GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

NOTES

ON THE

ROCKS OF CENTRAL KENTUCKY.

WITH

LIST OF FOSSILS.

BY W. M. LINNEY.

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INTRODUCTORY LETTER.

Hon. JOHN R. PROCTER, *Director Kentucky Geological Survey:*

DEAR SIR: I herewith submit a few notes on the rocks of Central Kentucky, a list of fossils collected from them, and a brief discussion of some of the problems connected with the geology of that region.

Yours truly,

W. M. LINNEY.

HARRODSBURG, KY., Nov., 1882.

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NOTES ON THE ROCKS OF CENTRAL KENTUCKY, WITH LIST OF FOSSILS.

The detailed work on the geology of Madison, Garrard, Lincoln, Boyle, Mercer, Washington, and Marion having been completed, and partial examinations made in some of the contiguous counties, a few general notes are now offered as bearing upon the geological problems of the State. The minor details of those investigations will be seen by consulting the reports on the above named counties.

The bedded rocks which come to the surface in this district amount in thickness to over twenty-one hundred feet; and when referred to the different formations, are divided as follows:

Carboniferous	100 feet.
Subcarboniferous	570 "
Devonian	65 "
Upper Silurian	100 "
Lower Silurian	1,330 "
Total	2,165 feet.

The rocks of the Lower Silurian age, which lie at the base of the section, are composed of the following subdivisions:

HUDSON RIVER GROUP.		
Upper Beds	325	
Middle Beds	150	
Lower Beds	200	
		675
TRENTON GROUP.		
Trenton Beds	175	
Birdseye Beds	130	
		305
CANADIAN GROUP.		
Chazy Beds		350

The greater part of these beds agree closely in lithological characters with their equivalent horizons in New York as they have been described in the reports on the geology of that State. So close is this correlation in many particulars that the same physical conditions must have existed over the two regions during the same periods of time.

The Chazy limestones in New York are described as *heavy-bedded, strong, tough stones, filled largely with fucoids and having Maclurea magna as their most characteristic fossil—the top layer plated with chert.*

The Birdseye limestone is characterized as *compact in structure, breaking with a conchoidal fracture—brittle, pure, susceptible of a good polish; the only crystalized particles are where fossils have been inclosed. It has a slight translucency, and there are ten feet of buff limestones in its lower part.*

Those descriptions apply equally well to the groups as seen in Kentucky.

When we come to examine the Trenton Group, the analogies are not so close throughout. Yet we have in the lower part some heavy beds marked by oblique lines of deposition, and some of the fossils beside, which mark the Black River division—*thin shaly layers, a bituminous layer, black shale, black limestones, breccia and heavy semi-crystalized grey limestones near the top*—are some of the other similar features.

It is probable that the grey limestone in the upper part of the Trenton in New York is the same as that which lies near the top of the same group in Central Kentucky; and if so, it must have been of vast extent, as it is seen near Cumberland Gap, in East Tennessee, includes the Capitol limestone at Nashville, and, doubtless, the building stones quarried at Point Pleasant, on the Ohio river above Cincinnati.

The dove-colored limestones lying at the top of the Trenton in Mercer, Garrard, and Boyle counties, which I have termed the Upper Birdseye, are a local phase; they soon run out, leaving the Hudson River Group resting upon the Trenton rocks, without a great change in their lithological characters. This was a condition highly favorable for the preservation of many Trenton species, by allowing their extension into the Hudson River Group.

The lithological characters of the Utica Slate Group, as seen in the East, are not distinguishable here. The Lower Hudson River beds contain some of its graptolites and a few others of its fossils.

In comparing the descriptions of the Lorraine shales of New York with the features of the Middle beds of the Hudson River, as displayed in this part of Kentucky, the relationship seems complete. They are described as *brown or yellowish brown on exposure, and so liable to disintegration that streams passing over them have so channeled them that free communication between them is prevented. A peculiar feature is the cone in cone structure exhibited in one of the layers.*

Whoever has attempted to pass over the Middle beds of the Hudson River Group, as presented in the Sugar Creek valley of Garrard county, would not desire other words to describe them.

The upper member of the Hudson River Group in New York contains a great number of fossils in its lower section, and the grey sandstone of Oswego in its upper. In Kentucky we have a wonderful development of fossils in the lower part and in the Cumberland sandstone, near the top—one well marked feature of the Oswego sandstone—*a greenish fine-grained sandstone, nearly destitute of fossils, and with yellow and green specks through it.*

In the following catalogue of fossils, which have been collected from the Lower Silurian rocks in Central Kentucky, the species are arranged under the divisions from which they were taken, and to some extent as they are vertically distributed. The latter arrangement is difficult, as often a number of forms are associated at the same horizon; and again, the position of fossils in a group could not be accurately determined, and a note was not always made. So this arrangement is not altogether satisfactory. Should this region ever receive from collectors that careful scrutiny which has been given to other localities, the number of species will be largely increased. I am much indebted to Prof. R. P. Whitfield, of New York City, Mr. U. P. James and Dr. R. M. Byrnes, of Cincinnati, for the identification of a number of forms:

UPPER HUDSON RIVER BEDS.

1. Tetradium minus (Safford).
2. Columnaria alveolata (Hall).
3. C. stellata (Hall).
4. Columnopora cribriformis (Nich.
5. Beatricia nodulosa (Billings).
6. B. undulata (Billings).
7. Streptelasma corniculum (Hall).
8. Gomphoceras eos (H. &. W.)
9. Buthrotrephis subnodosus (Hall).
10. Pasceolus globosus (Billings).
11. Strophomena rhomboidalis (Sowerby
12. Palæophyllum divaricans (Nich.)
13. Rhynchonella capax (Conrad).
14. R. dentata (Hall).
15. Arthraria biclavata (Miller).
16. Modiolopsis pholadiformis (Hall).
17. Orthis dentata (Hall).
18. Heterospongia subramosus (Ulrich).
19. Ambonychia alata (Meek).
20. Modiolopsis truncata (Hall).
21. Murchisonia milleri (Hall).
22. Streptorhyncus sulcatus (Vern.)
23. S. sinuatus (Em.)
24. S. planumbonus (Hall).
25. Strophomena alternata (Con.)
26. Asaphus gigas (De Kay).
27. Acidaspis anchoralis (Miller).
28. Calymene senaria (Con.)
29. Ceraurus pleurexanthemus (Green).
30. Orthis retrorsa (Salter).
31. O. occidentalis (Hall).
32. O. acutilirata (James).

33. O. laticosta (James).
34. O. insculpta (Hall).
35. O. sinuata (Hall).
36. O. lynx (Van B.)
37. Chætetes alter (Ulrich).
38. C. dalei (E. & H.)
39. C. ortoni (Nich.)
40. C. petechialis (Nich.)
41. C. nodulosa (Nich.)
42. Zygospira modesta (Say).
43. Strophomena nasuta (Con.)
44. Crania scabiosa (Hall).
45. Agelacrinites cincinnatiensis (Roemer).
46. Megambonia jamesi (Meek).
47. Serpulites jamesi (Nich.)
48. Cyclonema fluctuatum (James).
49. Hippothoa inflata (Hall).
50. Alecto confusa (Nich.)
51. A. arachnoidea (Hall).
52. Pterina demissa (Hall).
53. Stellipora antheloidea (Hall).
54. Conchicolites corrugatus (Nich.)
55. Protarea vetusta (Hall).
56. Retepora angulata (Hall).
57. Orthis linneyi (James).
58. Cyrtoceras vallandinghami (Miller).
59. Ptilodictya hilli (James).
60. Pt. falciformis (Nich.)
61. Streptorhyncus planoconvexus (Hall).

MIDDLE HUDSON RIVER BEDS.

1. Streptorhyncus planoconvexus (Hall).
2. Strophomena squamula (James).
3. S. alternata (Con.)
4. Orthoceras halli (Miller).
5. Ambonychia costata (James).
6. Calymene senaria (Con.)

LOWER HUDSON RIVER BEDS.

1. Leptæna sericea (Sow.)
2. Zygospira cincinnatiensis (James).
3. Chætetes tuberculatus (James).
4. Bellerophon bilobatus (Sow.)
5. Stromatopora scabra (James).
6. Dalmanites carleyi (Meek).
7. Climacograptus bicornis (Hall).
8. Heterocrinus simplex (Hall).
9. H. simplex var. grandis (Meek).
10. Ceramopora concentrica (James).
11. Chætetes clathratulus (James).
12. C. approximatus (Nich.)
13. Asaphus gigas (De Kay).
14. Orthis emacerata (Hall).
15. O. multisecta (James).
16. Palæophycus flexuosum (James).
17. Trematis punctostriata (Hall).
18. T. millepunctata (Hall).
19. Trinucleus concentricus (Eaton.)
20. Ceramopora multipora (James).
21. Palæophycus tubulare (Hall).
22. Conularia trentonensis (Hall).
23. Orthodesma contracta (Hall).
24. Ptilodictya shafferi (Meek).
25. Pt. arctipora (Nich.)
26. Beyrichia chambersi (Miller).
27. Acidaspis crossotus (Locke).
28. Cyclonema percarinatum (Hall).
29. Pholodops cincinnatiensis (Hall).
30. Telinomya obliqua (Hall).
31. Hyolithes americana (Billings).
32. Modiolopsis cancellatus (?) (Walcott).
33. Lingula covingtonensis (H. & W.)
34. Butrothrephis ramulosa (Miller).
35. Chætetes briarius (Nich.)
36. Leptobolus lepis (Hall).

37. Graptolithus gracilis (Hall).
38. Cyclora minuta (Hall).
39. C. parvula (Hall).
40. Lichenocrinus crateriformis (Hall).
41. Stellipora autheloidea (Hall).
42. Stenopora fibrosa (Gold.)

TRENTON LIMESTONES.

1. Stromatopora rugosa (Hall).
2. Columnaria alveolata (Hall).
3. Brachiospongia digitata (Owen).
4. Orthis borealis (Billings).
5. O. lynx (small form) (Von B.)
6. Rhynchonella increbescens (Hall).
7. Tetradium fibrosum (Saff.)
8. Endoceras magnumventrum (Hall).
9. Murchisonia gracilis (Hall).
10. M. perangulata (Hall).
11. M. bellicincta (Hall).
12. Arthraria antiquata (Billings).
13. Bucania bidorsata (Hall).
14. Raphistoma lenticularis (Sow.)
15. Lingula attenuata (Sow.)
16. L. quadrata (Eich.)
17. L. riciniformis (Hall).
18. Cyrtolites compressus (Con.)
19. C. ornatus (Con.)
20. Ceraurus pleurexanthemus (Green).
21. Lichas trentonensis (Con.)
22. Asiphus gigas (De Kay).
23. Calymene senaria (Con.)
24. Bellerophon bilobatus (Sow.)
25. B. troosti (Saff.)
26. Murchisonia umbilicata (Hall).
27. M. vittata (Hall).
28. M. tricarinata (Hall).
29. Telinomya ventricosa (Hall).

30. Leperditia canadensis var. (Jones).
31. Modiolopsis winchelli (Saff.)
32. Orthis clytie (Hall).
33. Ambonychia undata (Emmons).
34. Orthoceras capitolinum (Saff.)
35. Endoceras proteriforme (Hall).
36. Ormoceras tenuifilum (Hall).
37. Orthoceras undulostriatum (Hall).
38. Cypricardites ventricosum (Hall).
39. Bathyurus sextans (Hall).
40. Chætetes whiteavesi (Nich.)
41. C. multitabulata (Ulrich).
42. Pleurotomaria rotuloides (Hall).
43. Telinomya alter (Hall).
44. Strophomena alternata (Con.)
45. S. alternistriata (Hall).
46. Aulopora arachnoidia (Hall).
47. Lichenocrinus crateriformis (Hall).
48. Telinomya levata (Hall).
49. Zygospira modesta (Say).
50. Subulites elongata (Hall).
51. Heterocrinus heterodactylus (Hall).
52. Intricaria reticulata (Hall).
53. Chonchicolites flexuosus (Hall).
54. Conularia trentonensis (Hall).
55. Stictopora elegantula (Hall).
56. Raphistoma subtilistriata (Hall).
57. Ambonichia bellistriata (Hall).
58. Receptaculites neptunii (?) (DeFrance).
59. Trinucleus concentricus (Eaton).
60. Echino-encrinites anatiformis (Hall).
61. Streptelasma corniculum (Hall).
62. S. profundum (Hall).
63. Leptæna sericea (Sow.)
64. Orthis pectinella (Con.)
65. O. tricenaria (Con.)
66. O. testudinaria (Dal.)

67. Palæophycus simplex (Hall).
68. Callograptus (near elegans) (Hall).

BIRDSEYE LIMESTONE.

1. Phytopsis tubilosum (Hall).
2. Orthoceras multicamaratum (Hall).
3. O. amplicamaratum (Hall).
4. O. fusiforme (Hall).
5. Endoceras tenuiseptum (Hall).
6. Ormoceras tenuifilum (Hall).
7. Ptilodictya ramosa (Hall).
8. Trochonema umbilicata (Hall).
9. Buthotrephis gracilis (Hall).
10. Murchisonia angustata (Hall).
11. M. perangulata (Hall).
12. Leperditia canadensis (Jones).
13. Asaphus extans (?) (Hall).
14. Heterocrinus Milleri (Wetherby).
15. Ptilidictya acuta (Hall).
16. Columnaria alveolata (Hall).
17. Trochonema umbilicata (Hall).
18. Murchisonia ventricosa (Hall).
19. M. subfusiformis (Hall).
20. Pleurotomaria subconica (Hall).
21. Strophomena filitextua (Hall).
22. S. camarata (Hall).

CHAZY LIMESTONE.

1. Maclurea magna (Les.)
2. Asaphus marginalis (Hall).
3. Rhynchonella plena (Hall).
4. Retepora reticulata (Hall).
5. Orthis costalis (Hall).
6. Leperditia canadensis (Jones).
7. Rhynchonella (near recurvirostra).
8. Columnaria, with very large cells.

I am under especial obligation to Prof. A. G. Wetherby, of Cincinnati, Ohio, for a list of the following species, which he collected from the strata underlying the Hudson River Group in Mercer and Jessamine counties:

Blastoidocrinus carchandeus (Billings).
Hybocrinus tumidus (Billings).
Hybocrinus conicus (Billings).
Amygdalocystites florealis (Billings).
Amygdalocystites radiatus (Billings).
Hybocystites problematicus (Wetherby).
Heterocrinus Milleri (Wetherby).
Glyptocrinus priscus (Billings).
Porocrinus conicus (Billings).
Carabocrinus radiatus (Billings).
Palæocrinus angulatus (Billings).
Dendocrinus acutodactylus (Billings).
Cleiocrinus regius (Billings).
Rhodocrinus gigas (Billings).
Colpoceras virgatum (Hall).
Cypricardites obtusus (Hall).
Cypricardites cardiformis (Billings).
Conularia quadrata (Walcott).
Orthis perveta (Conrad).
Strophomena incrassata (Hall).
Streptorhyncus fillitextus (Hall).
Streptorhyncus subtendus (Conrad).

Beatricea.—This curious palæontological puzzle is seen in numbers through several counties, always at the top of the Hudson River Group. This fossil must be referred to one species only, as single specimens exhibit every character given to both specific names. Mr. W. T. Knott, of Lebanon, Kentucky, and myself have examined the conditions in which it exists in the beds, and have come to the conclusion that it can only be a cast of the creeping stems of some plant which grew on an old reef now marked with *Columnaria*, *Columnopora*, *Tetradium*, and *Streptolasma* corals.

Orthis borealis is a common shell near the top of the Trenton, occupying a vertical range of only a few feet, but seen wherever its horizon is exposed.

Orthis clytie is found in a somewhat lower horizon, but is exceedingly limited in its vertical distribution.

Orthis lynx, of a small form, such as is figured in the New York Report, is found near the top of the Trenton, but is not seen again until near a hundred feet of the Upper Hudson River beds are passed, when it reappears, but of thrice its former dimensions.

Columnaria alveolata, which is seen with very large cells in the Chazy, is found in the Birdseye, in the base and at the top of the Trenton, and it is not again encountered for nearly seven hundred feet, when it reappears at the top of the Hudson River Group. There is an interval of nearly eight hundred feet between the horizon where *Streptolasma corniculum* is seen in the Trenton and where it is again found at the top of the Lower Silurian.

Upper Silurian.—The rocks of the Upper Silurian age thin out from New York towards the Southwest, and largely lose their group characters. They are absent at St. Louis and to the southeast of Nashville, are patch-like in Ohio, Indiana, and northwest of Nashville, and such is their appearance in Central Kentucky. No satisfactory division of their groups has been made in the Ohio valley. Their distribution seems to have been made or modified by the causes which gave such near conditions as existed between New York and Kentucky during the Lower Silurian age.

The Medina sandstones are formed of materials transported from a distance and probably left as a reef accumulation. The clay of which the shales (Clinton or Medina?) are formed also had a foreign origin, and were deposited in perhaps unconnected patches. The Niagara and the Oriskany are in small force, and not at all times distinguishable. All of those appear to have been heavier and more connected toward the north than toward the south of Central Kentucky.

Devonian.—The Corniferous limestone, in which a mingling of Corniferous and Hamilton fossils appear, is only ten to fifteen feet in thickness in this district; yet it is seen everywhere that its horizon is reached. The black slate is remarkably uniform, having a thickness of about fifty feet, wherever seen, from Madison to Marion county.

Carboniferous Age.—The rocks of the Carboniferous present no strong features to distinguish them from what is known of them in other parts of Kentucky and in the adjoining States.

Physical History.—The lowest rocks brought to view in the State are the Chazy Limestones, seen near the mouth of Cooper's Branch, on the Kentucky river, at an elevation of five hundred and twenty-five feet above the level of the ocean. Within a distance of six miles, one may pass from those, over all the intervening groups, and stand seventy-five feet above the base of the Subcarboniferous Group. From this position may be seen, at no great distance, an elevation whose top contains rocks belonging to the Coal Measures. Or, in other words, a section of country would be presented in which more than twenty-one hundred feet of rocks were exposed. If those rocks were all horizontal, they would form an important elevation here, but they are not; they are seen dipping toward the southeast—the lower disappearing beneath the upper—until all save the higher ones are lost to view. If we should follow those upper rocks farther to the southeast, we would find them sinking beneath others in turn until we stood at the top of the present Coal Measures in Kentucky, four thousand feet above the Chazy Limestones.

If we should have examined those series as we went over them, we should have observed that, although there were some changes of dip to the northwest, yet they all conformed to the same slope, an evidence that the force which made this great displacement of matter acted upon it all at the same time and in the same way. It seems evident that when the coal-making period had ceased its labors over what is now Central

Kentucky, the Chazy Limestones were four thousand, perhaps five, or even six thousand feet beneath the surface. If this be true, a vast amount of matter has been removed from over the present surface of the Lower Silurian region of Kentucky. For this work only time and force were required, if the conditions were favorable. As greater erosions are recorded as having occurred elsewhere since the Carboniferous era, the question of time may be waived. The same forces—heat, cold, wind, and water—which war upon and destroy the surface of the earth to-day, were the only agents required. For the causes which produced the favorable conditions leading to such denudation, we must look into those great movements which thrust up the earth along certain lines, fracturing and crushing the rocks until their degradation and removal is comparatively easy.

There are three principal lines of disturbance which have originated and produced the present surface features of Kentucky: the Cumberland Mountain Fold, along whose axis flows Powell river; the "dome-like" elevation in Middle Tennessee; and a line of uplift in Central Kentucky which I have named the KENTUCKY ANTICLINAL. The first is well known; the second and third have had their relations thoroughly misunderstood. The first has determined the features of Southeastern Kentucky; the second modified the south-central part of the State; while the third determined the remainder, and extended its effects north of the Ohio into other States.

If we draw a line through a map of Kentucky, beginning near the mouth of the Little Sandy river and ending at the Tennessee border where it is nearest to Clarksville, it will be nearly coincident with the KENTUCKY ANTICLINAL. This disturbance is a well marked axis from which the rocks incline in two directions—strongly to the southeast, and more gently to the northwest.

The higher portion of this elevation extends through Montgomery, Clark, Fayette, Jessamine, Garrard, Boyle, and Marion counties, its apex being near Camp Nelson, on the Kentucky river. If we could restore to this denuded area the removed rock masses of the Lower Silurian, the thickness of which may be seen at a short distance, we would have the top of the Hudson River Group elevated one thousand eight hundred and fifty-five feet above the sea level, with a continuous dip toward the north, amounting along its highest line to seven hundred feet at Cincinnati, and nine hundred and twenty-nine feet at Dayton, Ohio. A more northwesterly dip would be toward Louisville, and that reaches to fifteen hundred feet. The latter was probably an average dip for a long time; the former having been modified by subsequent elevations along the Lake Region.

To the southeast of this Anticlinal the rocks through the counties named have a dip which averages a hundred feet to the mile, for six or seven miles; after which they are brought up by a slight fold, and then dip away again to the southeast. From Camp Nelson to Livingston, on the Rockcastle River, this dip amounts to fifteen hundred feet in less than thirty five miles.

A good idea of the lower structure of this uplift is seen on the Kentucky river. In going up that stream from Camp Nelson, six hundred feet of rocks can be seen sinking beneath the water in five miles. And here, instead of the massive walls of the Chazy rising perpendicular from the river's edge, one would be among the rounded hills made from the soft shales of the Hudson River Group. In going down the river the Chazy would disappear in Anderson, the Birdseye in Franklin, the Trenton in Henry, and so on till at the Ohio, the Upper Hudson River beds would alone be seen.

It is to this disturbance, and to it alone, must be referred the conditions which allowed the degradation of the blue limestone area of Kentucky, Ohio, and Indiana. Protected in the synclinals which lay to the southeast, the rocks have not been so extensively eroded in that direction. But, with an unprotected slope toward the northwest, down which the crushed and shattered rocks and shales and coals could be carried by the rains which fell and the waters that poured through the transverse fractures of this arch, their denudation was easy in that direction.

The erosion is the greatest immediately over the axis of this uplift, and gradually becomes less to the northwest. In Central Kentucky it reaches to the Canadian Period, in Northern Indiana to the Upper Silurian. Evidently the uplift was gradual, and consumed much time in its completion, thus, in part, accounting for the progressive denudation of the surface.

The Kentucky river and a number of other streams cross this Anticlinal in transverse fractures. The Cumberland river flows for part of its length in the synclinal between the Tennessee and the Kentucky uplifts, and, in fact, nearly every stream in the State has been determined or largely modified by the Kentucky Anticlinal. A careful study of its relations will alone solve many problems whose difficulties have been unsolved, and determine some facts which have been obscured by fallacious reasonings.