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FOUNDATION OF MODERN GEOLOGIC SCIENCE IN AMERICA.

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For permitting Iowa to furnish the foundation stones of modern science in the New World the Fates appear mainly responsible. Just a hundred years ago this work was accomplished. In several respects its bearings are more than state-wide. In the history of American geology it assumes national import and far-reaching influence. In the history of that science the circumstances surrounding the earliest discoveries within the limits of our State are worthy of special record and attention.

The scientific discoveries to which I allude were made in Iowa-land before Iowa was a State, before she was a territory, before she was hardly a part of the United States. It was in the earliest springtime of the last century, when our Nation was yet new, when the region was still remote and unknown, and when even the land itself was yet to receive its name.

For several reasons this pioneer scientific work is of exceptional historic interest. It was the first time that modern geological principles were successfully applied in this country. It was, up to the time, the boldest stroke at universal correlation of geological formations ever attempted by geologists. It was the first definite recognition of the two greatest geologic formations found on our continent. It was the first chronologic comparison of American Carbonic rocks with those of the typical locality in the Old World. It furnished the basis for all subsequent investigations of the mid-continental region. It gave rise to a host of perplexing problems many of which are still unsolved. Where else in all the

world have not the echoes of a century-long discussion long since died away? Singular is it that our Iowa should be the pivotal point.

When in England about a century ago, earth-study was made a modern science through William Smith's famous geologic discovery that the relative age and natural sequence of rock-layers were susceptible of accurate determination by means of the contained organic remains, America very early and from a wholly unexpected quarter furnished important aid in support of the newly-established principles. The circumstances were long since all but forgotten. In the few casual references made to them in later years either their importance was misunderstood or familiarity with the attendant conditions was entirely wanting. As the first successful application of modern geological principles in the New World the episode must ever remain of great historic interest.

Singularly, this primal American effort to correlate by their faunal contents geologic formations widely separated geographically, was not made in that portion of our continent which was most accessible and where it was most natural to expect it—that is, along the well-settled Atlantic border—but it was in the then remotest section of the Upper Mississippi valley. First fruits of research and observation were obtained in a region which was then perfect wilderness, but which now forms part of the great and populous State of Iowa. Moreover, these remarkable observations were made within a decade of the time when the novel method was originally announced in England. They antedated by fifteen years Samuel Morton's similar effort on the Tertiaries of our Atlantic coast, commonly regarded as the maiden attempt in America along these lines. By two decades they were in advance of the first work of that pioneer American paleontologist, Lardner Vanuxem. They anticipated by a full generation the famous investigations of Thomas Conrad and James Hall in New York. Indeed they were the means of actually and correctly interpreting the true position and biotic relations of the Carbonic rocks of the continental interior a

half century before their geologic age was otherwise generally admitted. The Mississippian limestones, as the rocks are now called, remain today as compact and as sharply delimited a sequence of geologic terranes as they appeared when first recognized in that memorable summer of the year 1809.

This successful use in America of faunal criteria for purposes of solving problems of geologic correlation and of identifying geological formations was the first real ray of modern light to penetrate the stratigraphic darkness shrouding the New World. The happy application of these criteria was due directly to the keen scientific perception and peculiar reasoning of one who was never known as a geologist at all, but who was raised to fame through a wholly different channel of scientific activity. This truly remarkable personage was Thomas Nuttall, botanist.

Nuttall's extensive travels in America were undertaken chiefly in the interests of his monumental works on North American plants and of his valuable contributions to American ornithology. On his first great trip, after traversing the southern shore of Lake Erie, and coasting by canoe Lakes Huron and Michigan, he entered Green bay, and, following to the West that famous all-water route which the Indians had used from time immemorial, ascended Fox river to the portage to the Wisconsin river, down which stream he floated to its mouth, near Prairie du Chien, thence down the Mississippi river to St. Louis. Subsequent trips took him far up the Missouri and Arkansas rivers.

On his Mississippi venture, besides garnering great quantities of interesting plants and taking voluminous notes on the birds, he appears to have made extensive collections of the fossils which he found along his path abundantly scattered through the limestones which in high cliffs bordered both sides of the great stream. In the course of his explanations of the geologic features of the region through which he passed, Nuttall naively notes that he is "fully satisfied that almost every fossil shell figured and described in the *Petrefacta Derbiensia* of Martin was to be found throughout the great calcareous platform of Secondary rocks exposed in the

eastern Mississippi valley." Thus by means of fossils he parallels these limestones of the Mississippi river with the Mountain limestone of the Pennine range, in Derbyshire, England, to which, several years later, Conybeare gave the title of Carboniferous.

Along the Mississippi river, as we now know, Nuttall really encountered little else than rocks of Early Carbonic age, so that his identifications of the fossils were doubtless, with very few exceptions, correct. Moreover, at this date and for some time afterward, the lower portions of the exposed stratigraphic sections, it must be remembered, were entirely undifferentiated, the great sequence of older beds which were subsequently separated from one another being jumbled together under the title of the Transition group. It was not until more than a quarter of a century later that out of them, in Britain, Murchison and Sedgwick established the Cambrian, Silurian and Devonian systems.

Another important geologic correlation is to be credited to Nuttall. On his journey up the Missouri river, in 1810, which he undertook with John Bradbury,¹ a Scotch naturalist, he reached the Mandan villages on the upper reaches of that stream. He makes especial mention of the Omaha village situated below the mouth of the Big Sioux river. A short distance upstream from the last-mentioned point he examined strata which, by means of their fossils presumably, he referred to the Chalk division of the Floetz, or Secondary rocks of northern France and southern England. This is the earliest definite recognition of beds of Cretacic age in America. It preceded by a decade and a half the separation by John Finch, of the newer Secondary rocks from the Tertiary section in the Atlantic states, and Lardner Vanuxem's and Samuel Morton's references of the same deposits to the Cretaceous age. Thus, also, was another great succession of one of our main geologic periods discovered in a then remote part of our continent years before it was recognized in the East.

¹*Travels in interior of America in 1809-1811*, London, 1817.

At the mouth of the Big Sioux river Nuttall fell in with an old trapper who described to him the great falls which blocked navigation at a distance of one hundred miles up that stream, and who told him of the famous Indian pipe-stone quarries beyond.

The analogy established by Nuttall between the general Carbonic section of Iowa and the Upper Mississippi valley and that of northern England was one of the important geologic discoveries in America. Its great significance was pointed out by Owen a couple of decades later. Its historical value grows with the advancing years. In the final recognition of a standard Carbonic section for this continent the sequence displayed in the Mississippi basin must prevail, since it is now generally conceded that the Appalachian succession of strata can never be considered as the typical development.

So conspicuously botanical in character are Nuttall's services to science that one can but wonder under what circumstances he could have obtained his keen insight into matters geological. Elias Durand said of him immediately after his death: "No other explorer of the botany of North America has personally made more discoveries; no writer on American plants, except perhaps Asa Gray, has described more new genera and species. Lists of his published memoirs and papers quite generally omit all reference to his recorded geological observations, probably because their importance would hardly be appreciated by writers in other fields of science. In the present connection our main interest centers on the transplanting so early to the interior of the American continent of William Smith's novel ideas concerning fossils. Brief reference to some of the early events in Nuttall's life seems to offer a clue.

Nuttall was born in Yorkshire, England, in the Mountain limestone belt and near the scene of Martin's labors on the Carbonic fossils of Derbyshire. He was early apprenticed to the printer's trade and after a few years removed to London. There he followed his trade until at the age of twenty-two years he set out for America, in 1808. He appears to have been a printer of the Benjamin Franklin order,

since while engaged at his trade he became proficient in the knowledge of the sciences, Greek and Latin and kindred subjects. During the period of six or seven years that he was in London he seems to have made the acquaintance of a number of the scientific men of the day. At least it is probable that at this time he acquired some familiarity with Smith's discoveries which were at that date attracting wide attention from English scientists. It is also quite possible that Nuttall gained much of his scientific information through setting up the types for those very memoirs which have since become geologic classics. It is not unlikely also that he even met Smith, since the latter is known to have been often in London at that time and to have taken up his permanent residence there several years before the printer-naturalist left his native country.

At any rate Nuttall had been in America scarcely a year before he was putting his geological knowledge to test. His familiarity with Martin's *Petrifacta Derbiensia* and Smith's principles clearly indicates that he must certainly have acquired his information at least several years previous. Then, too, his acquaintance with that pioneer American geologist, William McClure, for twenty years president of the American Philosophical Society at this period should not escape notice. Two other papers, partly geological in nature but chiefly mineralogical in character, on the rocks and minerals of Hoboken and of Sparta, New Jersey, and the many keen observations on the rocks recorded in his journal of a trip from Philadelphia to Pittsburg, attest his unusual intimacy with matters in geology.

Notwithstanding the fact that the brief memoir² which Thomas Nuttall published on Iowa-land and the contiguous regions was the only one which he seems ever to have printed on strictly geological subjects, so important are the principles set forth for the first time in this single, simple, short contribution to the literature of American terranal correlation that it places its author in the front rank among pioneer geologists, not only of Iowa, but of our country. Although

²*Observations on Geological Structure of Mississippi Valley; Jour. Acad. Nat. Sci., Vol. II, pp. 14-52, Philadelphia, 1821.*

one of the foremost botanists of his day and an ornithologist of world-wide reputation, his great service in first pointing out by method and by means the fundamental concepts of modern historical geology in America should not be forgotten.

REMOVAL OF THE POTTAWATTAMIES.

The following account of the gathering of the Pottawatamy tribe of Indians for removal furnishes an interesting picture of frontier scenes. It is from the Logansport, Ia., Telegraph of the 15th ultimo:

A small military force left Logansport on Wednesday, the 29th August, and having been reinforced on the route, reached the Indian chapel on Twin Lakes, in Marshall county, about 11 o'clock on Thursday. Here the principal chiefs with several other Indians were found and surrounded to prevent their escape. General Tipton then held a council with those present, and four chiefs appearing somewhat refractory, were taken and placed under guard in one of the rooms of the building which had been occupied as a chapel. The Indians present were then told that they must prepare to emigrate—that in three days they must be ready to go West; that they need not hope to remain on the lands which they occupied, for they would be compelled to leave them. They were further told that wagons would be provided to convey their furniture and utensils into camp, to be carried for them to their homes in the West; that their cornfields should be appraised by disinterested persons, and that they (the Indians) should receive the amount of their valuation; that the Government would furnish them with provisions and clothing and farming utensils for the term of one year from and after their arrival upon the lands assigned to them beyond the Mississippi; that they would not again be compelled to remove and that the Government would protect them in their new homes.

Parties of dragoons were then dispatched in different directions with orders to bring the various bands of Indians into camp. The dragoons were also ordered to treat the Indians kindly, to preserve their moveable property and to burn their wigwams. * * * *

The encampment occupied a space about one hundred yards square upon the banks of the Twin Lakes. This area was almost completely filled with Indian tents, ponies, pigs, public officers, dogs, cats, sentinels, wagons, &c. Throughout the whole proceedings great decision, energy and activity were displayed, accompanied by very little if any cruelty—that is, viewing the whole as a matter of settled national policy.—Albany, N. Y.—*The Jeffersonian*, Nov. 10, 1838.

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