

1912

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Recommended Citation

Keyes, Charles (1912) "Nether Delimitation of Our Carbonic Rocks," *Proceedings of the Iowa Academy of Science*, 19(1), 153-156.

Available at: <https://scholarworks.uni.edu/pias/vol19/iss1/25>

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NETHER DELIMITATION OF OUR CARBONIC ROCKS.

BY CHARLES KEYES.

The exact stratigraphic relations of, and the exact boundary line between, the latest Devonian formations and the earliest Carbonic rocks of the Mississippi valley north of the Missouri river have long remained some of the unsolved geographic problems. That the question should stand today much as it did 60 years ago is due chiefly to the circumstance that although three state geological surveys have repeatedly attacked it all the necessary facts were not available in any one state alone. No observer seems to have had the opportunity to make critical investigations in all three of the states or to have gone over all of the ground between the mouth of the Missouri river and the Minnesota line.

Recently during the progress of certain investigations for city water supplies in Iowa, Missouri and Illinois, it became necessary to make some rather nice calculations on the thickness and extent of sundry geologic formations. In the course of this work a number of facts were disclosed bearing directly upon the vexed problems mentioned. There are given us for the first time definite data upon the actual stratigraphic relations existing between the rocks of the two distinct geologic ages.

The general geologic section of the Devonian-Carbonic rocks of southeastern Iowa and northeastern Missouri is as follows:

General Geologic Section.

CARBONIC:

Burlington limestone	Feet—
Chouteau limestone	10
Hannibal shales	75
Louisiana limestone	50
Saverton (blue) shales*	50
Grassy (black) shales	40

UNCONFORMITY.

DEVONIC:

Lime Creek (blue) shales	125
Cedar limestone	—

The stratigraphic relations of the several terranes are best shown in cross-section as they are plotted along the line of the Mississippi river from Louisiana, Missouri, to Muscatine, Iowa. (Figure 1.)

Detailed vertical sections I have given in another place†. At this time the shales lying at the base of the Louisiana limestone were little considered, since at the town of Louisiana they were only two feet thick and the northern

*This name is the local one usually applied the blue shales lying between the Grassy black shales and the Louisiana limestones as well exposed at Saverton station in Ralls county, Missouri. The formation probably attains a maximum thickness of at least 75 feet.

†Bull. Geol. Soc. America, Vol. III, p. 283, 1892.

localities were not yet carefully studied*. Comparisons of the Iowa and Missouri sections are made in the report on the geology of Des Moines county†. At one time‡ it seemed that upon faunal grounds the Kinderhook shales as exposed at Louisiana could just as well be included in the Devonian section, but this old view long since gave way to the stratigraphic evidence.

The Chouteau limestone is quite thin on the Mississippi river, but rapidly becomes thicker to the westward. At Louisiana the Hannibal shales are 75 feet thick; at Keokuk, 65 feet; at Burlington about 50 feet of the blue shales in the base of the river-bluffs are assignable here. The Louisiana limestone which is 50 feet thick at the type-locality, becomes gradually thinner northward, until at Keokuk it is only 10 feet in thickness, and soon vanishes altogether, as shown by well-sections. This permits the overlying and underlying shales of Missouri to come together in Iowa and form one continuous shale-section.

Immediately beneath the Louisiana limestone at the original locality are two feet of blue shales. This apparently insignificant layer is usually included with the Grassy black shales below§. It now seems to have much greater importance. Northward from Louisiana these shales rapidly become thicker. At Hannibal they measure 50 feet in thickness; at Keokuk probably not less than 50 feet; beyond, they merge with the Hannibal shales.

The Grassy black shales|| are only four feet thick at Louisiana. They attain a greater vertical measurement northward. Before disappearing below river-level in the Keokuk syncline, they reach a thickness of 30 feet. In well-sections at Keokuk they have not been definitely recognized or separated from the associated shales. At Morning Sun, north of Burlington, they are distinctly present in a number of deep-well sections. They have been traced further north to beyond Muscatine, where Udden** has given them the title of Sweetland beds. Here they are 45 feet thick; rest in notable unconformity upon the Cedar limestones; and have resting upon them unconformably the Des Moines coal measures.

Below the black shales there are still other blue shales. They are not exposed above river-level at either end of the syncline; but as shown in deep-well sections, at Keokuk, there are at least 125 feet referable to them; at Burlington about 100 feet; and at Morning Sun, 50 feet. When the Iowa†† and Missouri‡‡ reports were printed it was surmised that this part of the great shale-section at Burlington rested directly upon or was an integral portion of the shales called farther north the Lime Creek formation. Since that time this view has proved to be really correct. The shales in question actually continue in full development to the Minnesota boundary. They rest on the Callaway limestone in Missouri, which appears to be the exact equivalent of the Cedar limestone in Iowa.

The Grassy shales are of exceptional interest since, in spite of their associated faunal asperities, they probably represent the basal member of the Carbonic

*American Geologist, Vol. X, p. 384, 1892.

†Iowa Geol. Surv., Vol. III, p. 436, 1894.

‡Trans. St. Louis Acad. Sci., Vol. VII, p. 369, 1897.

§Proc. Iowa Acad. Sci., Vol. V, p. 66, 1898.

||Proc. Iowa Acad. Sci., Vol. V, p. 60, 1898.

**Iowa Geol. Surv., Vol. IX, p. 289, 1899.

††Iowa Geol. Surv., Vol. I, p. 55, 1893.

‡‡Missouri Geol. Surv., Vol. IV, p. 56, 1894.

section of the Upper Mississippi region. At Louisiana these shales recline directly upon Silurian limestones. A few miles away they lie immediately upon the Callaway (Devonic) limestone. Farther on the Lime Creek shales are found immediately beneath. At their base, therefore, a marked unconformity exists, which is also well displayed at the north above Muscatine.

The present correlation of the Grassy black shales seems to set at rest several moot questions. They doubtless represent the Chattanooga black shales which in the south constitute, according to Schuchert*, the base of the Mississippian section.

They are not to be regarded as Devonic in age, as suggested by Udden†. They are not a local development of uncertain affinities as stated by Calvin‡; nor do they underlie the Lime Creek shales as indicated in his general geologic section of Iowa§. It appears that Owen and Norwood||, in drawing the line of separation of the Devonic and Carbonic strata in the Mississippi valley at the black shale, displayed phenomenally keen insight into the real geologic succession in the region.

Particularly noteworthy, the Burlington section remains. When discussing the Devonic Interval in Missouri** I was inclined to regard the entire shale-section between the Cedar limestone and the Chouteau limestone as a distinct unit, Devonic in age, and having intercalated the lens of Louisiana limestone. This conclusion was based largely upon faunal grounds and especially upon the Gomphoceras fauna, then newly found high up in the section at Burlington, and afterwards especially noted by Weller††. This fauna was discovered by me at the time that the report on Des Moines county was being printed‡‡; and six years later the fossils were turned over by Dr. Calvin to Professor Weller for critical examination. As a result, Weller was led to correlate§§ the lithographic limestone (bed 4) of the Chouteau formation, at Burlington, with the Louisiana limestone at the typical locality, and to regard the fossils of the shales as constituting the oldest Kinderhook fauna.

Stratigraphically there seems to be no doubt whatever that Bed 4 at Burlington cannot possibly be the continuation of the Louisiana limestone. Yet, there is really no serious faunal discrepancy in Weller's determinations. That the older fauna—a fauna of marked Devonic aspects—should occur at a stratigraphic horizon higher than that of the Louisiana limestone is not remarkable. It is easily explained. At Burlington the shale succession from the Grassy shales to the Chouteau limestone is uninterrupted; at Louisiana a thick limestone divides the shales. In the north the fauna of the Grassy black shales continued upward unbroken. The Gomphoceras fauna from the shales 40 feet below the Burlington limestone at Burlington is probably the characteristic fauna of the Hannibal shales, although the latter at the typical locality have thus far proved unfossiliferous.

*Bull. Geol. Soc. America, Vol. XX, p. 548, 1910.

†Iowa Geol. Surv., Vol. IX, p. 301, 1899.

‡Journal of Geology, Vol. XIV, p. 572, 1906.

§Iowa Geol. Surv., Vol. XVII, p. 192, 1907.

||Researches on the Protozoic and Carboniferous Rocks of Central Kentucky during the year 1846, 1847.

**Bull. Geol. Soc. America, Vol. XIII, p. 267, 1902.

††Iowa Geol. Surv., Vol. X, p. 69, 1900.

‡‡Ibid., Vol. III, p. 433, 1895.

§§Ibid., Vol. X, p. 70, 1900.

The blue shales below the Grassy shales and above the Cedar limestone show in deep-well sections a thickness of at least 125 feet. They are without doubt a continuation of the Lime Creek shales. Along the Mississippi river they become attenuated towards the northeast and some little distance south of Muscatine and to the south of Hannibal they fail altogether. Fifty miles southwest of the last mentioned place, near Fulton, they appear to be fully represented by the 50 feet of Snyder shales which immediately overlie the Callaway limestone. From Burlington to the northwest they are recognizable as far as Marshall county and characteristic Lime Creek fossils have been taken from well-drillings in this district. From Marshall the belt swerves to the east somewhat and in Floyd county the Kinderhook blue shales directly cover them.

In the delimitation of geologic formations I place far more weight on the stratigraphic evidence of a well-marked unconformity than on the occurrence of a fauna of Devonian aspects high up in the thick shale succession. To me unconformity means more than any other classificatory or correlative criterion*.

*American Geologist, Vol. XVIII, p. 289, 1896.