

CHAPTER XIII.

THE CRETACEOUS FORMATIONS; SERIES X.

1081. We come now to the comparatively unconsolidated strata of West Tennessee. (§ 272.) The formations hitherto considered are made up of solid rocks, and belong to the second great division of geological time, the *Paleozoic*. (See page 156.) The formations to be described in this and in the three following chapters, appertain to the *Mesozoic and Cenozoic* divisions, and some of the recent alluvial beds, to the *Age of Man*.

1082. The place of the *Cretaceous formations* in the complete geological column, (see pages 154 and 155,) is some distance above that of the *Coal Measures*, the interval being occupied by several heavy formations. In Tennessee, however, this interval is vacant, and we pass abruptly from the Coal Formation to the Cretaceous, no strata of the *Permian, Triassic and Jurassic* formations, appearing.

1083. In traveling westward from Middle Tennessee, we, very soon after passing the Tennessee River, meet with a line along which the older formations are suddenly and deeply beveled off. This has been already spoken of in §§ 272 and 832. This slope was perhaps the shore of the arm of the Atlantic mentioned in § 331. It is now, for the most part, the eastern rocky side of a deep trough, in which lie the stratified sands, clays, marls and loams of Western Tennessee and Eastern Arkansas. See also § 326, and the paragraphs referred to.

1084. The topographical features of West Tennessee have been given in the First Part of the Report. §§ 272-294. The reader is also referred to the Map and the section at its base, as well as to the diagram following.

1085. The *Cretaceous Series* includes in Tennessee, the following formations:

10,c. *Ripley Group*, (provisional.)

10,b. *Green Sand*, or the *Shell Bed*.

10,a. *Coffee Sand*.

Each of these, commencing with the lowest, will be the subject of a separate section.

SECTION I.

THE COFFEE SAND; FORMATION 10,a.

1086. This is the oldest member of the Cretaceous Series, outcrops in Hardin and Decatur Counties, and overlaps the western beveled edge of the older rocks. Its outcrop occupies a belt of territory varying from about two to eight miles in width, and running more than half way through the State.* (Sec 10,a. upon the Map.) The diagram on page 413 exhibits the relation this formation sustains to the older rocks and to the *Green Sand* above it.

1087. By referring to the Map it will be seen that the Tennessee River is, with the exception of *a single break in Hardin County*, bordered throughout on the west by a belt of Paleozoic rocks. Along this break the river comes in contact with the strata of the *Coffee Sand*, and washes them for eighteen or twenty miles, presenting, at intervals, several bluffs that exhibit interesting sections.

1088. These bluffs are much alike; they vary from 80 to 100 feet in height, and are capped with a layer of gravel belonging to one of the gravel beds to be described. The principal ones are given on the Map, and are *Coffee Bluff* (sometimes strangely called "*Chalk Bluff*") at *Coffee Landing*, that at *Crump's Landing*, and the one at *Pittsburgh Landing*. The first, which gives name to the bed under consideration, is nearly two miles long. One of its sections will be given below.

*There is some doubt in regard to the northern limits of this and of the succeeding formation. Their limits, as given on the Map north of Beech River, are provisional. The outline given is probably not far from the correct one.

1089. The Coffee Sand consists mostly of stratified sands usually containing scales of mica. Thin leaves of dark clay are often interstratified with the sand, the clay leaves occasionally predominating. Sometimes beds of dark laminated or slaty clay of considerable thickness—from one to twenty feet or more—are met with in the series. It very generally contains woody fragments and leaves, converted more or less into *lignite*. Silicified trunks of trees are not uncommon. The maximum thickness of the series in Tennessee is not known; it is probably not far from 200 feet.

1090. A section of the bluff at Coffee may be taken as a type of the materials and stratification of this group.

- (4) *On top*; gravel and ferruginous conglomerate.
- (3) *Sands*, with thin laminae of slaty clay; much like No. 1 below..... 10 feet.
- (2) *Slaty clay*, with but little sand; contains fragments of wood and leaves..... 20 feet.
- (1) *Gray and Yellow Sands*, interstratified with numerous thin laminae and some thicker layers of slaty clay; strata of sand occasionally from three to six feet, without clay. Leaves, in fragments, and pieces of lignitic wood abundant. Projecting from the mass are the ends of two large trunks, their bark converted into lignite, and their wood silicified.
 Contains pyrite and yields proto-salts of iron and ferruginous waters.
 Extending to the water's edge..... 65 feet.

1091. The following is a section seen at one point of the *Bluff at Pittsburg Landing*.

- (2) *Gravel*, on top,..... 30 feet.
- (1) *Yellow, Red and Orange Sands*, much interstratified with thin laminae of Clay; beds of sand occur, three or four feet thick without the clay laminae, then a bed as thick, or thicker, is full of them. The sands contain occasionally, a thin seam of ferruginous sandstone. But little vegetable matter is seen in this bluff,.....60 to 70 ft.

1092. In low sheltered places the sands in the exposures of this formation are generally dark gray, and contain pyrite. In exposed situations, however, as in old washes or near the sur-

face, their contents become peroxydized, their lignitic matter is removed, (consumed,) and the sands assume brighter colors, becoming white, yellow, red or orange, as the case may be.

1093. Although fragments of leaves are abundant at some localities, yet it is difficult to obtain good specimens. None that I know of have been described. Within the limits of Tennessee I have not found any animal remains in this group. Along the Memphis and Charleston Railroad, in Mississippi, I have seen many imperfect casts of shells in its southern equivalent, the *Tombigbee sand* of Hilgard, which, perhaps, ought to be included in his *Eutaw Group*. One of these was forwarded, with other Cretaceous fossils, to Mr. Wm. M. Gabb, of Philadelphia, who described it as *Volutilithes Saffordi*, giving "Tennessee," by mistake, as the locality. (*Jour. Acad. Nat. Sci.*, [2,] iv, 299.) The specimen was obtained from a cut about three miles and a half west of Burnsville.

1094. Away from the streams there are few characteristic exposures of this formation to be met with. At many points where its strata would otherwise outcrop, everything is covered



with *gravel*. Decaturville is located upon its feather edge, and west of this place its sands and clays are met with, resting upon the Silurian limestones.

1095. It is the formation at *Scott's Hill*, on the road from Lexington to Clifton, and sections of it may be seen in this vicinity.

1096. Following it westward, it runs under the Green Sand, and it is the reservoir yielding water, when the formation mentioned is pierced by the well-borers. (§§ 269-270.)



SECTION II.

THE GREEN SAND, OR SHELL BED; FORMATION 10.*b*.

1097. This is an interesting formation, and has long attracted attention on account of the great number of fossil shells it contains. These occur by cart-loads at some points, and are gathered and burned into lime. It is through this formation that the semi-artesian wells of Hardin, McNairy and Henderson counties are bored. And again, this bed contains grains of a soft greenish mineral, called *glauconite*, which give the mass a greenish color, and hence the name *green sand*. The material of the layers in which grains of glauconite are abundant, is a valuable fertilizer, and is applied like a marl to the lands. Such material, in fact, is often called *marl*.

1098. With reference to the *conspicuous shells*, the "*bald hills*," and the *bored wells* of this formation, see §§ 263 and 264, and also §§ 269 and 270.

1099. At many points along its eastern edge, this formation is seen to rest upon the *Coffee Sand*. Its mass consists generally of fine quartzose sand mixed with clay, forming a clayey sand, which is more or less calcareous. It contains *green grains* throughout, though not abundantly, and fine scales of mica. Owing to the clay present, and a certain degree of induration, the mass is generally firm enough to form the walls of the "bored wells," tubing being dispensed with. When dry, the material of the formation has a greenish gray color, which be-

comes much darker when wet. It has much uniformity in character. That of different layers, however, differs to some extent in hardness, and in the proportional amount of green grains. Some of the harder layers are called "rocks" by the well-borers. There is such a layer very generally at the bottom of the series.

1100. Below the soil, for ten or twenty feet from the surface, the green sand is usually converted, by atmospheric agencies, into a grayish or dirty-buff tenacious material, locally called "*joint clay*," from its tendency to cleave, when losing moisture, in irregular, block-like masses.

1101. It abounds in shells. *Exogyra costata*, *Gryphaea vesicularis*, *Ostrea larva* and *Anomia*, are found at nearly all exposures. Individuals of these species are plentifully strewn over the "*bald hills*," (§ 263,) the large shells being very conspicuous. This formation is pre-eminently the *shell-bed* of the Post-paleozoic beds of West Tennessee. A list of species collected will be given below. It also contains wood and leaves, but not as abundantly as the Coffee Sand.

1102. This bed is the northern extension of The *Rotten* limestone of Mississippi and Alabama. Its outcrop in Tennessee occupies a belt of the surface averaging about eight miles in width for at least half way through the State. (See Map, 10b, and also the diagram just given.) Further north it becomes inconspicuous. Its limits in this direction have not been satisfactorily made out. (See note under § 1086.) The thickness of the formation is known from data supplied by the well-borers. Along the western margin of its outcrop it varies from 200 to 350 feet, the maximum being in the southern part of the State.

1103. The list below contains the species collected by myself from this bed. These, together with the species collected from the succeeding group, were submitted to the examination of Messrs. Conrad and Gabb. The new forms were described by them in the *Jour. Acad. Nat. Sci.*, vol. iv, 2d series. In their descriptions some are referred to wrong localities. The principal and correct localities are indicated upon the Map by small crosses, and will be designated in the list by letters. They are as follows:

- (a.) The first, at the very bottom of the bed, in a cut in the Memphis and Charleston Railroad, about $2\frac{1}{2}$ miles east of Corinth, Mississippi.
- (b.) The "Bald Hills," 14 or 15 miles north of *a*, in Tennessee, and 3 miles northwest of Monterey, in McNairy county.
- (c.) A bank about $2\frac{1}{2}$ miles east of Purdy, Tenn., and very near the top of the bed.
- (d.) A cut in the Memphis and Charleston Railroad, very near the point where the railroad crosses the Mississippi and Tennessee line.

1. *Platytrochus speciosus*, Gabb and Horn,..... *d*.
2. *Corbula crassiplica*, Gabb,..... *d*.
3. *Crassatella vadosa* Mort., (Syn. *C. Ripleyana*, Con.,) *a, c*.
4. *Astarte crinulirata*, Con., *d*.
5. *Venilia Conradi*, Mort., *a, c*.
6. *Cardium abruptum*, Gabb, *c*.
7. *Cardium*. n. sp., casts. ("Common in New Jersey,")..... *a, c*.
8. *Trigonia thoracica*, Mort., *a, c*.
9. *Arca Saffordi*, Gabb,..... *d*.
10. *Nucula distorta*, Gabb,..... *d*.
11. *Cucullæa Tippiana*, Con.,..... *c*.
12. *Ctenoides (Lima) pelagica*, Mort.,..... *a*.
13. *C. reticulata*, Lyell and Forbes,..... *a*.
14. *Pecten virgatus*, Nilsson,..... *a*.
15. *Neithea occidentalis*, Con.,..... *a, b, c*.
(Syn. *P. quadricostata*, Rømer, and perhaps *quinquecostata* of Mort.)
16. *Ostrea larva*, Lam., (Syn. *O. Falcata*, Mort., not Sow.,) *a, b, c, d*.
17. *O. plumosa*, Mort., *a, b*.
18. *O. tecticosta*, Gabb, *a, b, c, d*.
(I think this must be *O. crenulata*, Tuomey.)
19. *Exogyra costata*, Say, *a, b, c, d*.
20. *Graphæa vesicularis*, Lam.,..... *a, b, c*.
(Syn. *O. convexa*, Say, and *G. mutabilis*, Mort.)
21. *G. Vomer*, Mort.,..... *a, b*.
22. *Anomia tellinoides*, Mort.,..... *a, b*.
23. *A. Argentaria*, Mort.,..... *a, b, c, d*.
24. *Placunanomia Saffordi*, Con *a, b, c, d*.
(Syn. *P. lineata*, Con. *P. lineata* can be connected with *P. Saffordi* by intermediate forms. The species is an abundant and variable one. Its individ-

uals are often much larger than those figured. Figure 21, pl. 46, (*Jour. Acad.*, vol. iv.) shows the appearance of the tooth after the *enamel*, that coats the inside of the valves, has been removed. Since the species was described, a few perfect valves have been found. The tooth is a prominent, nearly rhombic boss, the inner angle longer than the one behind and longitudinally striated. One muscular impression nearly central; another nearer the tooth from which the ossified plug appears to start.)

25. *Scalaria Sillimani*, Mort., *a*.
 26. *Natica rectilabrum*, Con., *c*.
 27. *Volutilithes Texana*, Con., *a*.
 28. *Rapa (Pyrula) Richardsonii?* Tuomey, *a*.
 29. *R. trochiformis*, Tuomey, *a*.
 30. *Anchura abrupta*, Con.,
c.
 31. *Baculites compressus*, Say, *a*,
c.
 32. *Enchodus ferox*, Leidy, *b*.
 33. *Sphyræna*, sp ? *a, b*.
 34. *Ischyrrhiza mira*, *b*.

Besides these, I have in my collection from this bed, uncertain species of *Teredo*, *Serpula*, *Rostellaria*, *Fusus*, *Turritella* and *Delphinula*.

SECTION III.

THE RIPLEY GROUP; FORMATION 10,*c*.

1104. This is a provisional series, and is mostly based upon observations made along and in the vicinity of the Memphis and Charleston Railroad. It is only in this region that determinable species have been found, although search has been made elsewhere for them. Its northern extension has been inferred from the general bearings and relations of its strata and of those of the adjacent groups.

Its outcrop occupies a belt of the surface, (10c, 10c, on the Map.) extending through the State, and being, along the railroad, about fifteen miles wide, but having a less average width.

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This belt is, in general, rough and hilly. The high ridges dividing the waters of the Tennessee and Mississippi rivers lie mostly within its area. (§§ 276-278.)

1105. The formation must be of considerable thickness, not less than 400 or 500 feet. It is mostly made up of stratified sands. Occasionally an interstratified bed of dark slaty clay, ten to thirty feet thick, is met with, but more frequently a sandy bed laminated with clayey leaves. In its lithological character, the group is much like the *Coffee Sand*. Its sandy mass, as seen at the surface, is very generally yellow, brown or orange, its contents being peroxydized; occasionally, however, in partially protected or in fresh exposures, its material is dark colored, abounding more or less in fragmentary lignitic matter.

1106. The outcrop of the group very commonly presents layers or masses of ferruginous sandstone, locally indurated by oxyd of iron. This sandstone often occurs in plates, scrolls, tubes and other curious shapes. At some points, especially upon high knobs and ridges, it is found in heavy massive blocks from two or three to fifteen feet in thickness. The occurrence of such sandstone is, however, common to all the sand-formations of West Tennessee. In this group it appears to be especially abundant.

1107. An interesting section of this formation, nearly 100 feet thick, is to be seen at the cut in the Big Hill, a few miles east of Pocahontas, through which the Memphis and Charleston Railroad passes.* The hills about Purdy, in McNairy, and about Lexington, in Henderson, show these rocks well.

1108. In the vicinity of the Memphis and Charleston Railroad, in Hardeman County, there are in the upper part of the series, two local beds; interesting on account of the fossils they contain. The first is a bed of buff gray, impure *limestone*, from two to six feet thick. It is found on both sides of the railroad, near Muddy Creek.† It abounds in two or three species of *Turritella*, (*T. Saffordi*, and *pumilla* of Gabb,) *Ostrea Vomer*,

* This section is noticed by Dr. Hilgard in his Mississippi Report, (p. 16,) who refers its strata to his superficial *Orange Sand Formation*. I cannot agree with my learned friend in this reference. Indeed, I think that much of his Orange Sand is nothing more than the peroxydized outcrops of formations lower than he makes this. I do not deny, however, that within certain limits, there is such a formation.

† On the Map Muddy Creek is the first stream represented east of Middleton.

Mort., claws of a *Calianassa*? (for which I propose the name of *C. Gwyni*,*) and other species. The position of the *limestone* is indicated on the Map by the short, heavy lines near Muddy Creek. It is doubtless the "Turritella" and "Bored" limestone of Hilgard's sections, Nos. 12, 13 and 14; pp. 86-88.

1109. The second is a bed of clayey sand with *green grains*.

This has been seen west of the limestone at two exposures; one in a small cut on the railroad, about two miles east of Middleton, the other about two miles south or southeast of Middleton, on a branch of Cypress Creek, (of Hardeman,) and near the "old stage road." Each point is indicated upon the Map by a small cross.

1110. The following is a list of species from the two beds, to which, it will be seen, quite a number of the forms are common. Most of them are described in the *Jour. Acad. Nat. Sci. of Phila.*, vol. iv., 2d series. The localities are (a.) *limestone*; (b.) *sand-bed*.

1. *Corbula subcompressa*, Gabb, b.
2. *Venus Ripleyana*, Gabb, a, b.
3. *Crassatella pteropsis*, Gabb, a, b.
(Conrad had previously given this name to a species of *Crassatella*; *Jour. Acad.*, iv, 279. I therefore propose *C. Gabbi*, for it.)
4. *C. Monmouthensis*? Gabb, b.
5. *Cardita subquadrata*? Gabb, b.
6. *Leda protexta*, Gabb, b.
7. *Modiola Saffordi*, Gabb, a, b.
8. *Ostrea denticulifera*, Con a, b.
9. *O. crenulimarginata*, Gabb, b.
(If No. 8 is referred to the proper species, then *O. crenulimarginata*, Gabb, is, I think, its lower or larger valve.)
10. *Gryphaea Vomer*, Mort., a.
11. *Turritella Tennesseensis*, Gabb, b.
12. *T. Saffordi*, Gabb, a, b.
13. *T. Hardemanensis*, Gabb, b.
14. *T. pumila*, Gabb, a, b.
15. *Natica rectilabrum*, Con., b.
16. *Fasciolaria Saffordi*, Gabb, b.

* Dedicated to Prof. H. A. Gwyn, of Saulsbery, Tennessee.

17. *Neptunea impressa*, Gabb,.....*b.*
 18. *Callianassa?* Gwyni, Safford *a, b.*
 19. *Lamna gracilis?* Ag.,*b.*
 20. *Crocodilus?* (Tooth.)*b.*

It will be seen that but two species of those given, *Gryphæa Vomer* and *Natica rectilabrum*, are common to this group and the Green Sand. Localities in Mississippi, however, furnish series of fossils which unite the groups more intimately. It will be found, perhaps, that the two form, paleontologically, but one formation.

1111. The group also contains wood and leaves. The leaves are generally found in an imperfect condition, and have received but little attention. As the age of the beds containing them are known, their study would be very interesting in connection with that of the leaves of the formation further west, which are of uncertain age.

1112. *Minerals, Materials of Special Use, and Agricultural Features of the Cretaceous Formations.* But few minerals of interest occur in these rocks. The *glauconite* in the Green Sand, is prominent among those that do occur. This is a compound of *silica, oxide of iron, alumina*, more or less, *potash and water*. The fertilizing effects of the *green marl* are, doubtless, due in good part, to the potash, and its commercial value as a fertilizer, depends upon the relative proportion of glauconite it contains. In samples, containing fragments of shells, or decomposing shells, a part of the effect is to be attributed to carbonate of lime. In such cases, the substance becomes, in good part, a true calcareous marl.

1113. Much of the Green Sand is too poor in glauconite to bear transportation. The richest beds are known by their dark green color. The formation is intersected by the Mobile and Ohio, and the Memphis and Charleston Railroads, which renders it accessible. But little use has been made, as yet, of the Tennessee Green Sand. Some experiments were made with it before the war with satisfactory results; and others on a larger scale had been commenced. The matter is worthy of attention. It will be referred to again.

1114. *Pyrite*, in small quantity, is a common mineral in the beds of all the Cretaceous formations, especially at points

where their materials have not been weathered. It is the source of the iron of many chalybeate springs.

1115. *Lignite* is also often met with, generally, however, as carbonized fragments of wood, sticks, pieces of bark, and leaves. I have not met with any considerable beds of this mineral in these rocks.

1116. A considerable belt of West Tennessee, including nearly all of McNairy, the western part of Hardin, much of Henderson, the western parts of Decatur and Benton, and the eastern parts of Carroll and Henry, is underlaid by the Cretaceous strata. Many sections of this area, both upland and valley, present good farming lands, the soil being generally a mellow siliceous loam, with a more or less clayey basis, and adapted to the growth of cotton and corn, and some parts to wheat and allied crops. In many of the valleys where the soils are stiffer, grasses find congenial conditions, and meadows might be established more extensively than they are.

1117. This belt, however, is the roughest part of West Tennessee, and not a few of its ridges are poor. It includes the "Tennessee Ridge" and its ramifications, mentioned in the First Part of the Report. (See §§ 276 to 278, inclusive.)