ART. XLIV.—*Some Phases of the Dakota Cretaceous in Nebraska*; by CHARLES NEWTON GOULD.

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NEBRASKA is the home of the Dakota Sandstone. It was along the bluffs of the Missouri River opposite Sioux City that Meek and Hayden first noticed the ledges of dark brown and red sandstone which formed the No. 1 of their now classic Cretaceous section of the Missouri River. This was as early as 1853. The name Dakota is not from the State, but from the town of Dakota, the county seat of Dakota County, the north-eastern county in the State. The first fossil leaves collected by Meek and Hayden were from Nebraska. These were dicotyledons, the first of the magnificent series, comprising perhaps the most luxuriant fossil flora in the world. It was to Nebraska that the noted French geologists Capellini and Marcou came in 1863 when they made their celebrated collection at Tekamah and Black Bird Hill. This collection, figured and described by Oswald Heer, the noted Swiss paleobotanist, forms the basis of all later Dakota paleobotanic literature. It was to Nebraska that Leo Lesquereux, "the Nestor of American paleobotanists," came when he first studied the Dakota in the field. The type sections and many of the type species of fossil leaves from the Dakota sandstone are Nebraska's.

Nevertheless, judged from the standpoint of exposures alone the Dakota in Nebraska is comparatively insignificant. The heavy mantle of Glacial drift and loess which covers the eastern third of the State in most places completely conceals the subjacent formations, including the Dakota. It is only in comparatively small areas where erosion has removed the post-Cretaceous deposits that the Dakota may be seen. Probably the entire area of visible Dakota would not cover a single county the size of Lancaster, while the country underlain by this group comprises more than a dozen counties in the east-central part of the State.

The largest single area is south of the Little Blue River, near Endicott and Fairbury in Jefferson County, just beyond the line of Glacial drift. The second largest is probably Iron Mountain, a few miles southeast of Beatrice. With a few minor exceptions the remaining outcrops are isolated points along the bluffs of Salt Creek, the Platte River below Fremont, and the Missouri River from Omaha to Ponca. The eastern limit so far as known is near the towns of Odell, Holmesville, Bennett and Plattsmouth, and the western limit near Fairbury, Milford, Seward, Fremont and Ponca. The

area of outcrops is about two hundred and fifty miles long and on an average thirty-five miles wide, extending crescent-like through Fairbury, Beatrice, Lincoln, Louisville, Blair, Tekamah, Decatur and Ponca. Dakota City, from which the group was named, is ten or more miles from the nearest bluff.

For the most part the Dakota in Nebraska consists of rather soft reddish brown or gray sandstone, usually in ledges or lenses, imbedded between strata of more or less arenaceous clay shales. These shales greatly predominate, perhaps in most places comprising two-thirds to three-fourths of the entire thickness of the formation. In color they are whitish, or bluish with many strata of red or brown, caused, as in the case of the sandstone, by the presence of iron. The reason that the shales are usually so seldom noticed may be accounted for by the fact that they weather very readily and their outcrops are generally occupied by covered slopes. On the other hand, the relatively harder sandstone forms the conspicuous bluffs, mesas and escarpments which give to the Dakota region its characteristic contour.

The clays and shales form an important economic phase of the Dakota. They have been excavated at several localities in the State, furnishing an excellent quality of brick, tile, etc. Endicott, Beatrice, Lincoln and Louisville in Nebraska and Sioux City and Sargeant's Bluff in Iowa are points from which clay for this purpose has been obtained. As the supply is practically inexhaustible and the quality exceptionally good, the Dakota clays promise to become an important economic factor.

The sandstone is used for building purposes in a number of localities in the State. The entire line of outcrops from Sioux City to Kansas may be traced by the brown sandstone foundations of houses and outbuildings. As a general rule, however, large buildings are not constructed of the Dakota sandstone, although at Endicott, Beatrice, Louisville and other places these may be found. The reasons for this are twofold; first, the Permian or Carboniferous limestones, which are exceptionally fine building material, are nowhere far distant; and second, the Dakota itself is not, as a usual thing, a first-class stone for building purposes. Representing all degrees of hardness from loose sand scarcely cemented together to the hard brittle ironstone concretions, it is usually too soft to withstand erosion or too hard to be dressed. Ledges yielding suitable building stone are comparatively rare.

At least one locality in the State furnishes a ledge of Dakota which is quite unique. About five miles northwest of Fairbury, Nebraska, on Whiskey Run, near the home of Mr. Oberhelmen, is a ledge some three feet thick of an extremely

hard, fine-grained, quartzitic sandstone. The color is light gray becoming reddish on exposure. This quartzite contains an abundant dicotyledonous flora, also some conifers, probably *Sequoia*. The ledge is quarried and makes an excellent building stone, but it is in bad repute among local stone masons, because of the fact that it is too hard to be dressed. It differs from anything seen elsewhere in the State except somewhat similar ledges found near the old mission on the Omaha Reservation and along the bluffs to the north, although quartzite boulders similar in character are found in Saline and McPherson counties, Kansas.

Another feature of the Dakota in Nebraska may be observed along the Platte River near Louisville and Cedar Creek. The lowest formations here exposed are the Upper Carboniferous limestones and shales. Upon these the Dakota rests unconformably and the whole is covered as elsewhere by the loess and drift. The pre-Cretaceous erosion was not only very considerable but also very irregular. The hills of the old Carboniferous rocks upon which the Dakota was deposited were probably higher and the hollows deeper than those in the same region to-day. It was in one of these eroded hollows, probably the bed of an ancient Dakota river, that there was deposited an immense amount of coarse sand and gravel. This forms the gravel pits near Cedar Creek and Springfield.

In the gravel bed a mile west of Cedar Creek a typical exposure may be seen. A spur from the B. & M. railroad runs along the base of the hill up to the quarry. The lower fifteen or twenty feet consist of an extremely hard conglomerate usually cross-bedded. The pebbles composing this conglomerate are smooth, water-worn, usually white or yellowish quartz. They vary from the size of a walnut to a very fine sand. This part of the ledge is not quarried, but forms the floor of the portion above, which is removed.

The upper part consists of similar material with the important difference that it is much more loosely cemented. The pebbles are usually somewhat smaller and there are some layers of rather fine sand and occasionally the characteristic ironstone concretions which are always present in the Dakota. This second member is thirty to forty feet thick and is excavated for nearly a quarter of a mile along the side of the hill. In many places it is so loosely cemented that it is removed with a team and scraper, not even a plow being necessary to remove the material. The gravel is used for railroad ballast and the conglomerate, known locally by the expressive name of "peanut rock," is employed as riprap and filling material for bridges.

A number of fragments of fossil wood, including a limb some three feet in length, were found in the quarry, but no leaves have so far been discovered.

If our theory that these gravel beds represent an ancient river bed be correct, it is not difficult to understand that the conditions would have been favorable for the preservation of wood, and not for that of leaves, the latter requiring still-water lakes and lagoons for perfect preservation. Besides, the principle first enunciated by Leo Lesquereux, that conditions which preserved leaves rarely preserve wood, and vice versa, has almost become an axiom in phytopaleontology.

Above the gravel and sand is the line of Drift bowlders surmounted by the characteristic loess. This gravel bed has been described as belonging to the Glacial age. It is incomprehensible that any one, who knew anything of the geology of the State of Nebraska and who had given the locality five minutes consideration, could place it elsewhere than in the Dakota.

Perhaps the most important phase of the Dakota, from an economic standpoint, is the water supply. This formation is characteristically a water-bearer. From Oklahoma to Minnesota along the entire line of outcrops are thousands of springs of soft water. This is especially fortunate in view of the fact that the region of the sandstone is particularly adapted to grazing. It almost never occurs that a pasture in the Dakota country is without a spring, and more often half a dozen will be found on a quarter section. Often these are of sufficient strength to supply running streams. If this is not the case, the stockmen usually pipe the water into tanks in the field or feed lot. In not a few instances the water from a Dakota spring is piped half a mile or more, through the house, and into the barn lot, furnishing an inexhaustible supply for all purposes. Some of the most important of these springs in Nebraska are Case's and Price's springs near Endicott; Robinson's spring, four miles southeast of Beatrice, and the hundreds along the bluffs of the Missouri River from Omaha to Ponca. These may be seen everywhere along the celebrated bench road at the foot of the bluffs. Golden spring, between Tekamah and Decatur, runs a stream half as large as a man's body, and numerous others are nearly as large.

A formation which yields such springs could scarcely fail to furnish good wells, and such is the case with the Dakota. Wells begun in the superjacent strata usually find an abundant supply of water when they reach the sandstone. The problem of water supply of eastern Nebraska is easy of solution, if one has as a key, a knowledge of the Dakota sandstone.

The origin of Dakota water is a mooted question. Some authorities look for the source of supply in the Dakota outcrops along the eastern slope of the Rocky Mountains. They would consider the water artesian, and argue that deep wells over the central part of the State should tap this supply and furnish artesian water. This theory seems quite tenable, but in practice it remains to be proven. That it will not account for all Dakota springs is demonstrated by the fact that in several instances some of the best springs issue from isolated buttes, cut off by erosion from the main body of the Dakota. It seems more probable that much of the water supply comes from local rainfall, although until the artesian theory is either proven or disproven we may well continue to look farther away for a part of the supply.

The most interesting point connected with the Dakota, from the standpoint of pure science, is of course the fossil leaves. Few formations in the world have yielded so many species. Of the nearly five hundred forms known to exist, Nebraska furnishes a large per cent. Numerous localities are known to yield leaves. The best collecting ground so far discovered in Nebraska is five miles south of Endicott, Jefferson County, and near Decatur, Burt County. Very little systematic work has been done on these leaves for a number of years, but at the present time the collections of the past summer are being studied in the department of Geology in the University of Nebraska, and it is expected that a detailed report on the subject will shortly be published.