INSOLUBLE RESIDUES OF DETROIT RIVER AND DUNDEE FORMATIONS

Gerald A. Cooley

INSOLUBLE RESIDUES OF DETROIT RIVER AND DUNDEE FORMATIONS

Gerald A. Cooley

Submitted in partial fulfillment
of the requirements for the degree
of Master of Science in Geology,
University of Michigan, 1947

TABLE OF CONTENTS

ILLUSTRATIONS

Insoluble Residues of Detroit River and Dundee Formations

INTRODUCTION

Statement of the Problem. The determination of the contact between the Dundee and Detroit River formations has long been a problem. Geologists have different opinions regarding the contact of these formations in both outcrop and subsurface studies.

The purpose of this investigation was to study insoluble residues of the Detroit River and Dundee formations to see whether or not there were any definite characteristics of the residues by which the two formations could be separated. This paper is submitted in partial fulfillment of the requirements for the degree of Master of Science at the University of Michigan.

Acknowledgments. For aid in this investigation the writer is indebted to Dr. George V. Cohee, Professor Kenneth K. Landes, Professor George M. Ehlers, and Professor Maurice W. Senstius.

AREAL DISTRIBUTION OF FORMATIONS AND LOCATION OF QUARRIES AND WELL STUDIED

The distribution of the Dundee and Detroit River formations in the area studied is shown in Fig. 1. The formation outcrops extend in a northeast-southwest direction from Amherstburg, Essex County, Ontario, Canada, through Wayne and Monroe Counties, Michigan, and then southward along the boundary of Monroe and Lenawee Counties, Michigan, to Holland, Lucas County, Ohio, where the strike changes to the southwest again. From Deerfield, Monroe, County, Michigan, to Holland, Lucas County, Ohio, the formation outcrops are restricted

to a narrow belt with a north-south strike. The narrow pattern is due largely to the relatively high west dip of the Lucas-Monroe County momocline and to a lesser degree to the thinning of the formations to the south.

The location of the quarries and of the well studied is also shown in Fig. 1. The Sibley quarry is in the NW $\frac{1}{4}$, Sec. 7, T.4S., R.11E., Wayne County, Michigan, about 2 miles north of Trenton, Michigan. The Brunner Mond quarry is about $1\frac{1}{2}$ miles northeast of Amherstburg, Essex County, Ontario, Canada. The Monroe County quarry is $1\frac{1}{2}$ miles south of the Raisin River near the western edge of the French concessions, Raisinville township, about $\frac{1}{2}$ mile east of the northeast corner of Sec. 23, T.6S., R.7E. The French Stone Company quarry and drainage ditch are north of Sylvania Road in Secs. 17 and 18 and south of Sylvania Road in Sec. 20, T.9S., R.6E., Lucas County, Ohio, at Silica, Ohio. In addition to the outcrops studied, the H. R. Ford Well in the NW $\frac{1}{4}$, SE $\frac{1}{4}$, Sec. 23, T.2S., R.10E., Dearborn, Wayne County, Michigan, was studied.

METHODS OF INVESTIGATION

Samples of the outcropping beds were taken at one foot intervals. In the laboratory the samples were examined with a binocular microscope and lithology of each sample described.

The laboratory procedure used in the investigation is essentially the same as that employed by G.E. Eddy.* The sample was broken up into small fragments and approximately 50 grams of material was

*G.E. Eddy: A study of the insoluble residues of the lower Traverse, Bell, and upper Dundee formations of Michigan, Mich. Acad. Sci., Vol. 28, pp. 345-361 (1932).

weighed on an analytical balance to an accuracy of 1/100 of a gram. The sample was placed in a 1,000 cc. beaker and 250 cc. of commercial hydrochloric acid, diluted to half strength, was added. The sample was then placed aside to digest at room temperature. A watch glass was placed over the beaker to hold the material in the beaker in case the reaction of the hydrochloric acid on the limestone was so violent that some of the clay residue might be carried out of the beaker by the effervescence.

After complete digestion the sample was filtered through a filter paper whose weight had been previously determined. Care was taken in transferring the liquid from the beaker to the filter paper so as to prevent tearing of the filter paper, which occurs occasionally when liquid is transferred too rapidly. Next, the residue and filter paper were thoroughly washed after filtration. If any soluble salts were to remain, the weight of the residue would be increased considerably in case the residue were small, thus causing an appreciable error in the subsequent computation of weight-percentages.

The filter paper and residue having been thoroughly washed, they were placed in the oven to dry at about 100°C. After about 6 hours they were removed from the oven, allowed to cool to room temperature, and weighed accurately to the second decimal.

The weight of the residue was obtained by subtracting the original weight of the filter paper from the weight of the filter paper and residue, and its weight-percentage computed. The residue was then scraped from the filter paper and placed in a glass vial for further study.

It was found to be most convenient to run about twenty samples at one operation. While one series of samples was being digested, another series was prepared, filter papers were weighed, and also the residues already obtained.

These residues were examined with a binocular microscope. Low to medium magnification was used in order to obtain a large field and still have sufficient magnification to distinguish the different types of residues. The residues consisted largely of sand, silt, clay, chert, gypsum, and pyrite. The percentage by volume of each was visually estimated in each sample.

Several difficulties were encountered in the residue determination of the well cuttings. In the first place, only a limited supply of samples was obtainable. Where 50 grams had been used in quarry samples, only 5 to 10 grams were available in well cuttings. When the residues were examined under the microscope, it was found that most samples were contaminated with material from the overlying glacial drift. Many of the residues were so highly contaminated that they could not be used, and every residue had some contamination which is reflected in the residue percentage. This explains why the percentage of residue in the Detroit River and Dundee formations is generally greater in the H. R. Ford well than in the outcrop samples.

DESCRIPTION OF ROCKS AND RESIDUES

Sibley Quarry. The Sibley Quarry is in the NW $\frac{1}{4}$, Sec. 7, T.4S., R.11E., Wayne County, Michigan. The strata of the quarry were described by C. F. Bassett* as follows:

* C. F. Bassett: The stratigraphy and paleontology of the Dundee Limestone of southeastern Michigan, G.S.A. Bull. vol. 46, pp. 425-462.(1935)

	Feet	Inches
Dundee Limestone		
25. Limestone, coarsely crystalline, light-gray to grayish white to light buff-gray, becoming darker and more finely crystalline toward the top. Fossiliferous at top.....	24	8
24. Limestone, finely crystalline, gray, weathering to buff. Lower part contains much chert, which is often laminated. On the west side of the quarry the top of this bed forms the present upper floor level. Many fossils are present.....	1	6
23. Limestone, granular with coarse coquina bands, buff-gray. Either this interval or interval 21 below contains the pelecypod Actinodesma occidentale (Hall) which is present in the exposure along Macon Creek..	6	0
22. Limestone, finely crystalline, buff-gray, containing bands of chert and chert nodules. Fossiliferous.	2	0
21. Limestone, coarsely crystalline, grayish-white. Two feet above the base is a zone of Cyrtina, from one to two inches in thickness: at some places in the quarry this zone is absent as the result of stylolitic action. Very fossiliferous.....	8	0
20. Limestone, finely crystalline, gray, having a lumpy appearance when broken. Contains many small and well preserved fossils.....		8
19. Limestone, coarsely crystalline, similar to interval 18 but darker in color.....		10
18. Limestone, finely crystalline, light buff-gray, with numerous small black specks. Small chert nodules scattered in the lower 1½ feet; stylolites abundant in the upper and lower parts. Fossils uncommon.....	5	6
17. Limestone, medium coarsely crystalline, finer than interval 16, light pinkish to buff-gray; minute circular areas of crystalline calcite in the lower 22 inches; lower 41 inches somewhat more finely crystalline and more buff than above. At points, 22, 29, and 39 inches above the base, are layers of chert nodules. The limestone above the chert is light gray and contains numerous dissociated columnals of crinoids, which stand out in relief onthe weathered surface of the rock. The limestone is massive in some places, and in others		

	Feet	Inches
breaks up into a number of thick beds. The upper 1 foot 7 inches of this limestone is light gray and contains numerous shells of fossils. Very fossiliferous.....	9	7
16. Limestone, coarsely crystalline, gray, somewhat finer than below, and containing fewer fossils than interval 15..	1	6
15. Limestone, coarse grained in the upper and lower parts, finer grained in the middle part; buff-gray in color. Coarse grained parts are fossiliferous coquina limestone. The presence of many dissociated columnals of crinoids gives the surface of the limestone a rough appearance. The upper part contains many shells of Rhipidomella variablis Grabau, cup corals, and favosites hemisphericus (Troost). In the lower part, shells of Stropheodonta are more abundant than those of Rhipidomella. The basal six inches of the interval is full of frosted quartz grains, which are sometimes concentrated in shallow depressions in the top of the underlying Anderdon (Detroit River) limestone. This arenaceous band at the base of the interval is the basal sandstone of the Dundee limestone. Distantly spaced chert nodules are present a short distance above and below the juncture of the lower coarse and the middle finer grained parts.....	10	2
Anderdon limestone (Detroit River)		
14. Limestone, finely crystalline, light gray, generally unfossiliferous, but in some places a few impressions of a minute gastropod are found near the top of the bed.....	2	4
13. Limestone, finer grained in the lower and upper parts: coarser grained, with some frosted sand grains, in the middle part; buff in color. Many carbonaceous laminae in the upper and the lower parts. Unfossiliferous.....	4	0
12. Limestone, finely crystalline, dark gray, from two to eight inches in thickness, containing small disseminated crystals of calcite. Unfossiliferous.....		8
11. Limestone, fine grained, light gray, unfossiliferous	4	0
10. Limestone, granular, dark buff at base to light buff-gray at the top. Lowest three inches contains many carbonaceous laminae. Above this is a band, three to four inches in thickness, which contains molds of several species of brachiopods and cephalopods. These species are present in the rock above and below, but		

	Feet	Inches
are less abundant. Most of the interval is characterized by digitate Favosites, and hemispherical and explanate stromatoporoids, in such abundance as to form a biostrome. A small, coarsely plicate Atrypa is fairly common in this biostrome...	5	0
9. Limestone, granular, buff, composed of finely comminuted shells, locally cross-bedded in the lower part. Contains many sand grains, especially in the cross-bedded part. Unfossiliferous.....	5	0
8. Limestone, fine grained, light buff with numerous carbonaceous laminae. Unfossiliferous.....		3
7. Limestone, fine grained, gray-buff, separated into linear and wavy laminae by thin films of carbonaceous matter. Upper three inches has small areas of dark gray limestone, some of which simulate pebbles. Many stylolites are present. Unfossiliferous.....	2	6
Flat Rock dolomite?		
6. Dolomite, finely crystalline, light buff, banded in light and dark shades of this color. Upper four inches has irregular, gray bands which are broken into angular fragments.....	1	3
Floor of Quarry		
5. Limestone, magnesian, fine grained, light buff-gray on weathering shows layers ½ to 4 inches in thickness. Contains many small, irregular shapped masses of calcite. Stylolites present. Unfossiliferous.....	1	0
4. Limestone, magnesian, coarser grained than 3, buff, with laminae of lighter and darker shades. Locally, the laminae are bent and fractured. Contains irregular masses of crystalline calcite. Unfossiliferous.....	4	0
3. Dolomite, exceedingly fine grained, light gray, on weathering shows mottling of pink or black. Unfossiliferous.....		4
2. Dolomite, fine grained, light to dark buff, with irregular shaped masses of calcite. Angular fragments of dolomite present in middle of bed. Unfossiliferous.	3	0
1. Limestone, magnesium, fine grained, dark to light buff, with some calcite geodes. Base below bottom of pump hole.....	1	6
Total Section	105	5

Plate 1. Eastern Face of the Sibley Quarry.

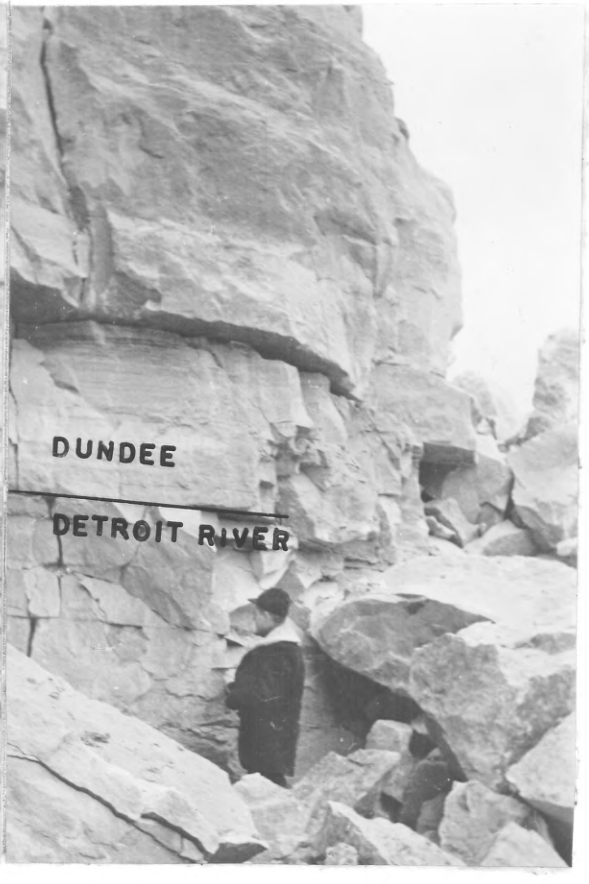

Plate 2. Northern Face of the Sibley Quarry

Dundee-Detroit River Contact in the Sibley Quarry

The full section of rocks in the Sibley quarry was sampled in two places. One section sampled was on the east face, where Bassett described his section, and the other was on the north face. The distance between the two faces is one-half mile. The shatter zone which is so conspicuous on the east face of the quarry is not found on the north face. The stromatoporoid zone, however, is present on both faces and is a good marker, as the contact between the Detroit River and Dundee formations is only a few feet above the top of this zone. On the basis of faunal evidence and the presence of a basal sandstone, Bassett placed the contact at the top of the shatter zone. However, in sampling the strata no sandstone was found at that level. On the basis of the insoluble residues, however, the writer would place the contact one foot below the base of the shatter zone, which is 5 feet above the top of the stromatoporoid zone. The great increase in percentage of residue in sample 15 on both the east and north faces is very conspicuous. The residue consisted of a medium to coarse grained, angular to rounded, frosted to clear sand. Although the percentage of residue is not constant within the Detroit River and Dundee formations, even over short distances, the basal sand at the contact is persistent.

The description of the samples taken from the north face of the quarry and of their residues follows:

Dundee Limestone

41. Limestone, finely to coarsely crystalline, light brown, banded, and fossiliferous.
Residue: 1.6%. Light gray clay, 75%; light gray silt, 20%; fine grained, rounded, and frosted sand, 5%.

40. Limestone, finely to coarsely crystalline, light grayish-brown, and fossiliferous.
Residue: 1.3%. Light grayish-brown clay, 35%; light brown silt, 35%; fine to coarse grained, angular to rounded, and frosted to clear sand, 30%.

39. Limestone, dense to moderately crystalline, grayish-brown, solution cavities, and fossiliferous.
Residue: 1.7%. Light gray clay, 40%; light gray silt, 30%; very fine grained, rounded, and frosted sand, 30%.

38. Limestone, dense to finely crystalline, grayish-brown, and fossiliferous.
Residue: 4.4%. Largely light gray silt, with a small amount of light gray clay.

37. Limestone, dense to finely crystalline, light brown, and banded.
Residue: 5.1%. Light gray clay, 60%; light brown silt, 40%.

36. Limestone, dense to finely crystalline, brown, and fossiliferous.
Residue: 4.4%. Light gray clay, 50%; light brown silt, 50%.

35. Limestone, dense, light brown, banded, and black carbonaceous laminae.
Residue: 5.7%. Largely light gray clay, with a small amount of light brown silt.

34. Limestone, dense to very finely crystalline, brown, and banded.
Residue: 5%. Light gray clay, 80%; light brown silt, 15%; white chert, 5%.

33. Limestone, finely to moderately crystalline, brown, and fossiliferous.
Residue: 3%. Very fine grained, rounded, and frosted sand, 50%; light brown silt, 40%; light gray clay, 10%.

32. Limestone, moderately to coarsely crystalline, light grayish-brown, and fossiliferous.
Residue: 1.2%. Light gray silt, 60%; light gray clay, 40%; few grains of sand.

31. Limestone, dense to finely crystalline, light brown, and fossiliferous.
Residue: 2.7%. Very fine grained, rounded, and frosted sand, 40%; light brown silt, 30%; light gray clay, 30%.

30. Limestone, finely to coarsely crystalline, light brown, banded, and fossiliferous.
Residue: 3%. Very fine grained, rounded, and frosted sand, 80%; grayish-brown clay, 20%.

29. Limestone, dense to moderately crystalline, light brown, and fossiliferous.
Residue: 1.2%. Largely light gray silt, with a small amount of light gray clay and a few sand grains.

28. Limestone, dense to finely crystalline, light brown, and fossiliferous.
Residue: 3.5%. Grayish-brown clay.

27. Limestone, finely to moderately crystalline, light brown, fossiliferous, and stylolitic.
Residue: 6%. Grayish-brown, silty clay.

26. Limestone, finely to moderately crystalline, light brown, black spots, and fossiliferous.
Residue: 3.8%. Light brown clay, 80%; light brown silt, 20%.

25. Limestone, finely to moderately crystalline, and grayish-brown.
Residue: 3.4%. Grayish-brown clay.

24. Limestone, dense to finely crystalline, light brown, and fossiliferous.
Residue: 3.2%. Light grayish-brown silt, 50%; light grayish-brown clay, 50%.

23. Limestone, dense to finely crystalline, brown black carbonaceous laminae, banded, and fossiliferous.
Residue: 2.8%. Light brown silt, 50%; light brown clay, 50%.

22. Limestone, finely to coarsely crystalline, light brown, and fossiliferous.
Residue: 1.5%. Light brown silt, 60%; light brown clay, 40%.

21. Limestone, finely crystalline, light brown, and fossiliferous.
Residue: 2%. Light gray clay, 70%; light brown silt, 30%.

20. Limestone, dense to finely crystalline, light brown, banded, and fossiliferous.
Residue: 14%. White chert, 98%; light gray clay, 2%.

19. Limestone, dense to moderately crystalline, brown, and fossiliferous.
Residue: 10%. Largely fine to moderately grained, subangular to rounded and frosted sand, with a small amount of brown clay.

18. Limestone, dense to moderately crystalline, light brown, and fossiliferous.
Residue: 4%. Largely fine to medium grained, subangular to rounded, and frosted sand, with a small amount of brown clay.

17. Limestone, finely to moderately crystalline, light brown, and fossiliferous.
Residue: 5.8%. Fine to coarse grained, subangular to rounded, and frosted sand, 90%; brown clay, 10%.

16. Limestone, finely to moderately crystalline, light brown, and fossiliferous.
Residue: 20.6%. Largely fine to coarse, subrounded to rounded, frosted, and pitted sand, with a small amount of dark brown clay.

15. Limestone, finely to coarsely crystalline, light brown, black spots, and fossiliferous.
Residue: 24%. Fine to coarse grained, subrounded to rounded, frosted, and pitted sand.

Anderdon Limestone

14. Limestone, dense to finely crystalline, brown, and banded.
Residue: 2.5%. Fine grained, rounded, and frosted sand, 60%; brown clay, 30%; brown silt, 10%.

13. Limestone, finely to moderately crystalline, light brown, and banded.
Residue: 6.5%. Fine to coarse grained, subangular to rounded, and frosted to clear sand, 90%; dark brown clay, 10%.

12. Limestone, dense to finely crystalline, light brown, and banded.
Residue: 2.2%. Largely fine to coarse grained, angular to rounded, and frosted to clear sand, with a small amount of white chert and brown clay.

11. Limestone, lithographic, light brown, and banded.
Residue: 1.7%. Rusty brown clay.

10. Limestone, dense to finely crystalline, light brown, and fossiliferous. Top of stromatoporoid zone.
Residue: 3.3%. Largely fine grained, rounded, and frosted sand, with a small amount of dark brown clay.

9. Limestone, dense to finely crystalline, brown, black carbonaceous laminae, and fossiliferous. Stromatoporoids abundant.
Residue: 3.6%. Largely dark brown clay, with some silicified fossil fragments.

8. Limestone, dense to finely crystalline, brown, black carbonaceous laminae, and fossiliferous. Stromatoporoids abundant.
Residue: 3.6%. Dark brown clay with a small amount of white kaolin.

7. Limestone, dense to finely crystalline, brown, and fossiliferous. Base of stromatoporoid zone.
Residue: 2.2%. Brown clay.

6. Limestone, dense to finely crystalline, light brown, and friable.
Residue: 5.1%. Fine to coarse grained, angular to rounded, and clear to frosted, 90%; dark brown clay, 10%; some white chert.

5. Limestone, finely crystalline, light brown, banded, and friable.
Residue: 3.4%. Fine to coarse grained, subrounded to rounded, and clear to frosted sand, 90%; dark brown clay, 10%.

4. Limestone, finely crystalline, light brown and friable.
Residue: 2.5%. Fine to coarse grained, angular to rounded, and frosted to clear sand, 90%; dark brown clay, 10%.

3. Limestone, finely crystalline, light brown, and friable.
Residue: 2.6%. Fine to coarse, subrounded to rounded, and frosted to clear sand, 90%; brown clay, 10%.

2. Limestone, finely crystalline, light brown, and banded.
Residue: 6.8%. Fine to coarse grained, subrounded to rounded, and frosted to clear sand, 98%; brown clay, 2%.

1. Limestone, dense, light brown matrix with dark gray fragments embedded in matrix.
Residue: 2.4%. Coarse grained, rounded frosted, and pitted sand, 75%; dark gray clay, 25%.

The descriptions of the samples taken from the east face of the quarry and of their residues follows:

Dundee Limestone

54. Limestone, dense to coarsely crystalline, dark grayish-brown, mottled, and fossiliferous.
Residue: 0.7%. Light brownish-gray clay, 85%; fine grained, rounded, and frosted sand, 10%; pyrite, 5%.

53. Limestone, coarsely crystalline, brown, and fossiliferous.
Residue: 1.3%. Fine grained, rounded, and frosted sand, 40%; light gray clay, 40%; pyrite, 20%.

52. Limestone, dense, dark brown, large crystals of calcite scattered, banded, and fossiliferous.
Residue: 3.6%. Brown clay, 80%; brown silt, 20%.

51. Limestone, dense to finely crystalline, light brown, and few large crystals of calcite scattered.
Residue: 3.3%. Brown clay, 70%; fine grained, rounded, and frosted sand, 30%.

50. Limestone, dense to finely crystalline, light brown, and few large crystals of calcite scattered.
Residue: 2%. Light brown clay, 90%; light brown silt, 10%.

49. Limestone, dense to finely crystalline, grayish-brown, and mottled.
Residue: 2%. Light brown clay, 90%; light brown silt, 10%; some pyrite.

48. Limestone, dense to moderately crystalline, brown, and a few small veins of calcite.
Residue: 2.9%. Light brown clay, 50%; light brown silt, 50%.

47. Limestone, dense to finely crystalline, gray, solution cavities, and fossiliferous.
Residue: 1.5%. Fine grained, rounded, and frosted to clear sand, 85%; brown clay, 15%; some pyrite.

46. Limestone, dense to finely crystalline, brown, banded, and black spots.
Residue: 4.5%. Fine grained, rounded, and frosted sand, 50%; brown clay, 50%.

45. Limestone, dense to finely crystalline, fossiliferous, and black spots.
Residue: 5.1%. Gray clay, 50%; light gray silt, 50%.

44. Limestone, dense to finely crystalline, brown and black spots.
Residue: 6%. Gray clay, 60%; light gray silt, 40%.

43. Limestone, dense to finely crystalline, brown, banded, and black spots.
Residue: 5%. Light gray silt, 70%; light gray clay, 30%.

42. Limestone, dense to finely crystalline, brown, and black spots.
Residue: 4.3%. Light gray silt, 50%; light gray clay, 50%.

41. Limestone, dense to finely crystalline, light brown, banded, and black spots.
Residue: 6%. Dark gray clay, 60%; light gray silt, 20%; white chert, 20%.

40. Limestone, dense to finely crystalline, light brown, stylolitic, banded, and black spots.
Residue: 4.4%. Gray clay, 60%; light gray silt, 40%.

39. Limestone, finely to moderately crystalline, light brown, and fossiliferous.
Residue: 1.9%. Light gray silt, 60%; gray clay, 30%; very fine grained, rounded, and frosted sand, 10%.

38. Limestone, dense to moderately crystalline, grayish-brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 2.8%. Very fine grained, rounded, and frosted, sand, 40%; light gray silt, 30%; gray clay, 30%.

37. Limestone, finely to moderately crystalline, few large crystals of calcite scattered, brown, banded, and fossiliferous.
Residue: 2.9%. Dark gray clay, 90%; light gray silt, 10%.

36. Limestone, dense to moderately crystalline, grayish-brown to brown, few large crystals of calcite scattered, banded, and fossiliferous.
Residue: 2.4%. Light gray silt, 40%; gray clay, 30%; fine grained, rounded, and frosted sand, 30%.

35. Limestone, finely to moderately crystalline, grayish-brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 2.2%. Dark gray clay, 60%; light gray silt, 30%; fine grained, rounded, and frosted sand, 10%.

34. Limestone, dense to finely crystalline, grayish-brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 2.5%. Light gray silt, 60%; gray clay, 30%; fine grained, rounded, and frosted sand, 10%.

33. Limestone, dense to finely crystalline, grayish-brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 4.3%. Gray clay, 80%; light gray silt, 20%.

32. Limestone, dense to moderately crystalline, grayish-brown, and fossiliferous.
Residue: 1.5%. Dark gray clay, 90%; light gray silt, 10%.

31. Limestone, finely to coarsely crystalline, gray, stylolitic, large crystals of calcite surrounded by a coarsely to finely crystalline matrix, and fossiliferous.
Residue: 4.5%. Gray clay, 80%; light gray silt, 20%.

30. Limestone, dense to moderately crystalline, light grayish-brown, and fossiliferous.
Residue: 1.2%. Light gray silt, 65%; light gray clay, 30%; fine to medium grained, rounded, and frosted sand, 5%.

29. Limestone, dense, grayish-brown, and fossiliferous.
Residue: 3.2%. Brownish-gray clay, 90%; medium grained, angular to rounded, and frosted to clear sand, 10%.

28. Limestone, dense to coarsely crystalline, brown, and fossiliferous.
Residue: 1.2%. Gray clay, 60%; gray silt, 20%; very fine grained, rounded, and frosted sand, 20%.

27. Limestone, moderately to coarsely crystalline, brown, solution cavities lined by crystals of calcite, and fossiliferous.
Residue: 1.8%. Dark gray clay, 70%; fine to medium grained, subangular to rounded, and frosted sand, 30%.

26. Limestone, moderately to coarsely crystalline, brown, and fossiliferous.
Residue: 1.1%. Light gray silt, 40%; gray clay, 40%; very fine grained, rounded, and frosted sand, 20%.

25. Limestone, dense to finely crystalline, and brown.
Residue: Gray clay, 50%; light gray silt, 45%; very fine grained, rounded, and frosted sand, 5%.

24. Limestone, finely crystalline, brown, and small calcite veins.
Residue: 1.9%. Light gray silt, 70%; gray clay, 30%.

23. Limestone, dense to finely crystalline, brown, few large crystals of calcite scattered, and solution cavities.
Residue: 2.2%. Light gray silt, 60%; gray clay, 40%.

22. Limestone, finely to coarsely crystalline, and brown.
Residue: 5%. Fine to medium grained, subrounded to rounded, and frosted sand, 98%; gray clay, 2%.

21. Limestone, finely to moderately crystalline, brown, and large crystals of calcite scattered.
Residue: 0.6%. Dark gray to black clay, 95%; medium grained, subangular to rounded, and frosted sand, 5%.

20. Limestone, dense, brown, solution cavities lined by crystals of calcite, and small veins of calcite. Top of shatter zone.
Residue: 1.2%. Dark brown to black clay, 80%; fine to medium grained, subangular to rounded, and frosted to clear sand, 20%.

19. Limestone, dense, light gray, and solution cavities lined by crystals of calcite. In shatter zone.
Residue: 1.3%. Dark brown to black clay, 65%; white chert, 35%.

18. Limestone, finely to moderately crystalline, brown, and banded. Base of shatter zone.
Residue: 1.6%. Fine to medium grained, subrounded to rounded, and frosted sand, 90%; gray clay, 10%.

17. Limestone, finely to moderately crystalline, brown, and several ellipsoidal inclusions.
Residue: 1.6%. Brown to black clay.

16. Limestone, dense, brown, banded, and solution cavities lined by crystals of calcite.
Residue: 0.4%. Fine grained, rounded, and frosted sand, 80%; black clay, 20%.

15. Limestone, moderately to coarsely crystalline, brown, and fossiliferous.
Residue: 28.8%. Medium to coarse grained, angular to rounded, and frosted to clear sand, 99.5%; black clay, 0.5%.

Anderdon Limestone (Detroit River)

14. Limestone, dense to finely crystalline, light gray, stylolitic, and a few crystals of calcite scattered.
Residue: 2%. Light gray clay, 80%; fine to medium grained, subangular to rounded and frosted sand, 20%.

13. Limestone, dense to finely crystalline, light gray, and a few large crystals of calcite scattered.
Residue: 2.4%. Fine to medium grained, angular to rounded, and frosted sand, 90%; light gray clay, 10%.

12. Limestone, dense to finely crystalline, and light gray.
Residue: 2.9%. Fine to medium grained, subangular to rounded, and frosted sand, 97%; light gray clay, 3%.

11. Limestone, dense to finely crystalline, light gray, and fossiliferous.
Residue: 3.2%. Fine to medium grained, subangular to rounded, and frosted sand, 95%; light gray clay, 5%.

10. Limestone, dense to finely crystalline, light gray, and a few large crystals of calcite scattered.
Residue: 2.6%. Very fine to medium grained, subangular to rounded, and frosted sand, 90%; light gray clay, 10%; few chert fragments.

9. Limestone, dense to moderately crystalline, brown, solution cavities, and fossiliferous. Top of stromatoporoid zone.
Residue: 2.5%. Fine grained, rounded, and frosted sand, 99%; black clay, 1%.

8. Limestone, dense to moderately crystalline, brown, banded, solution cavities, and fossiliferous. Stromatoporoids abundant.
Residue: 3.5%. White chert, 90%; brown to black clay, 10%.

7. Limestone, dense to finely crystalline, brown, banded, and fossiliferous. Stromatoporoids abundant.
Residue: 2.1%. Dark brown clay.

6. Limestone, dense to moderately crystalline, brown, banded, solution cavities, and fossiliferous. Stromatoporoids abundant.
Residue: 2.6%. Dark brown clay, 60%; fine grained, rounded, and frosted sand, 20%; silicified fossil fragments, 20%.

5. Limestone, dense to moderately crystalline, grayish-brown, banded, and fossiliferous. Base of stromatoporoid zone.
Residue: 1.7%. Fine to medium grained, subangular to rounded, and frosted sand, 70%; dark gray to black clay, 30%.

4. Limestone, finely to moderately crystalline, brown, and solution cavities.
Residue: 2.8%. Fine to medium grained, subangular to rounded, and frosted to clear sand, 90%; dark gray to black clay, 10%.

3. Limestone, finely to moderately crystalline, and brown.
Residue: 2.3%. Fine to medium grained, angular to rounded, and frosted to clear sand, 80%; dark gray to black clay, 20%.

2. Limestone, finely to moderately crystalline, and grayish-brown.
Residue: 10.5%. Medium grained, angular to rounded, and frosted to clear sand, 99%; dark brown to black clay, 1%.

5 feet above quarry floor

1. Dolomite, very calcareous, dense to finely crystalline, and large crystals of calcite scattered.
Residue: 1.5%. Dark gray clay.

Brunner Mond Quarry. The Brunner Mond quarry is 1½ miles northeast of Amherstburg, Essex County, Ontario, Canada. The strata of the quarry were described by Stauffer* as follows:

* C. R. Stauffer: The Devonian of southwestern Ontario, Canada, Geol. Surv., Mem. 34 (1915) pp. 202-203.

	Feet	Inches
16. Soil and drift.....	5	
Onondaga limestone (Dundee)		
15. Limestone, fairly compact, grayish brown, in layers from 1 to 2 feet in thickness.....	10	8
14. Limestone, earthy gray to brown, rather thin bedded with much fossiliferous gray chert.....	3	3
13. Limestone, semi-crystalline, gray, full of fossils, and comparatively thin bedded.....	3	
12. Limestone, compact, earthy, massive to semi-crystalline, gray, with few fossils and rather thick bedded.....	4	9
11. Limestone, rather massive, semi-crystalline, gray, full of fossils.....	3	4
10. Limestone, semi-crystalline, slight banded, gray to brown, with few fossils and in beds about 20 inches in thickness.....	5	9
9. Limestone, saccharoidal, brown, magnesian, with very few fossils. This is often one massive bed, but shows stylolites along the obscure bedding planes. Sometimes this part of the formation is separated into two, three, or even a half a dozen beds. Pockets of calcite crystals occur in this rock.....	8	
8. Limestone, very massive, gray to brown, saccharoidal, magnesian, containing occasional pockets of calcite crystals and a little fossiliferous chalky white chert, about three feet from the bottom. Except for the cherty nodules, these beds are very poor in fossils. They rest unconformably on the Anderdon beds and usually show a basal conglomerate which often includes some sand.....	10	8
Anderdon beds (Detroit River)		
7. Limestone, compact, drab, with numerous fossils. A large loosely coiled gastropod is usually very conspicuous on the eroded surface. The sand, above mentioned, has often sifted down into the cracks of these and the beds below, and may occasionally be found in considerable quantity even to a depth of 4 or 5 feet.....	0	6

	Feet	Inches
6. Limestone, semi-crystalline, gray, with very few fossils.....	2	
5. Limestone, semi-crystalline, gray, with an abundance of fossils. Corals and stromatoporoids are most abundant.....	4	8
4. Limestone, compact, banded, drab, with conchoidal fracture, emitting a semi-metallic ring when struck with a hammer.....	18	0
Flat Rock dolomite ?		
3. Limestone, brown, magnesian, in one layer. This forms the base of the larger part of the deep cut of the quarry. It contains a few corals and stromatoporoids.	2	2
2. Limestone, indistinctly banded, rough, thin-bedded, with crinoid stems and fragments.....	1	10
1. Limestone, compact, drab, rough, and irregular. The top of these beds is sometimes very irregular and has a shale parting between it and the overlying rocks. Corals and stromatoporoids are rather common in it...	2	6

The Brunner Mond quarry is almost directly across the Detroit River from the Sibley quarry. The stromatoporoid zone which is conspicuous in the Sibley quarry is also evident in the Brunner Mond quarry. Stauffer* places the contact between the Detroit River and Dundee formations two feet above the top of the stromatoporoid zone.

In the study of the insoluble residues, the characteristic basal aand is present at the base of the Dundee. The percentage of residue is not as high as that obtained in the Sibley quarry at the same level, but it is much greater than in the sample from one foot below it. Sand is the predominant constituent of the residue in the Detroit River strata exposed, while clay and silt are the predominant materials in the Dundee strata.

*Op. Cit.

Plate 3. Dundee-Detroit River contact in the Brunner Mond Quarry

Plate 4. Detroit River strata exposed in the Monroe County Quarry

The descriptions of the samples and of the residues obtained follows:

Dundee Limestone

53. Limestone, finely crystalline, light brown, and slight banding.
Residue: 3.5%. Light brown silt, 98%; gray clay, 2%.

52. Limestone, finely crystalline, light brown, and slight banding.
Residue: 0.56%. Light brown silt, 99%; fine grained, rounded, and frosted sand, 1%.

51. Limestone, finely to moderately crystalline, light brownish-gray, fossiliferous, and stylolitic.
Residue: 3.7%. Light gray silt, 60%; gray clay, 40%.

50. Limestone, coarsely crystalline, grayish-brown, mottled, and fossiliferous.
Residue: 0.6%. Very fine grained, rounded, and frosted sand, 70%; light brown silt, 30%.

49. Limestone, coarsely crystalline, light grayish-brown, and fossiliferous.
Residue: 0.54%. Very fine to fine grained, rounded, and frosted sand.

48. Limestone, finely crystalline, light grayish-brown, and fossiliferous.
Residue: 2.4%. Very fine grained, rounded, and frosted sand, 98%; dark gray clay, 2%.

47. Limestone, finely crystalline, light grayish-brown with light buff bands, and a few large crystals of calcite scattered.
Residue: 1.6%. Light brown silt, 80%; brown clay, 10%; very fine grained, rounded, and frosted sand, 10%; few silicified fossil fragments.

46. Limestone, moderately crystalline, mottled light grayish-brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 1.3%. Light gray silt, 70%; very fine grained, rounded, and frosted sand, 30%.

45. Limestone, moderately crystalline, mottled light brown, banded, and a few large crystals of calcite scattered.
Residue: 2.3%. Very fine grained, rounded, and frosted sand, 80%; gray silt, 10%; black clay, 10%.

44. Limestone, moderately crystalline, light grayish-brown, and a few large crystals of calcite scattered.
Residue: 0.5%. Very fine grained, rounded, and frosted sand.

43. Limestone, finely to moderately crystalline, mottled light brown, and fossiliferous.
Residue: 0.4%. Very fine grained, rounded, and frosted sand, 80%; light brown silt, 20%.

42. Limestone, finely to moderately crystalline, mottled brown, and fossiliferous.
Residue: 1.2%. Light gray silt, 60%; dark brown clay, 30%; silicified fossil fragments, 10%.

41. Limestone, finely to moderately crystalline, buff to grayish-brown, and fossiliferous.
Residue: 1.6%. Light gray silt, 90%; dark gray clay, 10%; few silicified fossil fragments.

40. Limestone, finely to moderately crystalline, buff to grayish-brown, and very fossiliferous.
Residue: 3.2%. Silicified fossil fragments, 90%; light gray silt, 10%.

39. Limestone, finely crystalline, grayish-brown, black spots, and banded.
Residue: 3.2%. Light brown silt, 85%; very fine grained, rounded, and frosted sand, 10%; dark gray clay, 5%.

38. Limestone, dolomite, finely crystalline, buff to grayish-brown, solution cavities, and banded.
Residue: 3.6%. Dark gray clay, 60%; light brown silt, 40%.

37. Limestone, finely crystalline, brown, black carbonaceous laminae, and banded.
Residue: 3.6%. Light brown silt, 90%; dark brown clay, 8%; silicified fossil fragments, 2%.

36. Limestone, dolomite, finely crystalline, brown, and a few large crystals of dolomite scattered.
Residue: 0.3%. Brown silt, 50%; very fine grained, rounded, and frosted sand, 40%; dark brown clay, 10%.

35. Dolomite, calcareous, finely crystalline, grayish-brown, black carbonaceous laminae, and black spots.
Residue: 1.5%. Dark gray clay, 70%; light gray silt, 30%.

34. Limestone, dolomitic, finely crystalline, grayish-brown, and black spots.
Residue: 2.8%. Light brown silt, 80%; dark gray clay, 20%.

33. Limestone, dolomitic, finely crystalline, grayish-brown, and black spots.
Residue: 3.1%. Light brown silt, 70%; dark gray to black clay, 30%.

32. Limestone, dolomitic, dense to finely crystalline, grayish-brown, few large crystals of calcite scattered, and black spots.
Residue: 2.8%. Light brown silt, 60%; dark gray clay, 40%.

31. Limestone, finely crystalline, grayish-brown, black spots and a few small calcite veins.
Residue: 2.5%. Light gray silt, 95%; dark gray clay, 5%.

30. Limestone, dolomitic, finely crystalline, brown, few large crystals of calcite scattered, and black spots.
Residue: 2.5%. Brown silt, 65%; brown clay, 25%; silicified fossil fragments, 10%.

29. Limestone, finely crystalline, brown, few large crystals of calcite scattered, and black spots.
Residue: 3%. Dark brown clay, 70%; brown silt, 10%; silicified fossil fragments, 20%.

28. Limestone, dolomitic, finely crystalline, brown, few large crystals of calcite scattered, and black spots.
Residue: 1.9%. Brown silt, 50%; brown clay, 50%.

27. Dolomite, calcareous, finely crystalline, light brown, and black carbonaceous laminae.
Residue: 1.6%. Brown silt, 90%; dark brown clay, 10%.

26. Limestone, dense to finely crystalline, light grayish-brown, and stylolitic.
Residue: 1.2%. Very fine to fine grained, angular to rounded, frosted, and pitted sand, 90%; brown silt, 10%.

25. Limestone, dense to finely crystalline, light brown, stylolitic, and solution cavities filled by calcite.
Residue: 1.4%. Dark brown clay, 70%; brown clay, 30%; few grains of sand.

24. Dolomite, calcareous, dense to finely crystalline, and light brown.
Residue: 1.5%. Brown silt, 70%; dark brown clay, 20%; fine grained, angular to rounded, frosted, and pitted sand, 10%.

23. Limestone, finely crystalline, light brown, and black carbonaceous laminae.
Residue: 1.3%. Brown silt, 70%; very fine grained, rounded, and frosted sand, 20%; dark brown clay,10%.

22. Limestone, dense to finely crystalline, and light brown.
Residue: 1.6%. Brown silt, 80%; dark brown clay, 10%; very fine grained, rounded, and frosted sand, 10%.

21. Limestone, finely crystalline, and light gray.
Residue: 1.6%. Fine grained, angular to rounded, frosted, and pitted sand, 60%; light brown silt, 30%; dark brown clay, 10%.

20. Limestone, dense to finely crystalline, light gray, and solution cavities lined by crystals of calcite.
Residue: 0.7%. Brown silt, 60%; dark brown clay, 20%; fine grained, rounded, and frosted sand, 20%.

19. Limestone, dense to finely crystalline, light brownish-gray, solution cavities, and stylolitic.
Residue: 0.8%. Very fine grained, rounded, and frosted sand, 60%; dark brown clay, 40%.

18. Limestone, dense, light gray, and solution cavities.
Residue: 1.3%. Fine grained, angular to rounded, frosted, and pitted sand, 98%; brown clay, 2%.

17. Limestone, finely to moderately crystalline, and light gray.
Residue: 5.2%. A very pure, fine grained, angular to rounded, frosted, and pitted sand.

Anderdon Limestone (Detroit River)

16. Limestone, dense, light gray matrix with dark irregular masses scattered, possibly a conglomerate, solution cavities, and fossiliferous.
Residue: 0.3%. Very fine grained, rounded, and frosted sand, 50%; brown clay, 50%.

15. Limestone, dense to finely crystalline, light gray, stylolitic, solution cavities, and fossiliferous. Top of stromatoporoid zone.
Residue: 0.4%. Very fine grained, rounded, and frosted sand, 98%; light brown clay, 2%.

14. Limestone, dense to finely crystalline, light gray, solution cavities, and fossiliferous, Stromatoporoids abundant.
Residue: 0.9%. Fine grained, subrounded to rounded, frosted, and pitted sand.

13. Limestone, dense to finely crystalline, light gray, solution cavities, and fossiliferous. Stromatoporoids abundant, base of stromatoporoid zone.
Residue: 2.6%. A very pure, fine grained, subrounded to rounded, frosted, and pitted sand.

12. Limestone, lithographic, light gray, and solution cavities filled with calcite.
Residue: 0.6%. Fine grained, angular to rounded, and frosted sand, 80%; dark brown clay, 20%.

11. Limestone, lithographic to dense, light gray, banded and solution cavities filled with calcite.
Residue: 0.6%. Fine grained, angular to rounded, frosted, and pitted sand, 98%; light brown clay, 2%.

10. Limestone, lithographic, light gray, and banded.
Residue: 0.5%. Light brown clay, 70%; fine grained, angular to rounded, frosted, and pitted sand, 30%.

9. Limestone, dense to finely crystalline, light grayish-brown, banded, and black spots.
Residue: 1.4%. Fine grained, angular to rounded, frosted, and pitted sand, 80%; dark brown clay, 20%.

8. Limestone, lithographic to dense, light gray, and large solution cavities lined by dog-tooth-spar.
Residue: 0.3%. Fine grained, angular to rounded, frosted, and pitted sand, 98%; dark brown clay, 2%.

7. Limestone, lithographic to dense, light gray, and large crystals of calcite scattered.
Residue: 0.8%. Fine grained, subrounded to rounded, frosted, and pitted sand, 98%; light brown clay, 2%.

6. Limestone, lithographic, and light gray.
Residue: 0.6%. Fine grained, rounded, and frosted sand, 70%;brown clay, 30%.

5. Limestone, lithographic to dense, light gray, and stylolitic.
Residue: 1.2%. Brown clay; few sand grains.

4. Limestone, lithographic to dense, and light gray.
Residue: 0.4%. Brown clay; few sand grains.

3. Limestone, dense, light gray, and black spots.
Residue: 1.9%. Fine grained, angular to rounded, and frosted sand, 99%; light brown clay, 1%.

2. Limestone, lithographic, and dark grayish-brown. Residue: 0.5%. Brown to black clay, 90%; fine grained, rounded, and frosted sand, 10%.

1. Limestone, lithographic, and dark grayish-brown. Residue: 0.8%. Black clay.

Monroe County Quarry. The Monroe County quarry is 1½ miles south of the Rasin River near the western edge of the French concessions, Raisinville town ship, about ½ mile east of the northeast corner of Sec. 23, T.6S., R.7E., Monroe County, Michigan. The strata of the quarry are described by the writer as follows:

Detroit River	Feet
5. Dolomite, dense to finely crystalline, speckled dark brown to brown, very sandy at top, not so sandy at base, containing small disseminated crystals of calcite.....	6
4. Dolomite, dense to finely crystalline, light gray, containing solution cavities filled with calcite.....	1
3. Dolomite, dense to finely crystalline, light brownish-gray to gray, black carbonaceous laminae and black spots at top, in beds from 1 foot to 6 inches.....	3
2. Dolomite, dense to finely crystalline, light gray to light brownish-gray, solution cavities, elongated dolomite crystals scattered, black spots present in all but top 1 foot, in beds from 1½ to 2 feet in thickness.....	6
1. Dolomite, dense to finely crystalline, light gray, few elongated dolomite crystals in middle, black spots near base, massive bedded, number of large vugs lined by yellow calcite crystals.....	5
Base of quarry	

At the Monroe County quarry, only the Detroit River formation is exposed. Sand is the predominant material in the residues. The high percentage of sand, according to J. W. Carman* is due to the Detroit

*J.W. Carman: Sylvania sandstone of northwestern Ohio, G.S.A. Bull., Vol. 47 (1936), pp. 253-266

River sea reworking the Sylvania sandstone and redepositing part of it with the dolomite that was being deposited at that time. The section obtained in this quarry can be correlated with the section obtained at Silica, Ohio, (See Fig. 2).

The descriptions of the samples and of the residues obtained follows:

Detroit River

21. Dolomite, dense to finely crystalline, speckled brown, and sandy.
Residue: 42%. Fine grained, angular to rounded, frosted to clear, and pitted sand.

20. Dolomite, slightly calcareous, dense to finely crystalline, dark brown, and sandy.
Residue: 15.4%. Largely fine grained, angular to rounded, frosted to clear, and pitted sand, with a small amount of black clay.

19. Dolomite, dense to finely crystalline, dark brown, few large crystals of dolomite scattered, and sandy.
Residue: 28.5%. Largely fine grained, angular to rounded, frosted to clear, and pitted sand, with a small amount of black clay.

18. Dolomite, dense to finely crystalline, speckled dark brown, and a few large crystals of dolomite scattered.
Residue: 18.1%. Largely fine grained, angular to rounded, frosted to clear, and pitted sand, with a small amount of black clay.

17. Dolomite, dense to finely crystalline, speckled dark brown, and a few large crystals of calcite scattered.
Residue: 27.4%. Largely fine grained, angular to rounded, and frosted to clear sand, with a small amount of black clay.

16. Dolomite, dense to finely crystalline, speckled dark brown, and solution cavities.
Residue: 4.1%. Fine grained, angular to rounded, and frosted to clear sand, 70%; black clay, 30%.

15. Dolomite, dense to finely crystalline, light gray, and solution cavities.
Residue: 2.1%. Largely fine grained, angular to rounded, and frosted sand, with a small amount of brown clay.

14. Dolomite, dense to finely crystalline, grayish-brown, black carbonaceous laminae, and black spots.
Residue: 0.9%. Fine grained, rounded, and frosted sand, 70%; brown clay, 30%.

13. Dolomite, dense to finely crystalline, light brownish-gray, and solution cavities.
Residue: 0.9%. Fine grained, rounded, and frosted sand, 50%; brown clay, 50%.

12. Dolomite, dense, light brownish-gray, and solution cavities.
Residue: 0.7%. Very fine grained, rounded, and frosted sand.

11. Dolomite, dense, light gray, banded, solution cavities, and elongated dolomite crystals scattered.
Residue: 4.1%. Largely very fine to fine grained, rounded, and frosted sand, with a small amount of dark gray clay.

10. Dolomite, dense to finely crystalline, light brownish-gray, black spots, and elongated dolomite crystals scattered.
Residue: 6.5%. Fine grained, angular to rounded, and frosted sand, 90%; dark gray clay, 10%.

9. Dolomite, dense to finely crystalline, light brownish-gray, solution cavities, and elongated dolomite crystals scattered.
Residue: 5%. Largely fine grained, angular to rounded, and frosted sand, with a small amount of dark gray clay.

8. Dolomite, dense to finely crystalline, light brownish-gray, black spots, and elongated dolomite crystals.
Residue: 4.9%. Largely fine grained, angular to rounded, and frosted sand, with a small amount of dark gray clay.

7. Dolomite, dense to finely crystalline, light gray, elongated dolomite crystals scattered, and solution cavities.
Residue: 3.3%. Fine grained, rounded, and frosted sand, 70%; dark gray clay, 30%.

6. Dolomite, dense to finely crystalline, light gray, and elongated dolomite crystals.
Residue: 3.7%. Largely very fine to fine grained, rounded, and frosted sand, with a small amount of dark gray clay.

5. Dolomite, dense to finely crystalline, light gray, and solution cavities.
Residue: 6%. Fine grained, subangular to rounded, and frosted sand, 90%; dark gray to black clay, 10%.

4. Dolomite, dense to finely crystalline, light gray, and solution cavities.
Residue: 3%. Fine grained, rounded, and frosted sand, 70%; dark gray to black clay, 30%.

3. Dolomite, calcareous, dense to finely crystalline, light gray, and elongated dolomite crystals scattered.
Residue: 1.6%. Fine grained, rounded, and frosted sand, 70%; dark gray clay, 30%.

2. Dolomite, calcareous, dense to finely crystalline, light gray, and black spots.
Residue: 4%. Largely fine grained, angular to rounded, frosted, and pitted sand, with a small amount of dark gray clay.

1. Dolomite, dense to finely crystalline, light gray, and black spots.
Residue: 4.6%. Largely fine grained, angular to rounded, frosted, and pitted sand, with a small amount of dark gray clay.

France Stone Company Quarry and Drainage Ditch. The France Stone Company quarry and drainage ditch are north of Sylvania Road in Secs. 17 and 18, and one sample was collected south of Sylvania Road in Sec. 20, T.9S., R.6E., Lucas County, Ohio, at Silica, Ohio. The section in the quarry and drainage ditch measured by the writer follows:

Top of section in drainage ditch north of Sylvania Road

Silica Shale — Feet

38. Limestone, dense to finely crystalline, brownish-gray, pyrite, thin-bedded and argillaceous..... 1

Dundee Limestone

37. Limestone, dense to coarsely crystalline, fossiliferous, pyrite, thin-bedded..... 3

36. Limestone, dense to coarsely crystalline, brown, some beds stylolitic, fossiliferous and thin-bedded..... 12

35. Limestone, dense to finely crystalline, brown, stylolitic and banded..... 1

34. Limestone, dense to coarsely crystalline, upper 4 feet brown, lower 2 feet grayish-brown, thin-bedded, mottled toward base, small irregular masses of crystalline calcite. 6

Feet

33. Limestone, finely to coarsely crystalline, mottled brown, more coarsely crystalline toward the top, more finely crystalline toward the base..... 10

32. Limestone, finely to moderately crystalline, brown, few solution cavities, fossiliferous, cherty..... 1

31. Limestone, finely to moderately crystalline, mottled grayish-brown, small solution cavities, some lined by crystals of calcite, dolomitic at base..... 3

30. Dolomite, finely to moderately crystalline, mottled brown, small solution cavities at top, large number of irregularly defined crystals of calcite 5 feet above base.. 8

29. Covered interval..... 2

28. Dolomite, dense to finely crystalline, dark gray brown to brown, small solution cavities 1-2 feet above the base, banded..... 6

Base of section in drainage ditch north of Sylvania Road

27. Covered interval..... 18

Detroit River Dolomite

Northeast corner of Sec. 20

26. Limestone, lithographic, mottled dark brown, banded, fossiliferous, stromatoporoids abundant..... 1

25. Covered interval..... 8

Top of section in quarry north of Sylvania Road

24. Dolomite, dense to finely crystalline, mottled light brown, top 1 foot banded..... 3

23. Dolomite, finely crystalline, mottled grayish-brown, small solution cavities..... 1

22. Covered interval..... 4

21. Dolomite, dense to finely crystalline, light brown to grayish-brown, abundant solution cavities 4 feet to 6 feet above the base. Beds 1 to 2 feet in thickness..... 8

20. Dolomite, dense to finely crystalline, brown, large fragments of dolomite in matrix..... 1

Feet

19. Dolomite, dense to finely crystalline, brown, abundant solution cavities at top, banding at top, none in middle, and faint banding at the base..... 7

18. Dolomite, dense to finely crystalline, grayish-brown, prominent banding and solution cavities. Beds 1 to 1½ feet in thickness..... 3

17. Dolomite, dense to finely crystalline, brown, solution cavities abundant at base, not so abundant at top, slight banding 4 feet above base. Beds 1 foot in thickness..... 7

16. Limestone, dolomitic, large fragments of dolomite in a finely crystalline matrix of calcite..... 1

15. Dolomite, dense to finely crystalline, grayish-brown, top foot out by large calcite vein, calcareous at base, pyritic and banded near top. Beds 1 to 2 feet in thickness. 9

14. Dolomite, dense to finely crystalline, grayish-brown, solution cavities filled by crystals of dolomite, faint banding 2 feet above base..... 4

13. Dolomite, dense to finely crystalline, grayish-brown, solution cavities filled by crystals of calcite. Beds 1 to 2 feet in thickness..... 7

12. Dolomite, dense to finely crystalline, brown, strongly banded..... 1

11. Dolomite, dense to finely crystalline, brownish-gray to light buff, abundant solution cavities, some lined by crystals of dolomite, banded and calcareous toward base. Beds 1 to 2 feet in thickness..... 5

10. Dolomite, finely to coarsely crystalline crystalline, light grayish-brown, abundant solution cavities lined by crystals of calcite, fossiliferous and thin-bedded..... 1

9. Dolomite, finely crystalline, grayigh-brown, solution cavities lined by crystals of dolomite, thin-bedded, banded, stylolitic, and mottled at base..... 7

8. Dolomite, finely crystalline, grayish-brown, banded, stylolitic, and mottled..... 4

7. Dolomite, dense, mottled light brown, solution cavities.. 2

6. Dolomite, dense to finely crystalline, grayish-buff, solution cavities..... 4

Feet

5. Dolomite, finely crystalline, light gray, abundant solution cavities..... 1

4. Dolomite, dense to finely crystalline, buff, solution cavities, banded at top, mottled at base..... 4

3. Dolomite, dense, finely crystalline, light grayish-buff, mottled pink..... 4

2. Dolomite, dense, to finely crystalline, light buff, mottled pink, very sandy at base, less sandy at top..... 4

Sylvania Sandstone

1. Sandstone, fine grained, dolomitic, white, and grains are are angular to round and frosted..... 1

The village of Silica, Ohio, is almost in the center of the Lucas County-Monroe County monocline, and the formations in that region have a dip ranging from 5^{o} to 12^{o} west. Sampling was begun at the Sylvania-Detroit River contact at the east end of the quarry and extended to the Dundee-Silica shale contact at the west end of the ditch, a horizontal distance of 1,665 feet. To bbtain the thickness of the section measured, the formula, Thickness equals the sine of angle of dip times the horizontal distance, was used. Using the approximate dip of 7^{o}, the thickness was found to be 201 feet. However, in sampling only 184 feet of section was obtained. The difference can probably be accounted for by variability of the dip.

Samples 1 to 90 were taken between the Sylvania-Detroit River contact and the west end of the quarry. Sample 92 was taken at the top of the section on the west side of the railroad cut, 65 feet west of the top of the section in the quarry. The vertical distance between samples 90 and 92 is 8 feet. It appears that this bed is just below the Detroit River-

Plate 5. Detroit River strata exposed in the French Stone Company Quarry.

Plate 6. Dundee strata exposed in the French Stone Company drainage ditch.

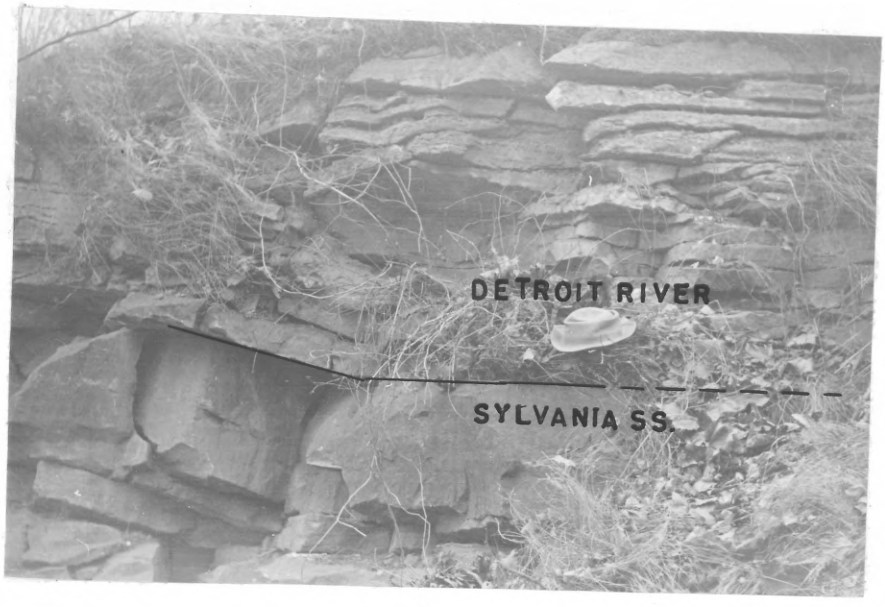

Plate 7. Sylvania-Detroit River contact in the French Stone Company Quarry

Dundee contact, which apparently is between the place where sample 92 was collected and the first sample taken in the drainage ditch.

Clay is the predominant material in the residues of the Dundee formation. The content and percentage of the residues are quite variable, however. As the Dundee-Silica shale contact is approached, there is a rapid increase in the percentage of residue, which is composed largely of clay and pyrite. Pyrite is very common at the base of the Silica shale in this area.

The residues of the Detroit River formation seem to follow a consistent pattern, with sand most prominent at the base and top, and clay most abundant in the middle of the formation. Immediately below the Sylvania-Detroit River contact, the percentage of residue increases sharply to 60%, and the residue consists of a medium grained, rounded, and frosted sand.

The description of the samples and of the residues obtained follows:

Silica Shale

Top of section in drainage ditch north of Sylvania Road

146. Limestone, dense to finely crystalline, brownish-gray, large amount of pyrite, and argillaceous.
Residue: 22.4%. Black clay, 50%; pyrite, 50%.

Dundee Limestone

145. Limestone, dense to coarsely crystalline, grayish-brown, fossiliferous and pyritic.
Residue: 7.8%. Gray clay, 50%; pyrite, 50%.

144. Limestone, dense to finely crystalline, brown, fossiliferous, and pyritic.
Residue: 5.3%. Largely light gray clay, with a trace of pyrite and some silicified fossil fragments.

143. Limestone, dense to coarsely crystalline, brown, fossiliferous, and pyritic.
Residue: 4.7%. Fine grained, rounded, and frosted sand, 70%; dark brown clay, 15%; pyrite, 15%.

142. Limestone, dense to moderately crystalline, brown, and fossiliferous.
Residue: 2.6%. Silicified fossil fragments, 70%; dark gray clay, 25%; pyrite, 5%.

141. Limestone, dense to moderately crystalline, brown, fossiliferous, and pyritic.
Residue: 7.%. Silicified fossil fragments, 80%; dark brown clay, 20%; trace of pyrite.

140. Limestone, finely to coarsely crystalline, brown, and fossiliferous.
Residue: 2.5%. Dark gray clay, 90%; silicified fossil fragments, 10%; trace of pyrite.

139. Limestone, dense to coarsely crystalline, brown, and fossiliferous.
Residue: 2%. Dark gray clay.

138. Limestone, dense to coarsely crystalline, brown, and fossiliferous.
Residue: 2.6%. Largely dark gray clay, with a trace of pyrite.

137. Limestone, dense to coarsely crystalline, brown, stylolitic, and fossiliferous.
Residue: 2.8%. Dark gray to black clay.

136. Limestone, dense to finely crystalline, brown, and fossiliferous.
Residue: 3.9%. Largely dark gray clay, with a trace of pyrite.

135. Limestone, dense, dark grayish-brown, solution cavities filled by pyrite, and banded.
Residue: 1.9%. Dark gray to black clay, 90%; pyrite, 10%.

134. Limestone, dense to moderately crystalline, brown, and fossiliferous.
Residue: 1.1%. Silicified fossil fragments, 70%; dark gray clay, 25%; pyrite, 5%.

133. Limestone, finely to coarsely crystalline, brown, few large crystals of calcite scattered, solution cavities, and fossiliferous.
Residue: 1.2%. Dark gray clay.

132. Limestone, finely to coarsely crystalline, brown, and fossiliferous.
Residue: 1.6%. Largely dark gray clay, with a small amount of recrystallized quartz.

131. Limestone, dense to coarsely crystalline, brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 2%. Silicified fossil fragments, 40%; pyrite, 30%; gray clay, 20%; fine grained, rounded, and frosted sand, 10%.

130. Limestone, dense to finely crystalline, brown, banded, and stylolitic.
Residue: 2.6%. Fine to medium grained, subangular to rounded, and frosted sand, 90%; gray clay, 10%.

129. Limestone, dense to coarsely crystalline, brown, and fossiliferous.
Residue: 1.2%. Dark brown clay, 90%; silicified fossil fragments, 10%; few fragments of chert.

128. Limestone, dense to coarsely crystalline, and brown.
Residue: 2.1%. Dark gray clay, few grains of sand.

127. Limestone, dense to coarsely crystalline, brown, and solution cavities.
Residue: 1.3%. Largely dark gray clay, with a few grains of sand.

126. Limestone, dense to finely crystalline, brown, few large crystals of calcite scattered, and fossiliferous.
Residue: 1.1%. Dark gray clay, 90%; fine grained, rounded, and frosted sand, 10%.

125. Limestone, moderately to coarsely crystalline, grayish-brown, and fossiliferous.
Residue: 3%. Fine grained, rounded, and frosted sand, 70%; dark gray clay, 20%; white chert, 10%.

124. Limestone, moderately to coarsely crystalline, grayish-brown, and fossiliferous. Sample 6 inches above 123.
Residue: 2.7%. Fine grained, rounded, and frosted sand, 70%; dark gray clay, 30%.

123. Limestone, finely to coarsely crystalline, brown, and fossiliferous. Sample 6 inches above 122.
Residue: 2.6%. Dark gray clay, 60%; fine grained, rounded, and frosted sand, 40%.

122. Limestone, finely to coarsely crystalline, brown, mottled, and large crystals of calcite scattered.
Residue: 2.8%. Fine grained, rounded, and frosted sand, 40%; brown clay, 40%; light brown silt, 20%.

121. Limestone, finely to coarsely crystalline, brown, and large crystals of calcite scattered.
Residue: 1.8%. Dark gray clay, 95%; fine grained, rounded, and frosted sand, 5%.

120. Limestone, finely to coarsely crystalline, brown, mottled, and large crystals of calcite scattered.
Residue: 1.7%. Largely dark gray clay, with small amounts of silt and sand.

119. Limestone, finely to coarsely crystalline, brown, mottled, and large crystals of calcite scattered.
Residue: 2%. Dark gray clay, 80%; fine grained, rounded, and frosted sand, 20%.

118. Limestone, finely to coarsely crystalline, brown, mottled, and large crystals of calcite scattered.
Residue: 1.7%. Fine grained, rounded, and frosted sand, 80%; gray clay, 20%.

117. Limestone, finely to moderately crystalline, brown, and a few large crystals of calcite scattered.
Residue: 2%. Dark gray clay, 60%; gray silt, 40%.

116. Limestone, finely to moderately crystalline, brown, mottled, and few large crystals of calcite scattered.
Residue: 1.8%. Gray clay, 75%; gray silt, 20%; fine grained, rounded, and frosted sand, 5%.

115. Limestone, finely to moderately crystalline, brown, and mottled.
Residue: 2.3%. Gray clay, 70%; fine grained, rounded, and frosted sand, 30%.

114. Limestone, finely to moderately crystalline, brown, and mottled.
Residue: 1.7%. Fine grained, rounded, and frosted sand, 80%; dark gray clay, 20%.

113. Limestone, dense to finely crystalline, brown, and mottled.
Residue: 1.7%. Light gray silt, 65%; fine grained, rounded, and frosted sand, 25%; dark gray clay, 10%.

112. Limestone, finely to moderately crystalline, brown, mottled, solution cavities, and fossiliferous.
Residue: 0.9%. Largely dark gray clay, with a few grains of sand and a few fragments of white chert.

111. Limestone, dense to finely crystalline, brown, and solution cavities.
Residue: 2.1%. Fine grained, rounded, and frosted sand, 60%; light brown silt, 30%; brown clay, 10%.

110. Limestone, dense to finely crystalline, brown, and solution cavities.
Residue: 1.9%. Light brown silt, 80%; gray clay, 20%.

109. Limestone, finely to moderately crystalline, grayish-brown, mottled, and solution cavities.
Residue: 2.2%. Dark gray clay, 80%; fine grained, rounded, and frosted sand, 15%; light gray silt, 5%.

108. Dolomite, calcareous, finely to moderately crystalline, brown, and solution cavities.
Residue: 2%. Light gray clay, 75%; light gray silt, 25%.

107. Dolomite, calcareous, finely to moderately crystalline, brown, mottled, and solution cavities.
Residue: 2.2%. Light gray clay, 70%; light gray silt, 25%; very fine grained, rounded, and frosted sand, 5%.

106. Dolomite, calcareous, finely crystalline, brown, mottled, and solution cavities.
Residue: 1.6%. Dark gray clay, 70%; light gray silt, 30%.

105. Dolomite, finely to moderately crystalline, brown, mottled, and banded.
Residue: 2.6%. Very fine grained, rounded, and frosted sand, 70%; brown clay, 20%; light brown silt, 10%.

104. Dolomite, calcareous, dense to moderately crystalline, brown, mottled, and large crystals of dolomite scattered.
Residue: 2.6%. Largely very fine grained, rounded, and frosted sand, with a small amount of light gray clay.

103. Dolomite, calcareous, finely to moderately crystalline, brown, mottled, and large crystals of dolomite scattered.
Residue: 2%. Very fine grained, rounded, and frosted sand, 70%; brownish-black silt, 20%; light brown clay, 10%.

102. Dolomite, finely to moderately crystalline, brown, banded, and mottled.
Residue: 2%. Light brown silt, 60%; brown clay, 35%; fine grained, rounded, and frosted sand, 5%.

101. Dolomite, finely to moderately crystalline, brown, and mottled.
Residue: 2.6%. Fine grained, rounded, and frosted sand, 70%; light brown silt, 20%; brown clay, 10%.

100. Covered interval 2 feet.

99. Limestone, dense to finely crystalline, dark grayish-brown, and large crystals of calcite scattered.
Residue: 1.8%. Fine grained, rounded, and frosted sand, 95%; dark brown, clay 5%.

98. Dolomite, calcareous, dense to finely crystalline, brown, banded, mottled, and solution cavities.
Residue: 1.1%. Dark gray clay, 50%; dark gray clay, 50%.

97. Dolomite, finely crystalline, brown, banded, and mottled.
Residue: 1%. Dark brown to black clay.

96. Dolomite, finely crystalline, brown, banded, mottled, and solution cavities.
Residue: 1.9%. Dark brown clay, 60%; brown silt, 40%.

95. Dolomite, finely crystalline, brown, banded, and mottled.
Residue: 0.7%. Brown clay.

94. Dolomite, finely crystalline, brown, banded, and mottled.
Residue: 0.5%. Fine to medium grained, rounded, and frosted sand, 70%; dark brown clay, 30%.

Base of section in ditch

93. Covered interval 18 feet. The contact between the Detroit River and Dundee formations lies somewhere in this interval between samples 92 and 94.

Detroit River Dolomite

Sample taken northeast corner of Sec. 20

92. Limestone, lithographic, dark brown, mottled, and fossiliferous. Stromatoporoids abundant.
Residue: 2.4%. Very fine grained, rounded, and frosted sand, 60%; light gray clay, 30%; light gray silt, 10%; few fragments of white chert.

91. Covered interval 8 feet.

Top of section in quarry

90. Dolomite, finely crystalline, light brown, banded, and solution cavities.
Residue: 1.2%. Dark brown clay, 95%; light brown silt, 5%.

89. Dolomite, dense to finely crystalline, light brown, mottled, and solution cavities.
Residue: 0.9%. Light brown silt, 50%; dark brown clay, 50%.

88. Dolomite, finely crystalline, light brown, and solution cavities.
Residue: 1.4%. Dark brown clay.

87. Dolomite, finely crystalline, grayish-brown, mottled, and solution cavities.
Residue: 0.8%. Dark brown to black clay.

86. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 0.5%. Black clay.

85. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 0.9%. Black clay, 85%; fine to medium grained, subrounded to rounded, and frosted sand, 15%.

84. Dolomite, dense to finely crystalline, light brown, banded, and solution cavaties.
Residue: 0.5%. Dark brown to black clay.

83. Dolomite, dense to finely crystalline, grayish-brown, and solution cavities.
Residue: 0.1%. Dark brown clay.

82. Dolomite, dense to finely crystalline, grayish-brown, mottled, and solution cavities.
Residue: 0.4%. Dark gray to black clay.

81. Dolomite, dense to finely crystalline, light grayish-brown, and solution cavities.
Residue: 0.1%. Dark gray to black clay.

80. Dolomite, dense, brown, banded, mottled, and solution cavities.
Residue: 0.7%. Dark brown clay.

79. Dolomite, dense to finely crystalline, brown, and banded.
Residue: 0.3%. Black clay.

78. Dolomite, dense to finely crystalline, brown, large fragments of dolomite scattered.
Residue: 2%. Dark brown clay.

77. Dolomite, dense to finely crystalline, brown, banded, and solution cavities.
Residue: 0.7%. Largely black clay, with a small amount of white kaolin.

76. Dolomite, dense to finely crystalline, brown, and banded.
Residue: 0.4%. Dark brown clay.

75. Dolomite, finely crystalline, brown, and banded.
Residue: 0.6%. Largely black clay, with a small amount of dark brown silt.

74. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 0.6%. Dark brown clay.

73. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 0.4%. Dark brown clay.

72. Dolomite, dense to finely crystalline, and grayish-brown.
Residue: 0.1%. Dark brown to black clay.

71. Dolomite, dense, brown, and banded.
Residue: 0.3%. Black clay.

70. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 0.9%. Largely black clay, with a small amount of white kaolin.

69. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 0.9%. Dark brown clay.

68. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 0.3%. Black clay.

67. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 1.9%. Dark brown clay, 70%; dark brown silt, 30%; few grains of sand.

66. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 1.1%. Largely dark brown clay, with a few grains of sand.

65. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 0.7%. Dark brown clay.

64. Dolomite, dense to finely crystalline, brown, and banded.
Residue: 0.7%. Dark brown clay.

63. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 0.7%. Brownish-black clay.

62. Dolomite, dense to finely crystalline, brown, and solution cavities.
Residue: 0.6%. Grayish-black clay.

61. Dolomite, finely crystalline, light grayish-brown, and solution cavities.
Residue: 1.1%. Black clay.

60. Limestone, dolomitic, brown, large fragments of dolomite scattered, solution cavities.
Residue: 0.9%. Dark brownish-gray clay.

59. Limestone, coarsely crystalline, grayish-white, some epidote, and solution cavities.
Residue: 0.7%. Grayish-black clay.

58. Dolomite, dense to finely crystalline, grayish-brown, pyritic, and solution cavities.
Residue: 1.4%. Largely dark gray clay, with a few sand grains.

57. Dolomite, dense to finely crystalline, brownish-gray, banded, and solution cavities.
Residue: 2%. Dark gray clay.

56. Dolomite, dense to finely crystalline, brownish-gray, banded, and solution cavities lined by crystals of calcite.
Residue: 0.6%. Largely black clay, with a few grains of sand.

55. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 1.4%. Dark brown clay.

54. Dolomite, dense to finely crystalline, grayish-brown, solution cavities, and banded.
Residue: 1.3%. Dark gray clay.

53. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 2.2%. Dark gray clay.

52. Dolomite, dense to finely crystalline, grayish-brown, and solution cavities lined by crystals of dolomite.
Residue: 1%. Gray to dark gray clay.

51. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities lined by crystals of calcite.
Residue: 1.4%. Largely dark grayish-brown clay, with a few sand grains.

51. Dolomite, calcareous, dense to finely crystalline, grayish-brown, and solution cavities lined by crystals of calcite.
Residue: 1.6%. Largely dark gray clay, with a few fragments of recrystallized quartz.

50. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities lined by crystals of calcite.
Residue: 1.8%. Dark gray clay.

49. Dolomite, dense to finely crystalline, brownish-gray, banded, and solution cavities lined by crystals of calcite.
Residue: 1.8%. Dark gray clay.

48. Dolomite, dense to finely crystalline, brownish-gray, banded, and solution cavities filled by crystals of calcite.
Residue: 1.6%. Gray to dark gray clay.

47. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities lined by crystals of calcite.
Residue: 1.6%. Largely dark gray clay, with a few grains of sand.

46. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 7.6%. Light gray clay.

45. Dolomite, dense to finely crystalline, grayish-brown, and solution cavities lined by crystals of calcite.
Residue: 1.8%. Grayish-brown clay.

44. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities.
Residue: 5.5%. Grayish-brown clay.

43. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities filled by crystals of calcite.
Residue: 1.5%. Grayish-black clay, 95%; fine grained, rounded, and frosted sand, 5%.

42. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 5.6%. Brown clay, 50%; brown clay, 35%; fine to medium grained, subrounded to rounded, frosted, and pitted sand, 15%.

41. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities lined by crystals of calcite.
Residue: 4.8%. Fine to medium grained, angular to rounded, frosted, and pitted sand, 90%; gray glay, 10%.

40. Dolomite, dense to finely crystalline, grayish-brown, and banded.
Residue: 1.5%. Fine to medium grained, angular to rounded, and frosted sand, 60%; dark gray clay, 40%.

39. Limestone, coarsely crystalline, brownish-gray, and solution cavities.
Residue: 2.6%. Dark gray clay, 90%; very fine grained, rounded, and frosted sand, 10%.

38. Dolomite, dense to finely crystalline, brown, and banded.
Residue: 1.6%. Black clay, 90%; black silt, 10%.

37. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities.
Residue: 2.5%. Dark gray to black clay, 90%; dark gray to black silt, 10%.

36. Dolomite, calcareous, dense to finely crystalline, brownish-gray, and solution cavities lined by crystals of calcite.
Residue: 1.8%. Dark gray clay, 60%; dark gray silt, 30%; fine grained, subangular to rounded, and frosted sand, 10%.

35. Dolomite, dense to finely crystalline, grayish-brown, banded, and solution cavities.
Residue: 2.3%. Gray clay, 70%; gray silt, 20%; fine grained, rounded, and frosted sand, 10%.

34. Dolomite, finely crystalline, brown, banded, and solution cavities.
Residue: 5%. Gray clay, 60%; gray silt, 40%.

33. Dolomite, finely crystalline, light buff, and solution cavities.
Residue: 6.5%. Fine to medium grained, angular to rounded, and frosted sand, 90%; light gray clay, 10%.

32. Dolomite, finely to coarsely crystalline, light grayish-brown, solution cavities lined by crystals of calcite, and fossiliferous.
Residue: 10.4%. Fine to medium grained, subrounded to rounded, frosted, and pitted sand, 98%; light gray clay, 2%.

31. Dolomite, finely crystalline, grayish-brown, stylolitic, and solution cavities lined by crystals of calcite.
Residue: 15.9%. Fine to medium grained, subrounded to rounded, and frosted to clear sand, 70%; light gray clay, 30%.

30. Dolomite, finely crystalline, gray, mottled, and large crystals of dolomite scattered.
Residue: 10.7%. Fine to medium grained, subangular to rounded, and frosted to clear sand, 70%; gray clay, 30%.

29. Dolomite, dense to finely crystalline, brownish-gray, and solution cavities lined by crystals of dolomite.
Residue: 5%. Fine to medium grained, rounded, and frosted sand, 80%; light gray clay, 20%.

28. Dolomite, finely crystalline, light brownish-gray, and solution cavities lined by crystals of dolomite.
Residue: 10.2%. Fine to medium grained, subrounded to rounded, and frosted to clear sand, 95%; light gray clay, 5%.

27. Dolomite, finely crystalline, light brownish-gray, and solution cavities lined by crystals of dolomite.
Residue: 7.2%. Fine grained, subangular to rounded, and frosted to clear sand, 70%; light gray clay, 30%.

26. Dolomite, finely crystalline, light brownish-gray, and solution cavities lined by crystals of dolomite.
Residue: 1.7%. Dark gray clay, 90%; gray silt, 10%.

25. Dolomite, finely crystalline, light grayish-brown, banded, and stylolitic.
Residue: 1.4%. Fine to medium grained, angular to rounded, and frosted to clear sand, 60%; black clay, 40%.

24. Dolomite, finely crystalline, light brown, banded, and stylolitic.
Residue: 1.8%. Gray clay, 95%; gray silt, 5%.

23. Dolomite, finely crystalline, light brown, banded, and mottled.
Residue: 4.6%. Light gray clay, 90%; light gray silt, 10%.

22. Dolomite, finely crystalline, light brown, and banded.
Residue: 6.3%. Fine to medium grained, subrounded to rounded, and frosted to clear sand, 85%; light gray clay, 15%.

21. Dolomite, dense, and light grayish-brown,
Residue: 8.8%. Light gray clay, 95%; fine grained, rounded, and frosted sand, 5%.

20. Dolomite, dense, light grayish-buff, mottled, solution cavities, and pyritic.
Residue: 4.7%. Light gray clay, 90%; fine to medium grained, subrounded to rounded, and frosted sand, 10%.

19. Dolomite, dense to finely crystalline, and buff.
Residue: 2.8%. Light gray clay, 90%; fine grained, subrounded to rounded, and frosted sand, 10%.

18. Dolomite, dense to finely crystalline, and buff to grayish-buff.
Residue: 2.3%. Dark gray clay, 80%; gray silt, 15%; fine grained, rounded, and frosted sand, 5%.

17. Dolomite, dense to finely crystalline, buff, and solution cavities.
Residue: 1.6%. Dark gray clay, 40%; gray silt, 30%; fine to medium grained, subrounded to rounded, and frosted sand, 30%.

16. Dolomite, dense to finely crystalline, buff, and solution cavities.
Residue: 5.7%. Fine to medium grained, rounded, and frosted sand, 70%; light gray clay, 30%.

15. Dolomite, dense to finely crystalline, light gray, and solution cavities.
Residue: 3.9%. Dark gray clay, 70%; light gray silt, 15%; fine to medium grained, rounded, and frosted sand, 15%.

14. Dolomite, dense to finely crystalline, buff, banded, and stylolitic.
Residue: 7.8%. Light gray clay, 80%; light gray silt, 10%; fine grained, rounded, and frosted sand, 10%.

13. Dolomite, dense to finely crystalline, grayish-buff, and solution cavities.
Residue: 3%. Light gray clay, 85%; fine grained, rounded, and frosted sand, 15%.

12. Dolomite, dense to finely crystalline, grayish-buff, and solution cavities.
Residue: 6.1%. Light gray clay, 95%; fine grained, rounded, and frosted sand, 5%.

11. Dolomite, dense to finely crystalline, grayish-buff, mottled, and solution cavities.
Residue: 5.6%. Fine to medium grained, subrounded to rounded, and frosted sand, 50%; light gray silt, 30%; light gray clay, 20%.

10. Dolomite, dense to finely crystalline, grayish-buff, mottled, and solution cavities.
Residue: 4.6%. Light gray clay, 80%; fine to medium grained, angular to rounded, and frosted sand, 20%.

9. Dolomite, dense to finely crystalline, grayish-buff mottled, and solution cavities.
Residue: 1.5%. Light gray clay.

8. Dolomite, dense, grayish-buff, mottled, and solution cavities lined by crystals of dolomite.
Residue: 2.2%. Light gray clay.

7. Dolomite, dense, grayish-buff, mottled, and solution cavities lined by crystals of dolomite.
Residue: 5.8%. Light gray clay, 80%; light gray silt, 15%; fine grained, rounded, and frosted sand, 5%.

6. Dolomite, dense, and light buff.
Residue: 3.6%. Gray clay, 80%; gray silt, 10%; fine to medium grained, rounded, and frosted sand, 10%.

5. Dolomite, dense to finely crystalline, and light buff.
Residue: 4.3%. Light gray clay, 70%; light gray silt, 20%; fine to medium grained, subangular to rounded, and frosted sand, 10%.

4. Dolomite, dense to finely crystalline, light buff, and sandy.
Residue: 7.8%. Fine to medium grained, subrounded to rounded, and ffosted sand, 60%; light gray clay, 40%.

3. Dolomite, finely crystalline, light buff, and sandy.
Residue: 40%. Fine to medium grained, angular to rounded, frosted, and pitted sand, 95%; light gray clay, 5%.

2. Dolomite, finely crystalline, light buff, and sandy.
Residue: 51.2%. Fine to medium grained, angular to rounded, frosted, and pitted sand.

Sylvania Sandstone

1. Sandstone, dolomitic, fine to medium grained, and grayish-white.
Residue: 60.6%. Fine to medium grained, angular to rounded, frosted, and pitted sand.

Base of section in quarry

H. R. Ford Well. The H. R. Ford well is in the NW 1/4 SE 1/4 Sec. 22, T.2S., R.10E., within the city limits of Dearborn, Wayne County, Michigan. The strata were described by L. Underwood* as follows:

	Feet	Depth
Dundee		
11. Limestone, light to dark gray to buff, cherty, fossiliferous and bituminour horizons.....	85	200
10. Limestone, light gray to dark gray to buff, crystalline, sandy bituminous streaks.....	15	215
Detroit River		
9. Dolomite, gray argillaceous and bituminous with bituminous streaks, strong odor of petroleum...	10	225

*L. Underwood: Written log in files at U.S. Geol. Surv., Ann Arbor, Mich.

	Feet	Depth
8. Dolomite, fine grained, dark gray to light gray, to buff, argillaceous with black shaley partings, and some fine white anhydrite and selenite.....	35	260
7. Dolomite, light to dark bluish gray and buff, with mottling and sand streaks of distinct grayish blue, pure white anhydrite at 270-275 feet.....	20	280
6. Dark brown granular dolomite and dark gray fine grained dolomite, filled with specks, masses, and streaks of carbonaceous material, and also some streaks of white anhydrite.....	30	310
5. Dolomite, light to dark buff, bituminous, locally argillaceous and with seams of pure white anhydrite...	25	335
4. Dolomite, light grayish-buff, to brown, argillaceous, bituminous, fine grained to sugary, considerable anhydrite and selenite, especially from 345 to 350 feet.....	80	415
Flat Rock Dolomite Member		
3. Dolomite, gray to dark grayish-buff to brown, black bituminous, granular, locally argillaceous and cherty, considerable anhydrite, especially from 490 to 495 feet.....	80	495
Sylvania Sandstone		
2. Dolomite, very porous and sandy, granular, dark buff to gray, pure white sand grains embedded in a matrix of dolomite.....	10	505
1. Sandstone, fine grained, grayish to pure white, slightly cemented, glass sand.....	50	555

A study was made of the H. R. Ford well samples for comparison with the outcrop samples. The percentage of residue is much higher in the well cuttings than in the outcrop samples. This is due largely to the contamination of the cuttings by cavings. Another factor is the occurrence of gypsum beds in the Detroit River formation in the well samples. However, the basal sand of the Dundee is present, and the increase in percent of residue is apparent.

The description of the residues for every five feet of section is as follows:

Dundee Limestone

75. No samples 10 feet.

74. Residue: 7.5%. Very contaminated, mixture of drift, clay, shale, and sand.

73. No sample 5 feet.

72. Residue: 4.1%. Very contaminated, mixture of shale, clay, and drift.

71. Residue: 24%. Fine grained, angular to rounded, frosted, and pitted sand, 70%; white chert, shale, and drift, 30%.

70. Residue: 25.6%. Fine grained, angular to rounded, frosted, and pitted sand, 60%; mixture of shale, clay, chert, and drift, 40%.

69. Residue: 21.1%. Fine grained, angular to rounded, frosted, and pitted sand, 90%; grayish-brown clay, 5%; chert and drift, 5%.

68. Highly contaminated.

67. Residue: 22%. White chert, 80%; fine grained, angular to rounded, and frosted sand 20%; some contamination.

66. Residue: 11.9%. Fine grained, angular to rounded, frosted, and pitted sand, 40%; brown clay, 40%; white chert, 20%; some contamination.

65. Residue: 3.3%. Mixture of chert, clay, sand, shale, and drift; contaminated.

64. Residue: 4.4%. Brown clay, 80%; fine grained, rounded, and frosted sand, 15%; white chert, 5%; some contamination.

63. Residue: 6.2%. Fine grained, angular to rounded, and frosted sand, 70%; brown clay, 30%; some contamination.

62. Residue: 7.7%. Fine grained, angular to rounded, and frosted sand, 60%; brown clay, 40%; contaminated.

61. Residue: 5.6%. Mixture of clay, chert, sand, shale, and drift; contaminated.

60. Residue: 6.3%. Largely brown clay, with small amounts of chert and sand; contaminated.

59. Residue: 7.2%. Fine grained, angular to rounded, and frosted sand.

Detroit River Dolomite

58. Residue: 2.7%. Dark brown clay.

57. Residue: 3.4%. Dark brown clay.

56. Highly contaminated.

55. No sample 5 feet.

54. Residue: 22.8%. Fine grained, angular to rounded, and frosted sand, 40%; white gypsum, 40%; white chert, 20%; contaminated.

53. No sample 5 feet.

52. Residue: 15.1%. White gypsum, 60%; fine grained, rounded, and frosted sand, 40%; contaminated.

51. No sample 5 feet.

50. Residue: 3.7%. Largely fine grained, rounded, and frosted sand, with a small amount of clay.

49. No samples 20 feet.

48. Highly contaminated.

47. Residue: 3.8%. Largely fine grained, rounded, and frosted sand, with a small amount of brown clay; contaminated.

46. Residue: 4.9%. Largely fine grained, angular to rounded sand with a few tabular crystals of gypsum; contaminated.

45. Residue: 18%. Fine grained, rounded, and frosted sand, 60%; white gypsum, 30%; brown clay, 10%; contaminated.

44. Residue: 17.9%. White gypsum, 80%; fine grained, rounded, and frosted sand, 10%; brown clay, 10%; contaminated.

43. Residue: 7.6%. Largely white chert, with small amounts of white gypsum and sand; contaminated.

42. Residue: 2.2%. Very fine grained, rounded, and frosted sand, 40%; white gypsum, 40%; brown clay, 20%.

41. No sample 5 feet.

40. Residue: 12.2%. Fine grained, angular to rounded, and frosted sand, 60%; white gypsum, 30%; white chert, 10%; contaminated.

39. Residue: 36.5%. White gypsum, 90%; fine grained, rounded, and frosted sand, 10%; some contamination.

38. Residue: 4.6%. Largely dark gray to black clay, with a few sand grains; contaminated.

37. No sample 5 feet.

36. Highly contaminated.

35. Residue: 9.6%. Mixture of sand, chert, gypsum, shale, and drift; contaminated.

34. No sample 5 feet.

33. Residue: 6.8%. Largely fine grained, rounded, and frosted sand, with a small amount of black clay; contaminated.

32. Residue: 3.4%. Black clay, 40%; fine grained, rounded, and frosted sand, 40%; white gypsum, 10%; white chert, 10%.

31. Residue: 31%. Largely white gypsum, with a small amount of light brown clay.

30. Residue: 14.9%. Largely white gypsum, with a small amount of brown clay; contaminated.

29. Residue: 3.2%. Largely brown clay, with small amounts of white chert and white gypsum; contaminated.

28. Highly contaminated.

27. Highly contaminated.

26. Residue: 2.7%. Fine grained, angular to rounded, and frosted sand, 80%; brown clay, 20%; contaminated.

25. No sample 5 feet.

24. Residue: 8.1%. Largely fine grained, angular to rounded, and frosted sand; contaminated.

23. Residue: 6.4%. Largely fine grained, angular to rounded, and frosted sand; contaminated.

22. Residue: 5%. White gypsum, 40%; white chert, 40%; dark brown clay, 20%; contaminated.

21. Residue: 12.3%. Largely fine to coarse, angular to rounded sand, with some brown clay; contaminated.

20. Residue: 4.2%. Largely very fine grained, rounded, and frosted sand, with small amounts of white chert and brown clay.

19. Residue: 3.6%. Largely black clay, with some white gypsum and pyrite; contaminated.

18. Residue: 1.9%. Black clay, 90%; white gypsum, 10%.

17. Residue: 3.6%. Largely dark brown clay, with small amounts of white gypsum and sand.

16. Residue: 4.2%. Largely dark brown clay, with small amounts of white gypsum and sand; contaminated.

15. Residue: 4.6%. Largely black clay, with a small amount of white gypsum.

14. Residue: 5.6%. Black clay; contaminated.

13. Residue: 4.3%. Largely brown clay, with small amount of white gypsum; contaminated.

12. Residue: 10.4%. White to gray gypsum, 95%; brown clay, 5%. contaminated.

11. Residue: 11.4%. White chert, 90%; brown clay, 10%.

10. Residue: 7.3%. White chert, 95%; brown clay, 5%.

9. Residue: 13.7%. Brown silt stone; contaminated.

8. Residue: 14.8%. Brown silt stone.

7. Residue: 16%. Brown silt stone.

6. Residue: 4.6%. Brown silt, 40%; white gypsum, 30%; brown clay, 30%.

5. Residue: 4.6%. Largely brown clay, with small amount of gypsum; contaminated.

4. Residue: 7.3%. Fine grained, angular to rounded, frosted, and pitted sand, 95%; brown clay, 5%.

3. Residue: 12.7%. Fine grained, angular to rounded, frosted, and pitted sand, 90%; brown clay, 10%.

Sylvania Sandstone

2. Residue: 80%. Fine grained, angular to rounded, frosted, and pitted sand.

1. Residue: 88.9%. Fine grained, angular to rounded, and frosted sand.

CORRELATION AND CONCLUSION

The correlation of the residues from the outcrop sections and the Ford well studied is shown in Fig. 2. The basal one foot of the Dundee formation is characterized by a comparatively high percentage of residue, which is composed of a fine to coarse, angular to rounded, and frosted sand. The percentage of the residue of the basal foot varies from outcrop to outcrop, but it is much higher than the residue from the rock one foot below. The contact of the Detroit River formation and the Sylvania sandstone is drawn at the base of the zone where the residue is 60% or greater and consists largely of sand. One foot above the contact of the Dundee formation and the Silica shale the percentage of residue which consists of clay and pyrite increases greatly.

The percentage and content of the residues of the Detroit River and Dundee formations are quite variable. The residues of the Detroit River formation are predominantly sand at the base and at the top, and mostly clay in the middle of the formation. The residues of the Dundee formation are largely sand at the base and clay toward the top.

From the study of the insoluble residues of the Detroit River and Dundee formations, three conclusions can be reached: (1) there is a

basal sand present above the contact of the Detroit River and Dundee formations; (2) outcrop areas of the Dundee and Detroit River formations can be correlated by means of insoluble residues; and (3) the use of insoluble residues to determine the contact in subsurface studies can be applied to well cuttings as well as to outcrop samples, although the results may not always be as satisfactory as outcrop studies because of contamination of drill cuttings by cavings from the overlying rocks.

BIBLIOGRAPHY

Bassett, C. F.: Stratigraphy and Paleontology of the Dundee limestone of southeastern Michigan, G.S.A. Bull., Vol. 46, pp. 425-462, (1935).

Caley, J. F.: Paleozoic geology of the Windsor-Sarnia Area, Ontario, Geol. Surv., Canada, Mem. 240, (1945).

Carman, J. E.: Sylvania sandstone of northwestern Ohio, G.S.A. Bull., Vol. 47, pp. 253-266, (1936)

Eddy, G. E.: A study of the insoluble residues of the lower Traverse, Bell, and Upper Dundee Formations of Michigan, Mich. Acad. Sci., Vol. XVIII, pp. 345-351,(1932).

Stauffer, C. R.: The Devonian of southeastern Ontario, Geol. Surv., Canada, Mem. 34, pp. 202-203, (1915).

Underwood, L.: Written log in files of U.S. Geol. Surv., Branch Office, Ann Arbor, Mich.

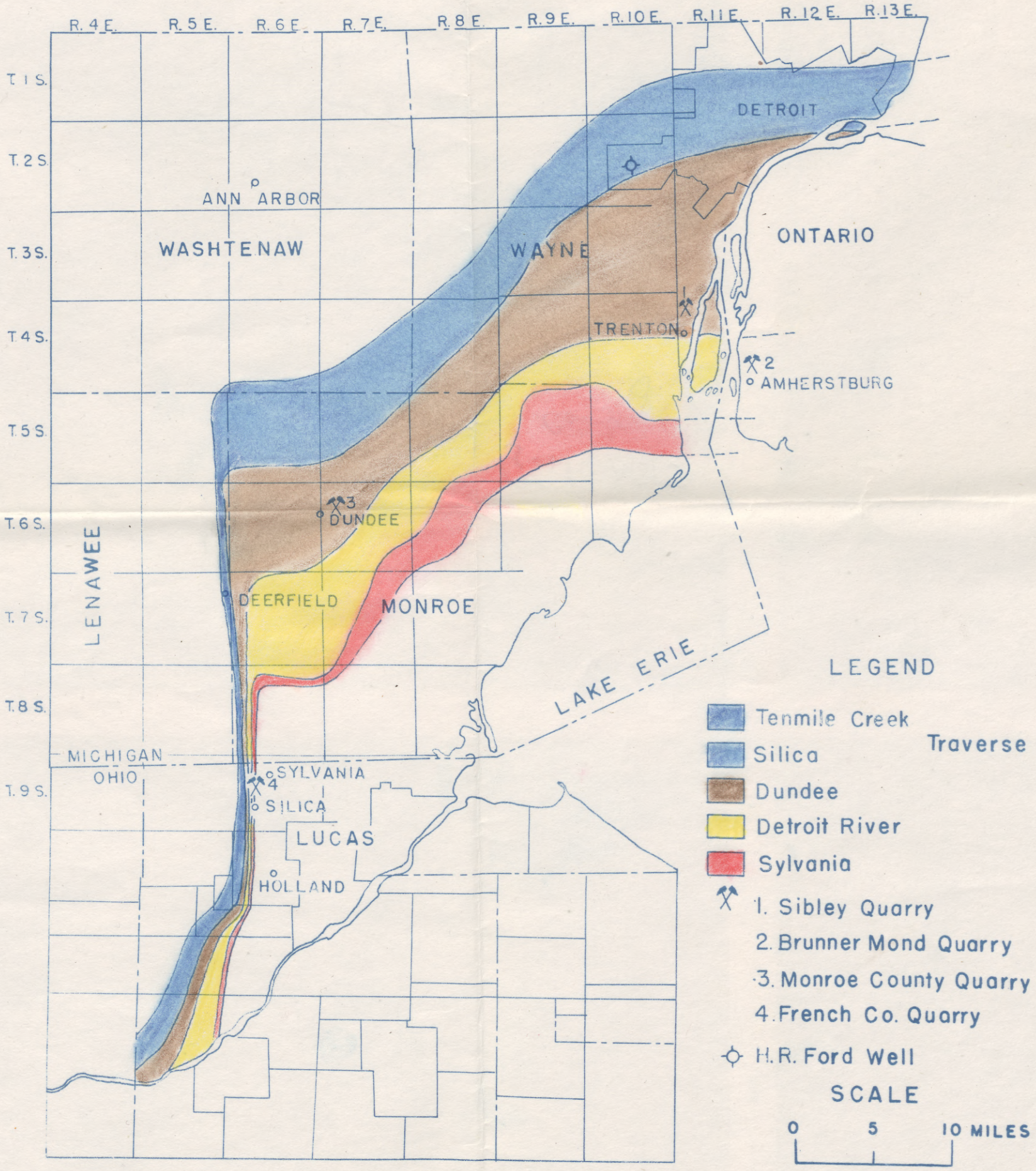

FIG. 1 GEOLOGIC MAP SHOWING LOCATION OF QUARRIES AND WELL STUDIED

After Carman & Ehlers

H. R. FORD WELL
N.W. 1/4, S.E. 1/4, Sec. 22
T. 2 S., R. 10 E.
Wayne Co., Mich.
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

135'

C

C

C

C

C

C

C

DUNDEE
DETROIT RIVER

BRUNNER WOND QUARRY
1½ Miles N.E. of
Amherstburg, Essex County
Ontario, Canada
10% 20% 30% 40% 50% 60% 70%

Covered Interval 1'

SIBLEY QUARRY
N.W. 1/4, Sec. 7- T.4 S.- R.11E.
Wayne County, Mich.

North Face of Quarry
10% 20% 30% 40% 50% 60% 70%

SIBLEY QUARRY
N.W. 1/4, Sec. 1- T.4 S., R.11E.
Wayne County, Mich.
East face of Quarry
10% 20% 30% 40% 50% 60% 70% 80%

SYLVANIA ROAD
Sec. 17, 18 & 20 - T. 9 S., R. 6 E.
Section along Sylvania Road
Lucas County, Ohio
French Company Quarry
10% 20% 30% 40% 50% 60% 70% 80%

SILICA SHALE
DUNDEE FORMATION

Covered Interval 2'

Covered Interval 18'

DUNDEE
DETROIT RIVER

Covered Interval 8'

MONROE COUNTY QUARRY
1½ miles South of Raisin River
near Western edge of
French Concessions
Raisinville Township, ½ mile
East of Northeast corner of
Sec. 25, T. 6 S., R. 7 E.
10% 20% 30% 40% 50% 60% 70%

DETROIT RIVER
SYLVANIA SANDSTONE

Detroit River
Sylvania Sandstone

Fig. 2-HISTOGRAMS OF INSOLUBLE RESIDUES OF DETROIT RIVER AND DUNDEE FORMATIONS

LEGEND

- Clay, Silt, and Chert
- Sand
- Gypsum
- X — No Sample
- C — Contaminated

1/8" = 1'

6'
6'
4'
2'
0
Vertical Scale of Histograms