or have a slight inclination to the southeast. This may be seen by tracing any bed of limestone ten or fifteen miles. The peculiar shale, which is numbered 22 in our section, is seen at the water's edge at Parkville, on the Missouri river; but twelve miles westerly, near the State Penitentiary, at Leavenworth and Atchison it is higher. Most of Jefferson, Leavenworth, Atchison, and the southern part of Doniphan counties, show little variation from a level, and that little is an inclination to the southeast.

Among the greatest angles of dip which we have noticed, is one extending from Lawrence to Lecompton, where, in a distance of ten miles, it is over one hundred feet.

It will be seen that this small disturbance of the strata is very favorable to the opening of coal shafts. No "faults" will be found in the beds, and the probability of reaching the coal at reliable depths at any given point, will be nearly certain. It also gives us a larger area of the coal field, as a higher angle of inclination would soon carry the heads too deep for mining.

This portion of the State also shows a great uniformity in the thickness of the strata. About one-fourth of the whole quantity of the deposit is limestone. South of the Kansas river, the strata show an increase of thickness, particularly in

the shales, accompanied with a slight increase of dip. This increase of thickness is very marked in Miami county, as developed by the oil and salt borings.

It is well understood that the extreme upper portion of the Coal Measures does not contain coal of the first quality, or seams of much thickness. Those peculiar favorable conditions of climate, &c., which were so important for the accumulation of vast amount of vegetable matter had begun to change, so that the coal was small in quantity and poor in quality. A fine illustration of this passing away of the peculiarities of the vegetation of the coal period is to be seen in the banks of the Neosho, about three miles below Council Grove. It consists of a stratum of shale, two feet in thickness, full of the remains of the vegetation of the period, but accompanied by a singular commingling of the material with other substances; and the vegetation shows less of the transformation from its original state than that of the true coal beds.

A marked peculiarity of our coal seams is that while the remains of plants are abundantly visible in most every coal stratum, few passably perfect specimens can be obtained. Nor do the shales, above and below the coal, furnish us with any better. Enough can be seen to give the general characteristics of the plants, but scarcely ever can any be found which will designate the species, and, consequently, sufficiently perfect to deserve a place in a cabinet.

SECTION.

The following section of the Coal Measures in Leavenworth county, including 100 feet in the coal shaft and about 200 in the borings connected with the same, will represent very closely the thickness of the strata in the northeastern part of the State, and approximately a large extent south of the same:

- No. 32.—10 feet of slope, probably covering shale.
- No. 31.—16 feet light gray to buff fossiliferous limestone, sometimes cherty. This is the highest limestone in this vicinity, being the upper bed, near Fort Leavenworth, and from which much of the materials of the

- Government buildings have been obtained. This is No. 13 of the Missouri River Section of Prof. Swallow, and is by him, on page 78 of his Geological Survey of Missouri, erroneously put down as No. 1. The first members of his section are not found in the bluffs of the Missouri river in Kansas, or at Parkville, Mo.
- No. 30.—16 feet variegated shale, at some places bituminous, varying somewhat in thickness.
- No. 29.—3 feet brown, ferruginous, fossiliferous limestone.
- No. 28.—18 feet blue and variegated shale.
- No. 27.—10 feet blue and gray, coarse grained, fragmentary limestone.
- No. 26.—25 feet blue and variegated, calciferous shale. This bed varies in thickness at different points.
- No. 25.—10 feet shaly limestone.
- No. 24.—8 feet shale and sandstone.
- No. 23.—20 feet buff and gray limestone, seen well developed near the landing at Fort Leavenworth, also at Quindaro and various places in Leavenworth, Atchison and Wyandotte counties, just above high-water mark.
- No. 22.—4 to 6 feet of bituminous shale. This, with the limestones above and beneath it, forms a well defined geological horizon, easily traced in numerous places in the eastern part of the State, from Kansas river as far north as Doniphan county.
- No. 21.—2 feet hard, dark limestone, furnishing larger blocks than any other bed in the northeastern portion of the State, and is much used in heavy work. This lies at the water's edge at Leavenworth and Quindaro.
- The above strata can be seen in the bluffs near Leavenworth and other places in the eastern part of the State north of the Kansas river, comprising the highest hills and descending to the water's edge. By the coal shaft at Leavenworth and its borings, sunk under the direction and calculations of Prof. G. C. Swallow and Major F. Hawn, we have a continuation of the stratifications as low as the six feet coal seam; as follows:
- No. 20.—77 feet of shale, inclining, near the middle, to sandstone.

- No. 19.—4 feet hard, gray and blue limestone.
- No. 18.—43 feet blue shale.
- No. 17.—13 feet limestone.
- No. 16.—4 feet bituminous shale.
- No. 15.—5 feet limestone.
- No. 14.—13 feet bituminous shale and coal. This is the position of the coal bed which crops out on the Osage river, near where it crosses the State line, and is there about 3 feet thick, and of good quality.
- No. 13.—6 feet blue limestone.
- No. 12.—15 feet shale.
- No. 11.—7 feet hard, gray shale.
- No. 10.—20 feet blue and bituminous shale, with a thin seam of coal.
- No. 9.—2 feet hard shale.
- No. 8.—4 feet hard limestone.
- No. 7.—6 feet bituminous shale, and a little coal.
- No. 6.—2 feet hard, compact limestone.
- No. 5.—7 feet common shale.
- No. 4.—2 feet hard shale.
- No. 3.—6 feet hard limestone.
- No. 2.—15 feet shale.
- No. 1.—9½ feet bituminous shale and coal.

This, according to all observations made in the southeastern part of Kansas, as well as in Missouri, as contained in Prof. Swallow's Report of that State, is the position of the thickest and best seam of coal in the State. It varies in thickness from five feet to six feet nine inches. The coal shaft at Leavenworth was commenced in 1863 or '64 to reach this coal bed. To test the situation of the underlying rocks at Leavenworth, boring was first instituted, which verified the geological calculations so closely that an open shaft, eight feet in diameter, was immediately commenced, and by August, 1864, was sunk 100 feet. The labor was then discontinued till September, 1865, and is now renewed.

This Section is a guide to all the northern and eastern part of the State, wherever it may be desirous to sink a shaft for coal. Nos. 21, 22 and 23 can easily be traced, near the water-line of the Missouri river, and in the low ravines twenty miles

west of it; and from them the position of the higher strata of limestone can be obtained without much trouble. As we pass south of Johnson and Douglas counties the strata are found to thicken, so that, at the same geological horizon, the depth of the coal seam No. 1 will be greater, the farther south any shaft may be sunk.

For the present wants of the greater portion of our population, coal shafts at Atchison, Leavenworth and Lawrence, by the aid of our various railroads, will yield a ready and cheap supply of fuel. But as population and the consumption of coal increases, coal mines will probably be sunk in all parts of the 22,000 square miles of the Coal Measures of the State.

PERMIAN.

This formation, so little represented in North America, is found well and clearly identified in Kansas. The characteristic fossils have been described by Meak, and Hayden, and Prof. G. C. Swallow. The extent of the area of this epoch, however, has not yet been clearly marked out, but is quite extensive; and future labors are necessary to obtain a full knowledge of its character, or the territory covered by it. The thickness of the Permian was placed, by Prof. Swallow, from observations made during our survey in the valley of Blue river, at 567 feet. Farther west, Major F. Hawn found it to be greater, placing it, according to his section, made in the Smoky Hill valley, 820 feet. See Rocks of Kansas, p. 5.

It consists mostly of calcareous and arenaceous shales and beds of limestone. The latter are frequently quite impure, but, sometimes, massive magnesian limestone is found, which furnishes an excellent building material.

TRIASSIC.

This epoch, and probably the Jurassic, are represented by a belt of territory crossing the Republican and Smoky Hill valleys, the extent of which is not fully known. The fossils, within it, are very scarce and poorly preserved, which renders it difficult to trace the outlines of the formations. The most important indications of animal life which have been

found are Ornithichnites, or foot-prints of birds in sandstone. We found but one slab, and that contained only four impressions. The locality from which it was obtained was about fifty miles northwest of Fort Riley, in T. 6, R. 1, east of the sixth principal meridian, on the top of a sandstone bluff, about one hundred and twenty-five feet above the Republican river. The slab was much weathered, which injures the distinctness of the minor markings. There are two species, both three-toed and liptodactylous, and new. They belong to the long-legged waders, the foot-prints of which have been so frequently found by Hitchcock, in the Connecticut sandstones. The length of the tracks are: the larger, five and a half inches, and the smaller, three and three-fourths. Those interested in a detailed scientific description, will find it in an article published in the American Journal of Science and Arts, Vol. XLL, No. 122. We could find no other tracks in the vicinity, yet it is most probable that they will be found in other places, as the deposit has a long extent in a northeasterly and southwesterly direction.

We cannot speak with confidence in relation to the geological age of the strata which contained the foot-prints, as we found no other fossils near the locality, except silicious wood. A few miles distant we discovered some impressions of exogenous leaves, which we suspected were in the same geological horizon as the tracks, but were unable, at the time, to verify it. We are inclined to place the deposit as high up as the Lias.

The beds of sandstone were much changed from their normal condition, principally caused by the presence of oxyde of iron. The stratification is not regular, much of it showing an oblique deposit, with other indications of shoal-water, at the time the tracks were made. When other foot-prints are found, it will become interesting to institute a comparison between the age of the Connecticut valley deposit and that in which these are found. It will throw light on both.

CRETACEOUS.

The Cretaceous Formation is represented rather largely, but

no definite examination has been made to show its extent, as it lies mostly beyond the settlements. Chalk is said to have been found within it. In fact, one specimen was shown us, obtained on the upper waters of the Solomon, which had all the fine, loosely-grained texture of true chalk, and we have good reason to believe that an abundance of the article will be found. So far as our knowledge extends, there appears to be a closer resemblance between our Cretaceous and the English than any other in the United States.

DRIFT.

The materials of the Drift epoch, in this State, consist of stones, gravel and sand, usual in other parts of the United States, but in less abundance. The larger stones attain the size of true boulders, being sometimes ten feet in length, and weighing ten or twelve tons. The most frequent are a metamorphic, stratified, quartzite rock. The metamorphic action has been very thorough, giving the boulders a hardness equal to common quartz, and on that account they are frequently known under the name of "hard-heads." They cannot fail to attract the notice of most persons, as they are so unlike any other rock that may be found in ledges, or in the stratified deposits of Kansas. The original stratification of these metamorphic boulders, is shown in the various shades of pink and purple bands, which give many of them a neat, ribboned appearance. The characteristics of the stratification are so much destroyed that no cleavage exists in the course of the layers. Sometimes they are dotted with white quartz pebbles, which were rounded and water-worn before the original stratification. The large boulders are usually angular, and not much worn by water. In this respect there is a strong contrast between them and the small pebbles, indicating different starting points at the time the Drift agency commenced. The pebbles, usually, are also of different materials.

Next to the quartz rock, boulders of green-stone are the most frequently found. A few of granite and sienite are also seen, but seldom as large as those of metamorphic quartz or green-stone. They are also more water-worn and less angular. Associated minerals are rather rare in the Drift, though

cornelian, homblende, feldspar, and, sometimes, agate are found. The deposit is not deep, seldom being seen over two feet, and more frequently only a few inches. The large boulders are found as far south as 38 deg. and 50 min., or ten miles south of the Kansas river, while the small pebbles may be seen twenty-five miles farther, as low as 38 deg. and 30 min. of latitude. The large boulders are found quite numerous in the Potawatomie reserve, on both sides of the Kansas, frequently numbering fifty to the acre. They lie on the tops of the bluffs and high prairies, more frequently than in the lower lands. We noticed one near Mill creek, in Wabaunsee county, on a high bluff about two hundred feet above the valley, which weighed fully eight tons. Some still larger, including one of green-stone, are to be found near Oskaloosa. They are found, more or less abundantly, in all parts of the State above the latitude named.

The original deposit from which these metamorphic boulders were brought, in the great Northern Drift period, is unknown; but their marked appearance is so peculiar, that when the country to the north shall be examined by any geologist who has seen them here, they can be easily identified. Owen, in his Geological Report of Wisconsin, Iowa and Minnesota, has identified the nearest metamorphic rock, on St. Peter's river, Wisconsin, four hundred miles from the most southern boulders in our State. Also, on the western shore of Lake Superior, and Lake of the Woods, from seven to nine hundred miles distant. In Europe, larger boulders than these have been transported, by drift agencies, over more distant points than a journey from Lake of the Woods to Kansas river.

No marks of grooving, stria, or other glacial action has been seen by us on any ledge in the State. The limestones, which crop out in every county, show no disturbance such as a glacier would make. The fragments of the strata in the bluffs or hillside always lay so uniform as to show that nothing but the present quiet agents has aided to drop them even a few feet from their original position. Only in one instance have we noticed a boulder with the marks of stria upon its surface, and that was under such circumstances as showed that they

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must have been made before it left its northern home. The whole circumstances show that however strong may have been the action of glaciers in drifting these eratics across the country in other places, they could have owed their present position in Kansas only to icebergs.

LOESS, OR BLUFF.

This is well represented in the eastern part of the State, particularly on the banks of the Missouri. At Wyandotte, south of the city, it is nearly one hundred feet in thickness. Extending westward, it grows thinner, and at fifty miles the deepest deposits are not over thirty feet. Still farther west, it almost entirely disappears. It is the same formation so extensively seen in the Missouri and Mississippi valleys. Sir Charles Lyell, in his visit to the United States, decided that it was the same as the Loess of the Rhine, but the fossils do not show a perfect identity between the two formations.

It consists of thick beds of fine, brown marl, often heavily intermingled with clay, so much so as to be used in the manufacture of brick. Its color is owing to the presence of peroxide of iron. Mingled with the more recent vegetable mould, it forms a rich soil.

To this formation belongs a part, at least, of the bones of the Mastodon, which have been frequently found in the State. A few years ago a part of a large jaw bone, containing three teeth, was fished from a stream near Osawatomie. It was sent to Ohio, and all trace of it is lost; but from the verbal description of those who saw it, the bones must have belonged to the Mastodon. A large tooth was shown us, which was found near Emporia. It was the sixth molar tooth from the lower jaw of the *Mastodon giganteus*, and belonged to a large and old individual. The three anterior ridges were worn through the enamel, and the last down to its base. The os femoris of another, found near Manhattan, is in the cabinet of the State Agricultural College. The smallest circumference of the shaft measures fourteen inches. Both extremities of the bone are gone, but it still measures thirty-three inches in length. Originally, it could not have been less than thirty-eight or nine inches, which would indicate that the entire skel-

eton measured about eighteen feet in length and twelve feet in height.

We hear of several other instances of portions of the skeletons being found, especially in the western part of the State. This animal, with the elephant, must formerly have been a common tenant of our valleys.

ALLUVIAL.

The Alluvial deposits in Kansas are so similar to those of the other Western States, that no particular description becomes necessary.

The river bottoms are usually broad and level, but well drained. The thickness varies from five to fifty feet. In various places in the valley of the Neosho, unaltered wood has been found at the latter depth, in the sinking of wells. The material of this alluvium, on the surface, is very rich in vegetable matter, and, in many places, furnishes a nourishing soil throughout its whole thickness. In some cases it is, in part, composed of modified drift. At the salt well in Brown county, a metamorphic boulder was found fifty-two feet below the surface.

The humus or vegetable mould of the high prairies is from one to three feet in depth. It is the usual development of the prairie features, so common in the other Western States. It is the same fine, black, rich loam, which has become noted as the most fertile soil in the world. No better exposition of its richness, in Kansas, can be given than to refer to the Agricultural Report of the Patent Office, since Kansas became a State. According to that high authority, in 1865 it was the fourth of the Western States in the production of wheat to the acre. In 1863 it stood with Missouri at the head of the list, and in 1862 and 1864 it ranked entirely at the top of the list. This shows the character of this Alluvial better than any description.