

RÉSUMÉ OF GEOLOGICAL OBSERVATIONS, AND THE
GEOLOGY OF THE STATE.

Prior to our visit the only portion of the State that had been examined geologically, or on which a geological report had been prepared, was the region lying north of a line running almost due northeast from the Manatee River, just south of Tampa Bay, to the east coast. Below this all was conjectural, although the existence of certain limestones of undetermined age was hinted at, or even located, by a number of casual observers (Tuomey, Conrad) who chanced to navigate some of the outer waters. Such a limestone was reported by Tuomey to be found in Charlotte Harbor, but the exact locality of its occurrence is not noted.

The first critical observations on the geology of the State were made by Conrad, who in 1846 described a limited number of fossils from a limestone found in the neighborhood of Tampa, which he correctly assigned to the Tertiary period. This is the earliest positive reference we possess of a definite formation occurring in the State. From the presence of a supposed nummulite in the limestone in question, *Nummulites Floridanus*, now shown to be in reality an orbitolite, Conrad correlated the deposit with the Vicksburg formation of Alabama and Mississippi, from which also a supposed nummulite, *Nummulites (Orbitoides) Mantelli*, had been described, and which had until then passed under the name of the American nummulitic formation. Although the determinations of both of the foraminiferal species have been proved to be erroneous, the correlation of the respective beds containing the fossils remains approximately correct, even if not absolutely so.

It is remarkable that in spite of the positive assurance given by Conrad of the existence of this Tampa limestone so little account should have been made of it in the subsequent theories regarding the formation of the Floridian peninsula, and that the seductive coral theory of growth advanced by Louis Agassiz, and so beautifully formulated by Professor Joseph Le Conte, should have been allowed the weight which it carried for a quarter of a century. Singularly enough, not even Conrad appears to have protested against the theory which had for its ground-work only an examination of the belt of coral reef and the coral keys which border the State on the south and southeast.

The only serious contribution to the geology of Florida made

between the date of the publication of Conrad's paper and 1880 is the report of personal observations made in the northern half of the State by Dr. Eugene A. Smith, State Geologist of Alabama, published in the American Journal of Science for 1881. This assiduous investigator collected largely in the way of rocks and fossils, and at localities sufficiently removed from one another as to permit of a broad insight into the geology of the region. From his observations it appeared that at least a considerable part of the northern half of the State, instead of representing a recent formation, as was supposed by many, was in reality underlaid by heavy beds of fairly ancient limestone, which in the characters of their organic remains recalled the upper white limestone of Alabama. The fossils, which were kindly placed in my hands for determination, proved the correctness of the inference as to their age. I identified among them two or more species of Foraminifera, one a large orbitoide, of very nearly the dimensions of the *Orbitoides Mantelli*, representing it, and undeniably the analogue of the European *Orbitoides ephippium*, and an Operculina, very nearly related to, if not identical with, the *O. complanata*. Some of the rock specimens submitted to me were made up of practically nothing but the tests of the aforesaid orbitoide, and of a smaller species more of the type of *O. Fortisii (dispansa)*. From the examination of these specimens I had no hesitation in referring the rocks holding them to the Oligocene formation. The localities noted by Dr. Smith for the occurrence of this formation are located in the tract included between Jackson Co. on the west, and Marion Co. on the south, and it was correctly conjectured that over much, or most, of the intermediate region where no observations had as yet been made, or where there were no outcrops, the same rock would be found as the underlying structure. From one locality, Rock Spring, Orange Co., Dr. Smith obtained rock specimens which differed very essentially in both lithological and faunal features from the specimens obtained at the other localities, indicating the existence of a distinct formation. Among the fossils I identified a number clearly indicative of the Miocene age of the formations—such as *Pecten Madisonius*, *Cardita arata*, *C. granulata*, *Venus alveata*, etc., fixing the most southerly extension of the Medial Tertiary formations of the Atlantic slope. This patch of Miocene is not improbably continuous with the Miocene area of southern Georgia.

The reference of the greater part of the northern half of the State to the Oligocene formation has been more than justified in the light of subsequent investigation, which has disclosed the existence of the older Tertiary rock in many new localities—on the Wacasassa, at Archer, Arredonda, on the Homosassa, Cheeshowiska, etc. From the Cheeshowiska, some four miles from its mouth, Mr. Joseph Willcox, in 1882, obtained large masses of rock, densely charged with foraminiferal remains,

among which I recognized great numbers of the Orbitoides occurring in the rock-fragments submitted to me by Dr. Smith, and what was of far greater moment, vast quantities of a true nummulite (named *Nummulites Willcoxi*), the first that had hitherto been discovered on the American continent. The nummulitic masses were embedded in, or bordered by, a fringe of a much newer fresh-water limestone, containing the remains of several recent species of non-marine mollusks—*Vivipara Waltonii*, *Glandina parallela*, *Ampullaria depressa*—indicating that there had been a working over of the older formation, and that the specimens obtained were not found *in situ*. Nevertheless, there could no longer be any doubt as to the existence of a true nummulitic formation in the United States, and the age which it represented in the peninsula of Florida. Other specimens obtained by Mr. Willcox at Wacasassa, in Levy Co., contained the remains of two species of sea-urchin, *Euspatangus Clevei* and *E. Antillarum*, identical with forms occurring in the equivalent (Oligocene) deposits of the island of St. Bartholomew.

Since the discovery of these nummulitic rocks on the Cheeshowiska River Mr. Willcox has obtained further specimens of the same foraminifer at a locality removed some fifteen miles northeast of the original locality, and *in situ*; and I have identified the species in rock fragments sent to me for determination by Prof. A. G. Wetherby, from a well-boring situated five miles S. W. of Gainesville. A second species of the genus (*Nummulites Floridensis*) has also been described by me from Hernando Co., associated in a rock mass with various other species of Foraminifera, of the genera *Heterostegina*, *Biloculina*, *Triloculina*, etc.

Concerning the (marine) Tertiary deposits newer than the Oligocene, the only positive indication that we had of their existence in the State prior to 1886, beyond the patch of Miocene above referred to as occurring at Rock Spring, was furnished by Dall (*Science*, VI, p. 82), who, in July, 1885, reported the discovery of *Ecphora quadricostata*, a characteristic Miocene fossil of the Atlantic border of the United States, in the rock of Tampa Point. Mr. L. C. Johnson about this time also indicated the occurrence of what appeared to be newer Tertiary deposits in the northwest of the peninsula, a conclusion at which I had likewise arrived from an examination of a limited collection of fossils obtained from Ballast Point, on Hillsboro Bay, a few miles south of Tampa.*

During the spring of 1884 the late Prof. W. C. Kerr, of the North Carolina Geological Survey, made a cursory examination of the region about Tampa, the results of which are embodied in a brief paper published

* Mr. Johnson (*Science*, May, 1885) does not give the paleontological evidence on which the rock of Hawthorne and Waldo is referred to the Miocene (or later) period; and I fail to see the full force of the argument which places it newer than the Oligocene, although this may be so.

in the Journal of the Elisha Mitchell Scientific Society for the years 1884-85 (Raleigh, N. C.), pp. 86-90. In this paper the author describes the limestones of Tampa Bay, and sundry outcrops of rock on Six Mile Creek, Alefia River (Bloomingdale), Manatee River (Rocky Bluff), and Peace Creek (Fort Meade), which are all referred to the Upper Eocene period. The general conclusions are thus stated: "The limestone rock underlying the region of country about Tampa belongs to the upper Eocene, as already pointed out by Conrad and Tuomey. And as a gentleman of intelligence who visited Fort Myers, informed the writer that the rock at that place was both in appearance and in fossils, similar to that about Tampa, the Eocene limestone rock almost certainly extends at least as far south as that point." It will thus be seen that the conclusions reached by this observer are absolutely at variance with the facts which our investigations have brought out; and it is not a little surprising that Prof. Kerr should have failed to recognize the post-Eocene age of the Rocky Bluff limestone, when the Miocene character of the fossils occurring at that locality is so clearly marked.

One of the most interesting contributions to the history of the extinct fauna of the State that had been made up to this time was the discovery by Dr. J. C. Neal, near Archer, Alachua Co., of an extensive series of mammalian remains, referable probably to several distinct geological periods, from among which Dr. Leidy has identified the parts belonging to one or more species of mastodon, rhinoceros, tapir, horse (*Hippotherium ingenuum*), llama, camel, and hog. One of the forms of mastodon appears to be distinct from any of the other species inhabiting the United States, and has been named *Mastodon Floridanus*. The hog is considered to represent the type of a distinct genus, *Eusyodon*, considerably removed from the peccary-forms, *Dicotyles*, *Platygonus*, which hitherto alone represented the Suidæ in the Tertiary and Post-Tertiary deposits of the North American continent.

The above sketch represents in brief the condition of our geological knowledge of the State up to 1886. It recognizes the existence of Tertiary (Oligocene and Miocene) deposits in the upper half of the State, or north of a line connecting Tampa Bay on the west with Sanford, on the Atlantic slope, on the east, but leaves, as has already been intimated, everything conjectural south of that line. From the broad extent of the Oligocene rocks in the north Dr. Smith was led to infer that in all probability the greater part of the peninsula, at least as far as the Caloosahatchie and Lake Okeechobee, was underlaid by the same formation, the hypothetical extension of which is indicated on the map accompanying his report in the American Journal of Science above mentioned. The conclusion reached here was a natural one, and is that which guided me in the delineation of the geological boundaries on the general map of

the Tertiary deposits accompanying my "Contributions to the Tertiary Geology and Paleontology of the United States" (1884). Our recent explorations, however, prove the utter erroneousness of the view here entertained, and indicate not only that the Oligocene formation is in great part, if not wholly, absent from the southern half of the peninsula, where it is replaced by the Miocene and Pliocene, but that even in the north its proper limits, as far as the determination of an absolute horizon is concerned, have probably not been satisfactorily ascertained. Thus, the foraminiferal rock of Tampa, containing the supposed nummulite, *N. (Orbitolites) Floridanus*, and through which it had been correlated with the Vicksburg formation, is very different from the true orbitoitic or nummulitic rock which is distinctively characteristic of the Oligocene districts of the further north and the interior. Indeed, it contains nothing in common with this rock, but very much that is distinctive of itself, and the underlying siliceous rock that forms the floor of Hillsboro River. It may, nevertheless, be Oligocene, but in that case it in all probability represents a higher horizon than the same formation further to the north. The reasons for considering the formation as of Miocene age, and as the partial equivalent of the medial Tertiary deposits of Santo Domingo, are fully set forth in pages 121-22 of this report.

A few words only need here be said with reference to the theory, advocated by Louis Agassiz and Prof. Joseph Le Conte, which held that the peninsula of Florida was of comparatively recent formation, and that it represented in greater part merely an accumulation of successive or consecutive coral reefs. Our observations, which had already been preceded in the northern part of the peninsula by the researches of Eugene A. Smith, clearly demonstrate the erroneousness of the views hypothetically set forth, and establish beyond a question of doubt that the progressive growth of the peninsula, as far, at least, as Lake Okeechokee, and probably considerably further, was the result of successive accessions of organic and inorganic material, brought into place through the normal methods of sedimentation and upheaval. A full exposition of Prof. Agassiz's views is embodied in his "Report on the Florida Reefs," published in the Memoirs of the Museum of Comparative Zoology for 1880, some twenty-nine years after its preparation. In this paper the author strenuously denies all evidences of upheaval over the greater part of the peninsula, and ascribes the varying elevations, at least of the more southerly portions, to upthrows or accumulations of material as depending upon the agency of gales and high-water. Prof. Le Conte, while still adhering to the fundamental ideas expressed in his original paper, published in the American Journal of Science for 1857, in a more recent paper (Science, Dec. 14, 1883) disclaims the agency of coral growths in the formation of the peninsula north of the Everglades.

ROCKS OF HOMOSASSA RIVER.—A good section of the rock of the region is exposed at Wheeler's, on the left bank of the stream, about one mile above its mouth. It is a tough limestone, rising at different stages of the water probably two or three feet above its surface—at the time of our visit about one and a-half or two feet—and exhibiting numerous holes, fissures and sinks that have been irregularly worn into it by the water. The surface appears to be practically horizontal, exhibiting no measurable dip. The rock is densely charged with foraminiferal remains, all, as far as I have been able to determine, referable to the Miliolidæ, or to the group of the imperforate Foraminifera, as distinguished from the Foraminifera Perforata, which, in the rock-masses further to the south, usurp their place. I propose to designate this formation, representing one of the four distinct types of foraminiferal rock found in the State, the "Miliolite Limestone"—a member, doubtless, of the Upper Eocene or Oligocene series, more likely the latter. Unfortunately, the absence of distinctive molluscan remains in the rock rendered the determination of its absolute age a little uncertain, but its close proximity to the unequivocal members of the Oligocene rocks of the Cheeshowiska River, a few miles to the south, leaves little room for doubt as to their near equivalence.

The genera of Foraminifera recognized as occurring in the Miliolite Limestone are:

Biloculina,	Quinqueloculina,
Triloculina,	Sphæroidina.

Another, and less compact, limestone, not unlikely belonging to the same series as the last, is found in the immediate neighborhood of Wheeler's. I examined large blocks of the rock that had been taken from a well-digging, but the numerous fossil impressions contained therein, mainly of bivalves, were so obscure or ill-defined as to permit of no satisfactory results being arrived at from their partial determination.

ROCKS OF THE CHEESHOWISKA RIVER.—These are exposed nearest to the sea on John's Island, at the entrance to the river, where a yellowish, spongy limestone, containing numerous molluscan remains and a few tests of the foraminiferal genus Orbitoides, appears on the ocean front at low-water. The main-rock, which is of Oligocene age, is bordered by, or incased in, a rock (limestone) of newer formation (Post-Pliocene), in which the remains of marine organisms are freely intermingled with those of a fresh-water type, such as Vivipara, Ampullaria, etc., represented by species living at the present day. The re-formation of the old limestone is thus made evident, but there can be no question, seeing

the character and structure of the country generally, that the unaltered or mother rock is the rock of the region—*i. e.*, that the Orbitoitic sees its true development here.

The same admixture of rocks is again observed at an outcrop on the right bank of the river, about one mile further up the stream. About three miles above this second point, in a clearing known as Loenecker's, is the famous nummulite locality where Mr. Willcox obtained the original nummulites described by me in 1882. The rock lies here in loose masses in a partially ploughed field, about four to six feet above the surface of the water. No indication of a true outcrop could anywhere be detected, but I am satisfied that the parent rock either immediately underlies the locality, or is found in its immediate vicinity. The very insignificant elevation of the entire region above water-level, its uniform horizontality, and the dense capping of vegetable matter beneath which it lies buried, necessarily reduce to a minimum the chances of finding an outcrop, and explain why to so many of its inhabitants this portion of the State is supposed to be wholly destitute of solid rock. Even along the river-courses, where we should most naturally expect to meet with an exposure, the vegetable growth is so dense and impenetrable as to practically completely hide the fundament, and were it not for an occasional or accidental clearing, such as Loenecker's, one might be left in absolute ignorance of its very existence.

The rock occurring at Loenecker's is of two kinds—one, in which almost the entire mass is made up of the tests of orbitoides, and the other in which the nummulites predominate to about the same extent. But several of the larger fragments indicate the most unmistakable inter-association of the individuals of both these genera of Foraminifera, and leave no doubt as to the equivalence in age of the two-classes of deposit. The Orbitoides found here represents two or more species, one of the type of the well-known Biarritz fossil, *O. ephippium* (*O. sella*), whose peculiarly infolded tests are very abundant, and another more nearly recalling *O. dispansa*. I am not sure that I recognized any undoubted *O. Mantelli*, the form of the Mississippi and Alabama "Vicksburg" beds, but not impossibly some of the smaller tests referred to the *O. dispansa* type may represent arrested forms of this species. Both species of nummulites occur here, *i. e.*, *Nummulites Willcoxi* and *N. Floridensis*, the former very largely predominating.

With reference to the physical history of these deposits, I can perhaps not do better than quote my own words published at the time of their discovery (Contributions to the Tertiary Geology and Paleontology of the United States, p. 81, 1884): "As to the age of the formation represented by these nummulitic deposits, there might appear to be at first sight no question of doubt. The presence alone of nummulites in any

formation is almost positive indication as to the Eocene or Oligocene age of that formation, and the more especially when the remains of these organisms occur in any abundance. Admitting the supposition of this age, we should naturally look to the associated fossils for further confirmatory evidence bearing on this point. Singularly enough, in the case of the Florida nummulitic rocks—at least in the fragments that have been placed at my disposal—with very few exceptions all the molluscan remains belong to a period much more recent than the Eocene, and to species that are still living at the present day. And what may appear still more singular, they are referable in principal part to land and fresh-water genera, *Glandina*, *Paludina*, *Ampullaria*.* From this association and the circumstance that nummulites are still met with in existing seas, it might readily be inferred that there has been here a commingling of contemporaneous marine and fresh-water organisms, and that the deposits in question were laid down under such conditions—proximity to the mouth of a river—where a commingling of this kind could take place. Indeed, it would be difficult from paleontological evidence alone to disprove such an assumption, were it not that almost incontrovertible proof to the contrary, in addition to that furnished by the *abundance* of nummulites, is afforded in the presence of the remains of *Orbitoides*, a genus which attained its greatest development in the Upper Eocene (“Nummulitic”) and Oligocene periods, and which does not appear to have survived the Miocene. There can, therefore, be little or no doubt that the rock fragments marked by this admixture of an older and a newer (Post-Pliocene or recent) fauna, and comprising both marine and fresh-water types of organisms, have derived their faunal character in great part from the deposits of a more ancient formation, which formation represents, and is the equivalent of, a portion of the European “Nummulitic” (whether Eocene or Oligocene). The exact locality (or localities) which these Florida nummulitic deposits occupy *in situ* has not yet been ascertained, but it is fair to assume that the beds lie along the Gulf border (possibly in great part submerged), where, through the disintegrating action of the oceanic surf, their fragments have at a comparatively recent period been washed together with the material that at the same time was being carried out by the fresh-water streams. The precise position which the formation holds in the nummulitic scale, as fixed by Hantken or La Harpe (*Études sur les Nummulites du Comté de Nice*, Bull. de la Soc. Vaud. des Sc. Nat., vol. xvi, pp. 223–24, 1879), cannot be positively determined from our present data, since exceptionally the group of the *Nummulites plicata* is represented as well in the oldest as in the newest of the Tertiary deposits marked by the members of this class of organisms.”

* The species identified with recent forms are *Glandina parallela*, *Paludina (Vivipara) Wallonii*, and *Ampullaria depressa*.

The above remarks remain applicable to the facts of the present day, and require little or no modification except in so far as more recently obtained data permit us to emphasize with greater positiveness certain points that had hitherto remained in a measure conjectural. Thus, the very extensive inter-association of the nummulites with *Orbitoides ephippium* leaves practically no doubt that the formation in question is not Upper Eocene, but Oligocene; and secondly, the finding of nummulites *in situ* at a locality some fifteen miles northeast of the original locality, and, again, five miles southwest of Gainesville, enables us to locate within definite limits the partial boundaries of the formation.

We were informed that an outcrop of the rock occurs in a morass about a half-mile or more inland from Loenecker's, but the lateness of the hour at the time of our visit, and the difficulty of reaching an unknown spot practically inaccessible in the heart of the wilderness, prevented us from making a search in that direction. About a mile and a-half above Loenecker's a mass of rock juts out from the bottom of the river-channel to within a few inches of the water's surface, in one or two spots rising slightly above it. Much to our surprise we found it to be almost entirely destitute of fossil remains, showing not a trace of either of the genera of Foraminifera so abundant in the rock below. Its stratigraphical relations could not be definitely ascertained, but without much question it is a member of the nummulitic series of deposits, and may be a near equivalent of a similar looking rock that appears on the beach at Clearwater, immediately north of the wharf. The fossil impressions are very obscure, and such as we observed can only doubtfully be referred to *Cytherea* and *Modiola*.

ROCKS OF THE PITHLACHASCOOTIE.—I was unable to make a personal exploration of the rocks of this region, and am, therefore, compelled to confine my remarks to an examination of rock specimens brought to me by Mr. Willcox, and to this gentleman's references bearing on their occurrence. The rock is a tough, partially siliceous, white limestone, in places densely charged with fossils. These are mainly in the form of casts of minute gasteropods, probably one or more species of *Cerithium*, among which I failed to find any species that we had observed elsewhere; the question of age is thus left undetermined, although a strong probability argues in favor of the Oligocene. According to Mr. Willcox the shores of the Pithlachascootie are in places rocky for a distance of two or three miles from the mouth, the bluffs rising 6-8 feet above the water, consequently higher than in the case of most of the western streams. Where the bank rises higher than three or four feet, it slopes back and is covered with soil. The fossiliferous beds were found to extend to a height of about three feet above the surface of the water, appearing in

both banks. Mr. Willcox also obtained fragments of a siliceo-calcareous rock, containing numerous casts and impressions of one or more forms of sea-urchin, from a small island situated about three miles southeast of the mouth of the Homosassa River. One of the species (the most abundant form) is, I believe, without question the *Pygorhynchus Gouldii* of Bouvé (Proc. Boston Soc. Nat. Hist., Dec., 1846; *Ibid.*, Jan., 1851. —*Nucleolites Mortoni* of Conrad, Journ. Acad. Nat. Sciences Phila., II, p. 40), from the older Tertiaries (Oligocene?) of Georgia. The same species was subsequently identified by McCrady in the limestone of Alligator (Columbia Co.?), Florida, and by him referred to a new genus *Ravenelia* (Proc. Elliott Soc. Nat. Hist., Charleston, March, 1858).

ROCKS OF THE TAMPA BAY AND HILLSBORO REGIONS.—Two distinct kinds of rock appear at Ballast Point, on Hillsboro Bay, at about water line, rising in most places not over two feet above it, still oftener less, and at Newman's perhaps three or four feet. The one rock, a highly fossiliferous yellow limestone, is manifestly in place, and forms the bed of the beach, shelving at a moderate angle beneath the waters of the bay. It contains numerous impressions of the *Venus penita* described by Conrad in 1846, and large numbers of the singular foraminifer referred by this paleontologist to Nummulites (*N. [Nemophora] Floridanus*). It is very remarkable, in view of the abundance and perfection in which the fossil occurs at this locality, that an imperfect or abnormal specimen, misleading in the details of its structure, should have served as a type for a description and illustration of the species.

The rock containing this supposed nummulite has generally been referred to the Vicksburg group, but as far as paleontological evidence goes, I see no valid reason for considering it to belong to this age. None of the distinctive Oligocene fossils of the formation occur in the rock, nor did we find in it any traces of the foraminiferal types so characteristic of the Oligocene region of the northern part of the peninsula. On the contrary, all the fossil forms occurring here appear to be distinct, except in so far as they are represented in the second kind of rock above referred to, and in the rock corresponding to it which forms the bed of Hillsboro River. If Oligocene, the rock in all probability represents a horizon higher than the Vicksburg beds and the Florida "Nummulitic" (or Orbitoitic), but the evidence is all but conclusive for considering it Miocene, and as the near equivalent of some of the beds of the island of Santo Domingo. I failed to detect in the rock any traces of distinctively Miocene fossils; but the association near by of an indisputable Miocene deposit leaves little room for doubt as to the absolute relationship.

The second form of rock found at Ballast Point is of much firmer consistency than the limestone, and appears in large, rounded or angular

bluish masses scattered over the latter, seemingly representing a newer formation. It contains numerous fossil impressions, partially silicified, a number of them, as the *Venus penita* above mentioned, identical with forms found in the limestone, but the greater number distinct. Among these the remains of one or more species of *Cerithium* are especially abundant, and might be said to determine the faunal character of the rock. We found no traces of the orbitolite. At no place could I detect a solid outcrop of the rock, and, therefore, from the observations made at this point alone it would be impossible to determine the stratigraphical relations of the two series of deposits occurring here. But along the Hillsboro River and on a small tributary, known as Magbey's Spring, which enters a short distance above the town of Tampa, the relationship is very clearly shown. The hard siliceous blue rock, charged with the remains of *Cerithium*, etc., appears at scattered intervals all along the river bank, now on one shore then on the other, and manifestly forming the bed of the channel. Just below the shipyard the nearly horizontal strata lie in beds of from one to two feet thickness. I was unable to determine any true dip. The orbitolite limestone is exposed a short piece above this point on Magbey's Spring, about three or four hundred feet from the borders of the Hillsboro, in a heavy mass some seven to ten feet in thickness. Although the irregularity of the outcrop and its small extent prevented me from locating its absolute position, there can be no question, seeing its proximity to, and elevation above the river, that it overlies the blue rock of the channel. This must then also be the relation existing between the two kinds of deposits exhibited at Ballast Point, which are manifestly the equivalents of the Hillsboro series. The big irregular masses or boulders which here extend into the bay, or lie scattered over the limestone, are evidently exposed as the result of outwash, and appear to have been scattered to their present positions through the action of a heavy sea.

The relations of the coralliferous deposit exposed at Newman's landing, as well as of the two other classes of rock just described, are fully set forth on pp. 120-123, and require little further consideration. An enumeration of the species of fossils occurring here is given on pp. 119-120, and 124. The fossils are nearly all completely silicified, and exhibit to the minutest detail the ornamentation characteristic of the different species. The coral geodes, some of them measuring as much as eight or ten inches across, are especially beautiful, and exhibit to good advantage the mammillated character of the substituting blue and blood chalcedony. There is little doubt in my mind that the formation is due to an infiltration of silica in a heated condition, but in what precise manner the peculiar method of hollowing was brought about I am unable even to guess at. Many of the species so closely resemble recent forms that it

is at first sight difficult to distinguish between them, but close comparison in almost all instances reveals some constant characters by means of which the two series can be separated. The number of clearly-marked extinct species is, however, very great, and sufficient to fix approximately, in default of direct stratigraphical evidence, the position in the geological scale which the deposits occupy. This is, without doubt, in the Miocene series, but just along what horizon it is difficult, or even impossible, to determine.

ROCKS OF THE MANATEE RIVER.—The deposits exposed on the right bank of the Manatee River at Rocky Bluff, a few miles above Braidentown, have been referred to in the narrative (p. 13) as consisting of a basal marly limestone, and yellowish sandstone, and an overlying siliceous conglomerate, almost totally devoid of fossil remains. The white marl, on the other hand, is distinctly a shell rock, in which casts of fossils, mainly bivalves, and their impressions, are exceedingly numerous. Among these I recognized several forms distinctive of the Miocene formation of the north, such as *Pecten Madisonius*, *P. Jeffersonius*, *Perna maxillata*, *Venus alveata*, *Arca idonea* (?), etc., which left no doubt in my mind as to the age of the deposit containing them. Fossils were much less abundant in the accompanying yellow sandrock, but the species represented were practically identical with those of the marl. The latter disappeared after a comparatively short distance, but the sandrock continued in irregular honeycombed ledges to the furthest point reached by us on the river. The total elevation of the exposure is not more than three or four feet above the river's surface.

The discovery of a Miocene formation in this portion of the State was not a little of a surprise, as it completely invalidated all the conjectural ideas that had been framed relative to the geological structure of the peninsula. It confirmed my impression as to the intermediate or equivalent age of the beds occurring near Tampa, and clearly indicated what would in all probability prove to be the true succession of the beds further to the south. In other words, it was made manifest that this portion of the State was neither that recent creation which the upholders of the coral theory of growth had claimed for it, nor of that antiquity which was assumed for it in virtue of the hypothetical extension of the Oligocene beds. On the contrary, the evidence was conclusive that the same physical forces which effected the formation of the newer Tertiary series of the eastern border of the United States were similarly operative on the Gulf coast, and that the peninsula of Florida participated in the same general movements that were known to have affected the United States between Georgia and New Jersey during approximately equivalent periods of time. In how far these movements were of both

elevation and subsidence still remains to be determined, but the facts point strongly to the conclusion that the growth of the peninsula southward was a nearly continuous one, without much interrupted sedimentation, or any great break in the chain of organic evolution to mark the successive accessions of territory which the peninsula received during its development.

ROCKS OF SARASOTA BAY.—The marine deposits bordering the sea on Big Sarasota Bay are mainly in the form of indurated sands, or where there has been a sufficient infiltration of iron, of partially compact sandstones. Fossil remains are almost wholly wanting, being limited, as far as our own observations went, almost exclusively to the casts of one or more species of single coral of undetermined relationships. These we found in a semi-compact yellow rock, of about three or four feet thickness, at a locality known as Whittaker's. The rock has the appearance of being a comparatively recent formation, and I should probably unhesitatingly have referred it to the modern epoch were it not for the coral impressions which it contains. For the present I feel some hesitation in assigning to it a definite position, although fairly assured that it is late Tertiary, or, possibly, even Post-Tertiary. The same impressions occur in a much more compact and highly fossiliferous rock of White Beach, Little Sarasota Bay, which in the character of its organic remains seems to occupy a position intermediate between the Miocene and Pliocene series.

The ferruginous sandrock exposed at Hanson's, whence I extracted a part of the skeletal remains (converted into limonite) of man, as well as the more compact terrestrial rock that appears some three-quarters of a mile lower on the bay, have been discussed in the narrative (p. 15), and require no further consideration at this place. The only other localities about the bay where we observed fossiliferous deposits were on Philippi's Creek, an eastern tributary, where a yellow arenaceous limestone, highly charged with fossils, most of them in the form of casts or impressions, and but barely determinable, could be observed at intervals along the shore, rising about two feet out of the water. A number of the fossils appeared to be identical with forms occurring in the yellow rock of the Manatee River; especially was this the case with the corals and polyzoans, but the only species that I could definitely locate were *Pecten Madisonius*, *P. Jeffersonius*, and possibly also *Arca idonea*. The formation is evidently either Miocene or Pliocene, or one holding a position intermediate between the two. At one or two spots near the mouth of the creek, well observed on the right bank, this rock is seen to be overlaid by a heavy bed of coquina, some three or four feet in thickness, the shell fragments composing which are largely triturated, and only differ from the typical coquina of the east coast in their greater compactness. This is, I believe, the first instance

that a recent rock of this kind has been noted as occurring on the west coast.

A similar rock, now rapidly undergoing destruction through the wash of the sea, guards the entrance to Little Sarasota Inlet. On White Beach, on the inner side of the inlet, probably two and a-half or three miles from its mouth, a reef-rock, very tough in places, and extensively honeycombed through the action of the water, forms the shore line, and doubtless, also constitutes in greater part the bottom of the bay. Unfortunately, the fossils, which are markedly abundant, are in the main in a very bad state of preservation, and for the most part do not admit of specific determination. The impressions of reef-corals, probably a species of madrepora, are numerous, and we also found several casts of apparently the same species of simple coral which has been noted as occurring in the sandrock at Whittaker's. Most of the molluscan remains are in the form of casts and impressions, and belong chiefly, at least as far as the more prominent forms are concerned, to *Pecten*, *Cardium*, *Arca*, *Venus* and *Turritella*, the last being by far the most abundant of the gasteropod genera, and in our own collections almost the only one represented. The rock is either of Miocene or Pliocene age, but I could not positively determine which, although from its position, and in the light of our present knowledge regarding the formations on the Caloosahatchie, I should consider it not far from the junction line of the two series, if it does not, indeed, effect a passage between the two. The only forms that appeared to be recognizable, and even these were somewhat doubtful, were fragments bearing a close resemblance to *Pecten Jeffersonius*, *Venus alveata* and one of the northern forms of *Turritella*.

In a rock manifestly belonging to the same series, although of a somewhat different lithological aspect, we found numerous casts of one or more species of large oyster, one of them, with little doubt, the *Ostrea Virginiana*, in association with which were the casts also of a cockle (*Cardium magnum?*), clam (*Venus Mortoni?*), and a *Perna*. Many of these were lying loose on the beach, having been evidently washed out from the parent rock. A short distance beyond this point, where a not exactly insignificant creek has cut a nearly vertical channel, the rock is exposed in heavy beds of from one to two feet thickness, rising to a total height above the creek of some eight or ten feet, or possibly more. Among the fossils gathered here, which were neither numerous nor well-defined, there were a number of gasteropod casts, probably *Turritellas*, and fragments of a large scallop which bore a strong resemblance to *Pecten Madisonius*.

ROCKS OF THE CALOOSAHATCHIE.—The remarkable series of deposits exposed on this river, which I have designated the "Floridian," and

which give us the first unequivocal evidences of the existence of a marine Pliocene formation in the United States east of the Pacific slope, have been fully detailed in the narrative (pp. 27-31), and only require incidental mention in this place. They appear in most places as a partially indurated marl or earthy limestone, of a yellowish, buff, or white color, and either largely destitute of organic remains, or so densely charged with them as to constitute a pure shell-rock. At their first visible outcrop, about twenty miles by water above Fort Myers, they barely reach water level, but they gradually rise higher and higher, until some twenty or twenty-five miles below Fort Thompson, their elevation reaches (or reached at the time of our visit) fully six to eight feet, and this elevation is maintained throughout a considerable part of the nearly continuous exposure of some twelve or fourteen miles that immediately precedes the Fort Thompson rapids. At this locality they, in company with the overlying Post-Pliocene Venus bed, disappear beneath the heavy capping of Fort Thompson fresh-water limestone, fully described in the narrative, but there can be no question that their inward extension is still very much greater.

Inasmuch as the deposits in question have been traced to a point removed by fully 40-50 miles in a direct line from the sea, or to a position one-third across the State, they afford the most conclusive evidence, if any such were still needed, of the utter fallaciousness of the theory that seeks to explain the formation of the peninsula on the assumption of successive coral growths. They, moreover, clearly indicate that one of the last chapters in the history of the formation of the State was practically identical with the series of closing chapters that rounded off the physical history of the eastern border of the United States generally—steady sedimentation, slow and gradual upheaval, and absence of specially disturbing forces which might otherwise have interfered with the regular processes attending local organic evolution.

TAYLORS
CREEK.



OKFCHOBBE WILDERNESS

GENERAL SUMMARY AND CONCLUSIONS.

1. The whole State of Florida belongs exclusively to the Tertiary and Post-Tertiary periods of geological time, and consequently, as a defined geographical area, represents the youngest portion of the United States.

2. There is not a particle of evidence sustaining the coral theory of growth of the peninsula; on the contrary, all the facts point conclusively against such theory, and indicate that the progressive growth of the peninsula, at least as far as Lake Okeechobee, has been brought about through successive accessions of organic and inorganic material in the normal (or usual) methods of sedimentation and upheaval. The evidence, further, is very strong that beyond Lake Okeechobee and the Caloosahatchie the structure of the State is for the most part identical with that above it, and the observed facts clearly prove that this correspondence must exist over at least a considerable portion of the unexplored region of the Everglades.

3. The Florida coral tract is evidently limited to a border region of the south and southeast. Fossil corals occur sparingly in the Pliocene and older Tertiary deposits, but their appearance indicates only sporadic cases of coral growth, such as are observed at the present day on the borders of the reef-seas, or marginal and included reefs of limited extent, similar to those found on the Miocene border of the Atlantic States generally (Maryland, Virginia, North and South Carolina).

4. The formations represented in the State are the Oligocene, Miocene, Pliocene and Post-Pliocene, which follow one another in regular succession, beginning with the oldest, from the north to the south, thus clearly indicating the direction of growth of the peninsula. The successive Tertiary belts do not follow a direct east and west course, but appear to be deflected from the west northeastwards, so as to conform more nearly with the Atlantic coast line on the eastern border of the United States. The amount of overlap possibly resulting from deposition on opposed borders could not be ascertained.

5. No indisputable Eocene rocks have thus far been identified in the State, but not improbably some such exist in the more northerly sections, and possibly include even a part of what has generally been referred to the Oligocene. In how far the older formations were overlaid by deposits of a newer date, or to what extent the northern half of the State may have participated in a general submergence coincidently with the formation of the more southerly portions, remains to be determined.

6. Sedimentation and deposition along this portion of the American coast appear to have been practically unbroken or continuous, as is indicated by the gradational union of the different formations, and the absence of broad or distinct lines of faunal separation.

7. The strata as far as could be ascertained are very nearly horizontal, or dip at only a very moderate angle, but no true or direct line of declination could anywhere be detected. At no locality could any two formations be unequivocally identified as resting one above the other, except in so far as the Post-Pliocene represents one of the factors under consideration.

8. No disturbance of any moment, or one sufficient to sensibly react upon the rock masses, seems to have visited the Floridian region since the initial formation of the present State in the Older Tertiary period. The elevation of the peninsula, especially in its more southern parts, appears to have been effected very gradually, judging from the perfect preservation of most of the later fossils, and the normal positions—*i. e.*, the positions which they occupied when living—which many of the species still maintain.

9. The northern half of the State represents in great part a deep-sea formation, whereas the southern half is marked by deposits indicative of a comparatively shallow sea. It would appear that before its final elevation a large part of the peninsula, especially its southern half, was for a considerable period in the condition of a submerged flat or plain, the shallows covering which were most favorably situated for the development of a profuse animal life, and permitted of the accumulation of reef-structures and of vast oyster and scallop banks. The present submerged plain or plateau to the west of the peninsula may be taken to represent this condition. Fresh-water streams, and consequently dry land, existed in the more southern parts of the peninsula during the Pliocene period, as is proved by the interassociation of marine and fluviatile mollusks in the deposits of the Caloosahatchie.

10. The modern fauna of the coast is indisputably a derivative, through successive evolutionary changes, of the pre-existing faunas of the Pliocene and Miocene periods of the same region, and the immediate ancestors of many of the living forms, but slightly differing in specific characters, can be determined among the Pliocene fossils of the Caloosahatchie. The doctrine of evolution thus receives positive, and, most striking, confirmation from the past invertebrate fauna of the Floridian region.

11. Man's great antiquity on the peninsula is established beyond a doubt, and not improbably the fossilized remains found on Sarasota Bay, now wholly converted into limonite, represent the most ancient belongings of man that have ever been discovered.
