

cretionary and amorphous portions of the same matter dispersed throughout the sandstone of this bed, were masses of the fossilized bodies of the animals which had become disengaged from their shells, and had floated in the sea till enveloped in the sand and mud, which is now concreted to the coarse sandstone called Kentish Rag. In proof of this opinion reference is made to an account published in the 'American Journal of Science' for 1837, of the effects of an epidemic among the shell-fish of the Ohio, which, killing the animals, their decomposed bodies rose to the surface of the water, leaving the shells in the bed of the stream, and floating away covered the banks of the river. Mr. Bensted points out that nearly the whole of the shells in the Kentish rag of his quarry appear to have been dead shells, and infers that their death might have been owing to a similar cause with that which destroyed the *Uniones* in America; while their bodies intermingling with the drift wood on a sand-bank furnished the concretions described in this communication.

The Rev. J. B. Reade submitted some of the substance of these bodies to an analysis by Mr. Rigg, who confirmed Dr. Mantell's suspicion of the presence of animal carbon in it, and states that the darker portion of the substance contains about 35 per cent. of its weight of carbon in an organized state.

Dr. Mantell adds, that a microscopical examination with a low power detects innumerable portions of the periosteum and nacreous laminae of the shells of extreme thinness intermingled with the carbonaceous matter, together with numerous siliceous spiculæ of sponges, very minute spines of *Echinodermata*, and fragments of *Polyparia*, and remarks that these extraneous bodies probably became intermingled among the soft animal mass before the latter had undergone decomposition. He proposes to term the substance *Molluskite*, and states that it constitutes the dark spots and markings in the Sussex and Purbeck marbles.

"On the Geological position of the *Mastodon giganteum* and associated fossil remains at Bigbone Lick, Kentucky, and other localities in the United States and Canada." By Charles Lyell, Esq., V.P.G.S.

With a view to ascertain the relations of the soil in which the bones of the Mastodon are found, to the drift or boulder formation, whether any important geographical or geological changes had taken place since they were imbedded, and what species of shells are associated with them, Mr. Lyell visited a number of places where they had been obtained. In this paper he gives the result of his researches.

The most celebrated locality visited was Bigbone Lick, in the northern part of Kentucky, distant about 25 miles to the S.W. of Cincinnati, situated on a small tributary of the river Ohio called Bigbone Creek, which winds for about 7 miles below the Lick before joining the Ohio. A "Lick" is a place where saline springs break out, generally among marshes and bogs, to which deer, buffaloes, and other wild animals resort to drink the brackish water and lick the salt

in summer. The country around Bigbone Lick, and for a considerable distance on both banks of the Ohio, above and below it, is composed of blue argillaceous limestone and marl; constituting one of the oldest members of the transition or Silurian system. The strata are nearly horizontal and form flat table-lands intersected by numerous valleys in which alluvial gravel and silt occur; but there is no covering of drift in this region. The drift is abundant in the northern parts of Ohio and Indiana, but disappears almost entirely before we reach the Ohio.

Until lately herds of buffaloes were in the habit of frequenting the springs, and the paths made by them are still to be seen. Numbers of these animals have been mired in the bogs, and horses and cows have perished in like manner. Along with their remains are found innumerable bones of Mastodon, Elephant, and other extinct quadrupeds, which must have visited these springs when the valley was in its present geographical condition in almost every particular, and which must have been mired in them as existing quadrupeds are at present. The mastodon remains are most numerous and belong to individuals of all ages. The mud is very deep, black, and soft. In places it is seen to rest upon the limestone, and at some points it swells up to the height of several feet above the general level of the plain and of the river. It is occasionally covered by a deposit of yellow clay or loam, resembling the silt of the Ohio, which is from 10 to 20 feet thick, rising to that height above the creek and often terminating abruptly at its edges. This loam has all the appearance of having been deposited tranquilly on the surface of the morass and of having afterwards suffered denudation. The Mastodon and other quadrupeds have been mired before the deposition of the incumbent silt, for a considerable number of fossil bones have been found by digging through it. Accompanying the bones are freshwater and land shells, most of which have been identified by Mr. Anthony with species now existing in the same region.

Mr. Lyell observes that the surface of the bog is extremely uneven, and accounts for it partly by the unequal distribution of the incumbent alluvium which presses with a heavy weight on certain parts of the morass, from which other portions of the surface are entirely free. He also attributes it in part to the swelling of the bog where it is fully saturated with water near the springs.

The author is of opinion that the fossil remains of Bigbone Lick are much more modern than the deposition of the drift, which is not present in this district. But although the date of the imbedding of these mammalian fossil remains is so extremely modern, considered geologically, it is impossible to say how many thousand years may not have elapsed since the Mastodon and other lost species became extinct. They have been found at the depth of several feet from the surface, but we have no data for estimating the rate at which the boggy ground has increased in height, nor do we know how often during floods its upper portion has been swept away.

*Ohio.*—The Ohio river immediately above and below Cincinnati is bounded on its right bank by two terraces consisting of sand, gra-

vel and loam, the lower terrace consisting of beds supposed to be much newer than those of the upper. In the gravelly beds of the higher terrace teeth both of the Mastodon and elephant have been met with. Mr. Lyell was assured that a boulder of gneiss, 12 feet in diameter, was found resting on the upper terrace, about 4 miles north of Cincinnati, and that some fragments of granite had been found in a similar situation at Cincinnati itself. These facts show that some large erratics have taken up their present position since the older alluvium of the Ohio valley was deposited. In travelling northwards from Cincinnati towards Cleveland, Mr. Lyell found the northern drift commence in partial patches 25 miles from the former city and about 5 miles N.E. of Lebanon, after which it continually increased in thickness as he proceeded towards Lake Erie.

*New York—Niagara Falls.*—In a former paper Mr. Lyell alluded to the position of the remains of Mastodon, 12 feet deep, in a fresh-water formation on the right bank of the river Niagara at the Falls. He remarks that if we had not been able to prove that the cataract had receded nearly four miles since the origin of the fluviatile strata in question, we should have been unable to assign any considerable duration of time as having intervened between the inhumation of the Mastodon in marl full of existing shells and the present period. The general covering of drift between Lakes Erie and Ontario is considered to be of much higher antiquity than the gravel containing the bones of the Mastodon at the Falls.

*Rochester.*—In the suburbs of this city remains of the *Mastodon giganteum* were found associated with existing species of Mollusca in gravel and marl below peat.

*Genesee.*—Here remains of the *Mastodon giganteum* were found with existing shells in a small swamp in a cavity of the boulder formation, so that the animal must have sunk after the period of the drift when a shallow pond fed by springs was inhabited by the same species of freshwater mollusca as now live on the spot.

*Albany and Greene Counties.*—Mr. Lyell examined, in company with Mr. Hall, two swamps west of the Hudson River, where the remains of Mastodon occurred in both places at a depth of four or five feet, precisely in such situations as would yield shell marl, and peat, with remains of existing animals in Scotland. Cattle have recently been mired in these swamps.

According to Mr. Hall the greatest elevation at which Mastodon bones have been found in the United States is at the town of Hinsdale, situated on a tributary of the river Allegany in Cattaraugus county in the State of New York, where they occur at an elevation of 1500 feet above the level of the sea.

*Maryland.*—In the museum at Baltimore, Mr. Lyell was shown the grinder of a Mastodon, distinct from *M. giganteum*, and which had been recognised and labelled by Mr. Charlesworth as *M. longirostris*, Kaup. It was found at the depth of 15 feet from the surface in a bed of marl near Greensburgh, in Carolina County, Maryland, and is considered by Mr. Lyell as a miocene fossil.

*Atlantic border.*—Between the Appalachian mountains and the

Atlantic there is a wide extent of nearly horizontal tertiary strata, which at the base of the mountains are 500 feet and upwards in height, but decline in level nearer the ocean and at length give place to sandy plains and low islands skirting the coast, in which strata containing marine shells of recent species are met with, slightly elevated above the sea. Occasionally deposits formed in freshwater swamps occur, below the mean level of the Atlantic or overflowed at high tide. In this district Mr. Nuttall discovered, on the Neuse 15 miles below Newburn, in South Carolina, a large assemblage of mammalian bones, including those of the *Mastodon giganteum*, resting on a deposit containing marine shells of recent species. Mr. Conrad presented Mr. Lyell with the tooth of a horse covered with barnacles, from this locality. Professor Owen has examined it and could find no corresponding tooth of a recent species, but considers it as agreeing with the horse-tooth brought by Mr. Darwin from the north side of the Plata in Entre Rios in South America.

*South Carolina.*—Remains of the Mastodon were found in digging the Santee Canal, in a spot where large quadrupeds might now sink into the soft boggy ground.

*Georgia.*—Bones of the Mastodon and Megatherium occur in this district in swamps formed upon a marine sand containing shells of species now inhabiting the neighbouring sea.

Mr. Lyell in conclusion offers the following observations :—

1. That the extinct animals of Bigbone Lick and those of the Atlantic border in the Carolinas and in Georgia belong to the same group, the identical species of Mastodon and elephant being in both cases associated with the horse, and while we have the Mylodon and Megatherium in Georgia, the Megalonyx is stated by several authors to have been found at Bigbone Lick.

2. On both sides of the Appalachian chain, the fossil shells, whether land or freshwater, accompanying the bones of Mastodons, agree with species of Mollusca now inhabiting the same regions.

3. Under similar circumstances Mr. Darwin found the Mastodon and horse in Entre Rios, near the Plata, and the Megatherium, Megalonyx and Mylodon, together with the horse, in Bahia Blanca in Patagonia; these South American remains being shown by their geological position to be of later date than certain marine Newer Pliocene, and Post-pliocene strata. Mr. Darwin also ascertained that some extinct animals of the same group are more modern in Patagonia than the drift with erratics.

4. The extinct quadrupeds before alluded to in the United States lived after the deposition of the northern drift, and consequently the coldness of climate which probably coincided in date with the transportation of the drift, was not as some pretend the cause of their extinction.