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## SILURIAN REEFS NEAR TIFFIN, CAREY AND MARSEILLES, OHIO

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In the paper by Cumings and Shrock (1928, p. 614) on Niagaran coral reefs of Indiana and adjacent States, reefs are indicated, on the authority of Winchell (1873), near Tiffin and Carey, Ohio. Recently the writer visited the localities mentioned by Winchell, and confirmed the surmise of 1828 that these structures are reefs.

In his report on Seneca county, Winchell described (p. 615) abnormal dips along the Sandusky river, between Tiffin and Fort Seneca. On page 614 he says, "Throughout the most of this distance the dip of the formation (Niagara) is from five to ten degrees toward the southwest, but with various flexures and undulations in all directions." On page 615 these flexures are described in detail. Winchell did not suspect that these are reef structures. He mentions reversed dips as high as 10 degrees.

This locality was visited by the writer on Oct. 10th, 1929, and studied rather carefully, with the following results.

A few small outcrops may be seen within the city of Tiffin along the edge of the river, below the concrete retaining wall; but nothing of consequence. At the first dam north of Tiffin the dip is slight and the layers of rock not very massive. One-fourth mile north, massive beds of light brown somewhat banded dolomite (Greenfield) are exposed in the east bank of the river, underlain by Niagara (Guelph) to river level. The contact is exposed, and is clean-cut.

At the second dam, and concrete bridge, one mile north of Tiffin, the upper layers, at the east end of the bridge, are thin, even, saccharoidal dolomite, of light gray color. They dip 5 to 6 degrees upstream (south). North of the bridge the dip changes to north (down stream). Under the bridge very massive ledges of ash-colored, saccharoidal, sandy dolomite are exposed in the bed of the river. These ledges are very rough looking, and are probably reef rock. Just north of the west end of the bridge, massive unstratified, very rough, ragged, much brecciated dolomite, full of stromatoporoids, is exposed in the bed and bank of the river. *Pavosites* is also common. This is typical reef-core rock. The overlying layers here dip to the southeast. The reef is apparently a ridge running in a northwest-southeast direction across the river.

Four-tenths of a mile north of this bridge the layers rise again, on the south side of the river opposite the power house, to a dip of 4 degrees south; but within a few rods reverse to a north dip. The rock under the center of this arch is irregular, but not very massive, and is probably just above the core of a reef.

A similar structure appears in the west bank of the river at the old timber dam two-tenths of a mile farther north; and another with very slight dips at the old mill two miles north of Tiffin. At the quarry in the east bank of the river, about two and one-half miles north of Tiffin, the dip is about 2 degrees toward the river (west). Here the floor of the quarry is a massive, light blue brecciated rock, with many druses of well crystallized calcite. It is not certain that this is reef rock.

North of this point the river flows over rock for some distance, but with only slight undulations of the layers.

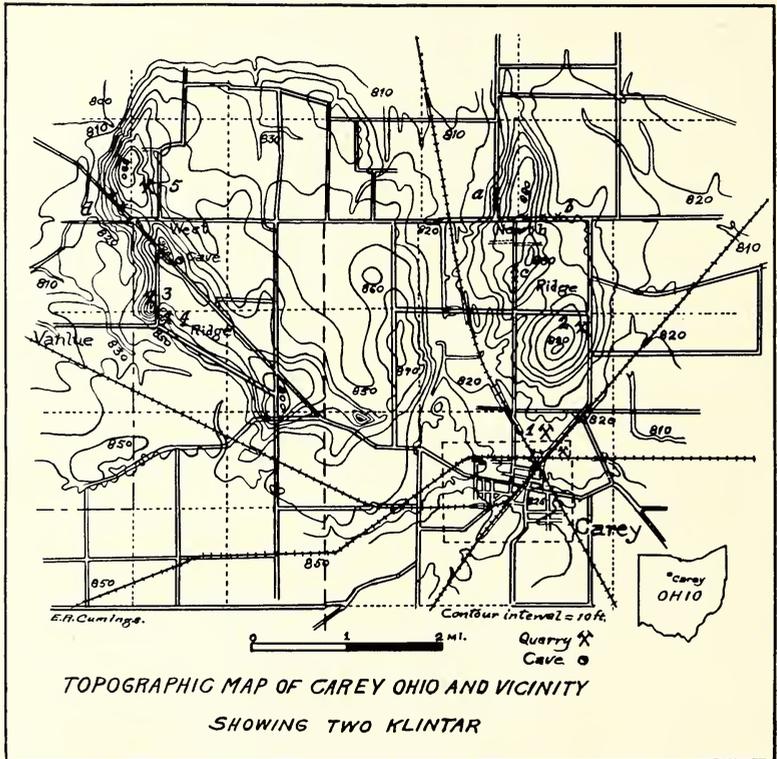


Fig. 1—Topographic map of Carey, Ohio, and vicinity; showing location of the "Limestone Ridges," quarries and other outcrops.

In his report on Wyandot county Winchell (1873, pp. 625-639) described in some detail the peculiar "limestone ridges" north and northwest of Carey, Ohio. On page 627 he says, "The *Niagara limestone* has, near Carey, an unusual and somewhat remarkable exposure. The surface of the country for many miles in every direction is flat, without exposure of rock. At this point the Niagara swells up suddenly in two separate mounds or ridges, which rise so obtrusively that the drift has been in many places entirely denuded. They rise to the height of forty or fifty feet. They are each about five miles long, and are so situated

toward each other, and in relation to the direction of the natural drainage, that they enclose the marsh known as Big Spring Prairie. They are distinguished as the *North Ridge* and the *West Ridge*." On page 628 he gives a rough sketch indicating the position of the ridges, Big Spring Prairie, and the quarries around the edges of the ridges. "In these [quarry] openings the stone appears very different from that seen in bare places higher up the ridges and on their summits, and the dip is uniformly toward the low ground, whatever the position of the quarry." Dips as high as 18 degrees are mentioned (p. 629). Winchell explains these structures (p. 631) as due to a "concretionary and crystallizing force. . . . which, working from below, caused the even beds of deposition to swell upward over the growing mass or masses. . . . the even, friable beds seen in the quarries about their flanks having once been continuous over their summits, but, unable to resist the forces of the glacial epoch, were denuded down to the more enduring rock."

These limestone ridges are mentioned by T. A. Bonser (1903) in his paper on an "Ecological Study of Big Spring Prairie, Wyandot County, Ohio," but without details of the geology. He gives maps showing the ridges and the prairie. Alfred Dachnowski (1912) also mentions the ridges in his report on the peat deposits of Ohio, and states the depth to bed-rock in the prairie between the ridges and to the north of the West Ridge. Outside of Winchell's report there seems to have been no further description of the geology of these exceedingly interesting structures.

The writer visited the locality on Oct. 11th, 1929. Most of the quarries mentioned by Winchell have long since been abandoned; but several newer quarries are in operation; and numerous exposures of rock may be seen along several of the roads that traverse the ridges.

The most interesting and significant exposure is in a recently abandoned quarry a mile north of the large quarry of the National Lime and Stone Company in the north edge of Carey, and just west of the north-south road. (See quarry No. 2 on map, fig. 1). The floor of this quarry is very massive, unstratified, much brecciated, very fossiliferous reef-core rock, the surface of which dips several degrees toward the road (east). The thinner layers above show a slight east dip in the southwest corner of the quarry. This reef rock is full of stromatoporoids, corals (*Favosites*, *Halysites*), and beautiful cross-sections of a large *Megalomus*. There are also many large gastropods. The owner of the farm says that all along the ridge the layers slope down hill, and that in plowing down hill, the plow point "catches the edges of the layers"; but that in plowing up hill it rides smoothly over them. A similar ragged dolomite is seen at the points marked *a b c*, two miles north of Carey.

The National Lime and Stone Company has very large quarries on either side of the railroad tracks in the north edge of Carey. The north quarry (No. 1, fig. 1) is in the Guelph dolomite, except at the southeast corner, where the Greenfield dolomite overrides it. The contact is clear-cut and slopes about 5 or 6 degrees to the south. No Greenfield is seen along the north and west sides of the quarry. The north wall, in the northwest corner of the quarry, shows an east dip, but on the stripped surface just west, the dip is westerly. Thinner layers, due in part to westering, cap the west side. Below these and forming the main wall of the quarry, the rock is exceedingly massive, strongly brecciated, with many fragments of large size, and filled with fossils. *Favosites*, *Halysites* (some very large colonies), gastropods, crinoids, many stromatoporoids, algae (?), and *Megalomus* are the common forms. Portions of the rock are composed entirely

of crinoid segments. It will be seen from the map (fig. 1) that this quarry is on the extreme southern margin of the North Ridge.

Three quarries, the so-called Wyandot Indian cave, and various other outcrops were visited along the West Ridge. These quarries (3, 4 and 5, fig. 1) are in the Greenfield dolomite, except a very small exposure of the Guelph in the east end of No. 3. In numbers 3 and 4 the Greenfield is filled with stromatoporeid bioherms (so-called reefs), which give it an extremely irregular appearance. Some of these are several feet in diameter. There is much brecciation. In the east end of No. 3, near the crusher, the Guelph dolomite, filled with *Favosites*, rises in a cone-like mass of very ragged, brecciated, massive gray rock, extending about half way up the quarry wall. It is overlain with very sharp contact by thin layers of Greenfield dolomite, which slope away more or less in sympathy with the surface slope of the Guelph. This very interesting contact strongly reminds one of the similar abrupt contacts of the Kokomo and Kenneth limestones with the Huntington limestone west of Logansport, Indiana (See Cumings and Shrock, 1928a).

Wyandot Indian cave, managed by Mr. Fred C. Hess, is in the crest of West Ridge, four miles northwest of the center of Carey, on State road No. 15. It is a small but very interesting cave. It was evidently formed before the Glacial Period and partially silted up during that time. Most of the rock exposed in the cave is Greenfield dolomite, very deeply weathered, and filled with irregular bioherms of stromatoporeids, so that the mass has an incomprehensibly tangled and irregular structure. There is intense brecciation. At a few points the Guelph appears to be exposed, but the weathering is so great that this could not be determined with certainty. It is evident that in places the Greenfield caps the ridge. A mile northwest of this point, however, the Guelph appears to extend to the top of the ridge, as it does also on the North Ridge. Quarry No. 5 is in the Greenfield dolomite, and shows much less irregularity of structure than numbers 3 and 4.

It is evident that the two ridges at Carey contain a core of very massive, unstratified, coarse, brecciated, highly fossiliferous Guelph dolomite, rising in numerous places to the crests of the ridges; but flanked, and in some places capped, by unconformable Greenfield dolomite. The flanking rock, and the Guelph itself, wherever the bedding is distinct enough to show it, dip outward toward the low ground, as Winchell long ago pointed out. There can be no doubt that these ridges are klintar, due to the superior resistance of the reef rock of which they are composed. These klintar rise 80 to 100 feet above the Big Spring Prairie on the north and west; and according to the figures of Dachnowski (1912), 90 to 114 feet above the level rock floor beneath the prairie. They stand 40 to 50 feet above the general level of the glacial plain to the south.

In the same report (1873, pp. 631-632) Winchell mentions dips as high as 25 degrees along sections 18 and 13 near the county line in the southwestern part of Wyandot county. The Niagara "here appears as a thick-bedded, gray, and crystalline dolomite." It "rises rapidly. . . . . from below the Water-lime [Greenfield] which lies to the north."

The writer visited this locality on Oct. 9th, 1929, and in company with Mr. Hensel, a life-long resident of the community, saw a number of the outcrops mentioned by Winchell. No dips as high as 25 degrees were seen, however; and neither Mr. Hensel, nor the quarry operators interviewed knew of any such steep dips. On Mr. Hensel's farm a mile southwest of Marseilles, in the extreme northwestern corner of Marion county, the Guelph is exposed in the ditch by

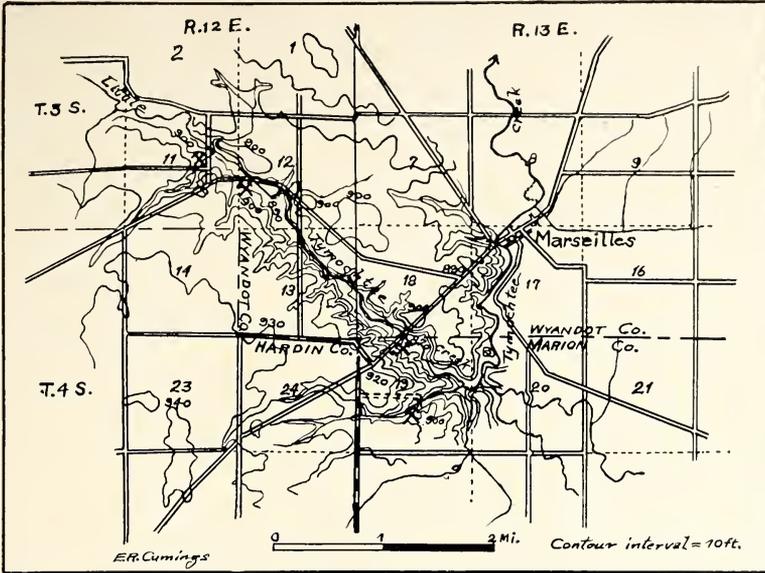


Fig. 2.—Map of Marselles, Ohio, and vicinity, showing location of quarries and outcrops.

the side of the road past Mr. Hensel's house; and in the small gully that leads up the hill from his barn lot, the outcrops running nearly to the top of the hill. The rock along the road is massive and hard, and appears to dip down hill; but the exposure is too limited to permit an accurate determination. At the base of the hill, below Mr. Hensel's house, a small quarry, nearly filled with water, exposes thin bedded Greenfield dolomite. This is 30 to 40 feet lower than the highest outcrops of Niagara. The quarry one and one-half miles southwest of Marselles, in section 19, T. 4 S., R. 13 E., is in rather even bedded, thin, saccharoidal dolomite of typical Guelph lithology. The Gilland quarry, two miles west of Marselles, in section 12, exposes the same kind of rock in the main quarry wall; but the floor of the quarry is in very massive, hard, porous, blue dolomite. The dips are slightly irregular, and this quarry may be underlain by reef rock; but the evidence is not clear. The Herzog quarry, near Patterson, 10 miles northwest of Marselles, shows some arching of the thinner strata near the top of the quarry. The main wall consists of extremely massive, blue, drusy, rough dolomite. This quarry is about 80 feet deep.

It is clear that a ridge of Guelph dolomite rises conspicuously higher in the hills south of Little Tymochtee creek than the outcrops of Greenfield dolomite along the creek. This fact was long ago pointed out by Winchell. In the absence of conspicuous dips, unless those mentioned by Winchell are authentic, it would not be altogether safe to conclude that this is due to reef structures. It is probable that such exist in the locality; but conclusive proof of their presence is not at hand.

The extremely massive character of the Guelph of northwestern Ohio, not only at the localities described above; but at many others, such as Woodville, Genoa, etc., is believed by the writer to be everywhere closely associated with

reef formation. The proven presence of reefs in the Tiffin-Carey area strongly supports this conclusion. Cumings and Shrock (1928) came to the conclusion from their detailed study of the Indiana reefs that in Huntington (Racine-Guelph) time "the reefs. . . . . spread like a Great Barrier Reef over the entire sweep of the shallow waters around the Michigan basin, littering its floor with their pure, calcareous sand, and yielding a congenial habitat to vast swarms of giant brachiopods and massive-shelled molluscs." Clarke and Ruedemann (1903) from general considerations of lithology and faunas and from analogy with known reef formations came to a similar conclusion. On page 121 they say, "In New York the Guelph period was still a time of coral reefs, and the distribution of the peculiar fauna, characteristic of this reef in Ontario and Ohio, shows that probably the entire shallow Guelph basin was more or less studded with coral reefs." And again (p. 135) "Over all this amphitheatre, bounded without by the Niagaran, we may conceive of a shallowing sea, dotted with coral banks which must in no small measure have fringed its shore." So from general considerations these distinguished paleontologists anticipated by a quarter of a century the conclusions now demonstrated by detailed studies such as those of the present paper.

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#### LISTS OF SPECIES FROM THE NEW CORYDON, KOKOMO AND KENNETH FORMATIONS OF INDIANA, AND FROM REEFS IN THE MISSISSINEWA AND LISTON CREEK FORMATIONS

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1. *The New Corydon dolomite.* In our report on the Silurian rocks of northern Indiana (1928), Dr. Shrock and the writer named and described the New Corydon limestone, from outcrops in Huntington, Adams and Jay counties, Indiana. We also listed a fauna of 13 species—all that had been identified from the formation at that time. These species were mostly well known Lockport corals. The fauna and the lithology of the New Corydon, especially its extremely