

University of Minnesota
Minnesota Geological Survey
George M. Schwartz, Director

Summary Report No. 4

THE HIGH MAGNESIUM DOLOMITES AND
DOLOMITIC LIMESTONES OF MINNESOTA

by

Clinton R. Stauffer

January, 1950

THE DOLOMITES OF MINNESOTA

Geologic Range and Distribution

The dolomites of southeastern Minnesota belong to the early and middle Paleozoic. Although they begin in late Cambrian and end in upper Devonian, the most important from the standpoint of distribution belong to the Ordovician. The bulk of the Minnesota limestones are more or less dolomitic although there are some notable exceptions. Those running high enough in magnesium carbonate to be of interest as a possible source of the metal are limited to the Nicollet Creek, the Oneota, the Shakopee, and the lower part of the Cedar Valley. The Nicollet Creek is probably the most widely distributed, but it is often highly arenaceous and where that is the case it is wholly unsuited to use as a source of magnesium. The Oneota and Shakopee are nearly coextensive and cover a large area. The Cedar Valley is found only in several southern counties, and its high magnesian content is limited chiefly to the region about Spring Valley.

Geologic Classification

In order to show the relationship of these various dolomitic beds to other formations and to each other within the state, the classification of the Paleozoic for the region under discussion is given. This is best accomplished by the regular table of formations with the older at the bottom and the progressively younger above:

Table of Formations

Paleozoic

Devonian

Cedar Valley limestone

Ordovician

Maquoketa formation

Wyckoff member

Dubuque member

Galena formation

Stewartville member

Prosser member

Decorah member

Platteville formation

Spechts Ferry member

McGregor member

Glenwood member

St. Peter sandstone

Shakopee dolomite

Root Valley sandstone

Oneota dolomite

Blue Earth siltstone

Kasota sandstone

Cambrian

- Jordan sandstone
 - Van Oser member
 - Norwalk member
- St. Lawrence formation
 - Lodi member
 - Nicollet Creek member
- Franconia formation
 - Bad Axe member
 - Hudson member
 - Taylor's Falls member
 - Ironton member
- Dresbach formation
 - Galesville member
 - Eau Claire member
 - Mt. Simon member

The Dolomites

The Nicollet Creek is the oldest of the dolomites in southeastern Minnesota. It is usually an arenaceous, glauconitic gray to pink dolomite which rarely exceeds twenty feet, but at Judson and Hebron, along the Minnesota River, it has a total thickness of about thirty-five feet. Part of this is very sandy dolomite, but some of the better layers exceed 40% in magnesium carbonate. A general sample, however, may prove less encouraging. The type section is along the lower course of Nicollet Creek, the outlet to Swan Lake, in Nicollet County, in the E. 1/2 Sec. 33, T. 109 N., R. 28 W. This is near Hebron and across the Mississippi River from the northwest corner of the town of Judson. The Nicollet Creek constitutes the major part of the St. Lawrence formation, as that formation is now defined, and is the rock at the old Hewett and Beeson quarries near St. Lawrence from which place the name of the formation was derived. This member was sampled only along the Minnesota River where it is better developed than elsewhere in the state and where it is perhaps more promising.

The Oneota is a thick bedded, gray to buff and tan dolomite covering a large area in southeastern Minnesota, but over much of this area it is so deeply buried beneath later formations that it is useless to consider its economic value in such regions. Outcrops occur in the high bluffs along the Mississippi River and along some of its more important tributaries, such as the Minnesota, the St. Croix, the Cannon, the Zumbro, the Whitewater, and the Root, where quarries have been opened in it and the rock used for building purposes and for road metal. The upper part of this dolomite is often cherty, especially near and at the outcrops along the Mississippi River where most of the upper forty feet may be rough fossiliferous gray chert.

The Shakopee usually crops out in the bluffs above the Oneota. It is more evenly bedded than the preceding, also more calcareous, often dolitic, and may contain great quantities of oolitic chert. In some regions part of the formation changes into algae reefs in which the bedding is nearly obliterated.

Analyses of the samples collected from this formation show it to be more of a dolomitic limestone than a true dolomite, and it is probable that at no place is it a suitable rock from which to recover the magnesium.

The Stewartville dolomite received some consideration in this study, but it is even less suitable as a dolomite for the recovery of magnesium, by the Pidgeon process, than the Shakopee. It is, in fact, another dolomitic limestone, finally considered of too low magnesium content to include here with the more dolomitic rocks.

The Cedar Valley is a variable formation usually referred to as a limestone which, in fact, it is as a rule. In the region around LeRoy it contains an exceptionally high calcium rock which is the purest limestone of the state. At Spring Valley, however, where the lowest layers crop out, the rock is a typical dolomite, falling well within the range of possibility as a source of magnesium. The Cedar Valley is a Devonian formation and constitutes the last Paleozoic formation in the state.

Sections Sampled

The sampling started along the St. Croix River near the northern end of the Oneota outcrop and continued down that stream and southward along the tributaries of the Mississippi to the state line. Then finally the outcrops along the Minnesota River were covered by the sampling process. This consisted of obtaining a continuous sample through each ten foot interval of rock exposed.

The numeral attached to the sample designates the locality and the letter the position in the section. "A" is always at the bottom and the others in alphabetic succession indicate higher and higher divisions of the rock section. Each sample, like 2b, represents a rock thickness of 10 feet unless otherwise designated. Usually only that part of the section sampled is given.

Location #1

Section at Arcola, Washington County. The old quarry near Soo Line High Bridge. (Sec. 32-31-19):

- | | |
|---|-----|
| 6. Drift covered to top of hill back of the old lime kiln. | 12' |
| Oneota dolomite: | |
| 5. Dolomite, rough, massive, with quartz geodes.
No. sample. | 5' |
| 4. Dolomite, rough, thick bedded, gray to drab. Sample #1. | 15' |
| 3. Covered. | 5' |

2. Dolomite, sandy, gray. 3'
1. Covered, probably Jordan sandstone.

This old quarry is located 100 yards north of the Soo Line; there is little stripping and plenty of rock available, but the quality, as a dolomite, is low.

Location #2

Section of the old McNaughton Quarry in Stillwater, Minnesota. Now owned by Henry Radle.

Oneota dolomite:

4. Dolomite, medium to thick beds, gray to brown. The upper layers of the quarry along west side. Sample #2d. 8'
3. Dolomite, thick beds of gray to brown. Sample #2c. 10'
2. Dolomite, medium to thick beds, gray to drab, extending up from floor of quarry. Sample #2b. 10'
1. Dolomite, sandy, drab, to gray, thick bedded, probably worthless. This extends down to the Jordan sandstone. Sample #2a. 25'

Location #3

Section on Gray Cloud Island, Washington County.

Gray Cloud Island is in the southwest corner of the county. The St. Peter sandstone has been stripped off essentially the whole region by the Mississippi River and rock is near the surface. The sample was taken at the East center of Section 25, T. 27 N., R. 22 W.

Oneota dolomite:

4. Dolomite, rough and slightly sandy, gray to drab in color. Upper part of sample #3a. Only one sample taken. 8'
3. Dolomite, gray to drab, rough and vesicular at the top. Lower part of sample #3a. 10'
2. Dolomite, sandy, poor, not sampled. Covered interval to water level in channel. 10'
1. Same as No. 2.

This location is about 1,000 yards from the railroad but it is not a recommended location.

Location #4

Section of the Hastings Stone Company's Quarry at Hastings, Minnesota.

Shakopee dolomite:

10. Dolomite or dolomitic limestone, gray to drab, thick bedded, oolitic, with some oolitic chert. Sample #4j. 10'
9. Dolomitic limestone, gray to drab, somewhat oolitic. Sample #4i. 10'
8. Dolomitic limestone, gray to drab, thick bedded. Sample #4h. 10'
7. Dolomitic limestone, gray to drab. Sample #4g. 10'

Root Valley:

6. Dolomite and dolomitic sand, gray, not very well sampled. Probably a mixture of beds above and below. Sample #4f. 10'

Oneota dolomite:

5. Dolomite, gray to brown, thick bedded. Sample #4e. 10'
4. Dolomite, gray, brown to pink, thick bedded. Sample #4d. 10'
3. Dolomite, gray to drab or brown, medium to thick beds. Sample #4c. 10'
2. Dolomite, gray to brown. Sample #4b. 10'
1. Dolomite, gray, hard, dense, in lower part of quarry. Sample #4a. 10'

This quarry is located about 4 miles down the river from Hastings and is about 300 yards from the Milwaukee railroad--overburden 40 ft.

Location #5

Section in Memorial Park, Red Wing, Minnesota.

Oneota dolomite:

6. Dolomite, gray to drab, massive beds weathering thin. Sample #5f. 5'
5. Dolomite, gray to drab, thick bedded. Sample #5e. 10'
4. Dolomite, gray. Sample #5d. 10'

3. Dolomite, gray to drab. Sample #5c. 10'
2. Dolomite, drab. Sample #5b. 10'
1. Dolomite, gray to drab, somewhat sandy. Taken below quarry floor. Sample #5a. 10'

The Oneota in Red Wing lies high above the Milwaukee Railroad, with its base nearly 200 feet above the river. Transportation is easily available and the overburden is light in part of the area.

Location #6

Section of Frontenac Quarries at Old Frontenac, Goodhue County, Minnesota.

Oneota Dolomite:

5. Dolomite, gray to brown, somewhat weathered, vesicular thin bedded. Sample #6e. 10'
4. Dolomite, gray to drab, thick bedded. Sample #6d. 11'
3. Dolomite, compact, gray. Sample #6c. 10'
2. Dolomite, gray to drab, thick bedded. Sample #6b. 10'
1. Dolomite, gray, thick bedded, the fine building stone layer in base of quarry. Sample #6a. 10'

Railway accommodations near by and plenty of rock, although this quarry is not suitably located.

Location #7

Zumbro Falls, Wabasha County. Section along highway, eastward from town.

St. Peter sandstone:

15. Sandstone, white to yellow. 7'

Shakopee dolomite:

14. Dolomite, gray. Sample #7m. 6'
13. Dolomite, gray, slightly sandy. Sample #7l. 10'
12. Dolomite, gray, hard, in old quarry in field. Sample #7k. 10'
11. Dolomite, hard, gray. Sample #7j. 10'
10. Dolomite, compact, hard, gray, with Cryptozoons. Sample #7i. 10'

9. Dolomite or dolomitic limestone, gray to drab, with masses of calcite crystals, with Cryptozoons common. Sample #7h. 10'
- Root Valley sandstone:
8. Dolomite and sandy dolomite. Probably the upper three feet belong to the Shakopee. Sample #7g. 10'
7. Sandstone and sandy gray dolomite. Sample #7f. 10'
6. Sand and sandy gray dolomite. Sample #7e. 10'
- Oneota dolomite:
5. Dolomite, gray. Sample #7d. 10'
4. Dolomite, thick bedded, gray. Sample #7c. 10'
3. Dolomite, even bedded, hard, gray. Sample #7b. 10'
2. Dolomite, massive, hard, gray to buff. Sample #7a. 10'
1. Covered interval to level of Zumbro River.

Location #8

Lake City, Wabasha County. Section along Highway #63, four miles south of town.

18. Covered to top of hill in field. 25'
- Shakopee dolomite:
17. Dolomite, compact, gray to drab, somewhat sandy. 38'
- Root Valley sandstone:
16. Sand, yellow to white. 4'
15. Dolomite, somewhat sandy, not sampled. 20'
14. Shales and sandy beds. 16'
- Oneota dolomite:
13. Dolomite, hard, compact, gray weathering to yellow. Partly covered at top. This is last bed sampled. Sample #8k. 5'
12. Dolomite, thick bedded, hard, tough, gray to drab. Sample #8j. 10'
11. Dolomite, thick bedded, gray. Sample #8i. 10'

- | | |
|---|-----|
| 10. Dolomite, thick bedded, gray to drab. Sample #8h. | 10' |
| 9. Dolomite, thick bedded, gray. Sample #8g. | 10' |
| 8. Dolomite, thick bedded to massive, gray, somewhat cavernous, beds irregular. Sample #8f. | 10' |
| 7. Dolomite, irregular bedding, somewhat massive, gray. Sample #8e. | 10' |
| 6. Dolomite, massive, gray, with poorly preserved fossils common. Sample #8d. | 10' |
| 5. Dolomite, massive beds, gray to buff, with some quartz geodes. Sample #8c. | 10' |
| 4. Dolomite, thick bedded to massive, gray. Sample #8b. | 10' |
| 3. Dolomite, thick bedded, gray to buff. Sample #8a. | 10' |
| Jordan sandstone (no samples): | |
| 2. Sandstone, soft, yellow, with hard masses or lenses. Medium to fine grain. | 15' |
| 1. Covered interval to the creek level under Bridge #4661. | 9' |

Truck transportation available but the Oneota is under heavy cover of Shakopee which consistently shows low magnesium content. It is quite probable the Oneota would not be found to vary greatly in composition from that in the above section if a suitable location were found along the railroad nearer the Mississippi River below Lake City.

Location #9

E. L. Schwirts Quarry, (S.W. 1/4, Sec. 36-110-13), Millville, Wabasha County.

- | | |
|---|-----|
| 9. Soil covering. | 5' |
| Root Valley sandstone: | |
| 8. Sandstone, brown. | 2' |
| 7. Sandstone and sandy dolomite. | 5' |
| 6. Shales, gray, and sandy beds with layers of sandy dolomite. No sample. | 5' |
| Oneota dolomite: | |
| 5. Dolomite, thick bedded, hard, gray. Sample #9d. | 10' |
| 4. Dolomite, thick bedded, gray. Sample #9c. | 10' |

3. Dolomite, massive, gnarly or knotty, gray. Sample #9b. 10'
2. Dolomite, massive, gray, with calcite filled cavities. Sample #9a. 10'
1. Covered interval from creek to floor of quarry. 9'

Truck transportation. Highway passes the quarry, which is located 4 1/2 miles east of Zumbro Falls.

Location #10

Section along Highway #60, two miles southeast of Wabasha, Wabasha County.

11. Soil and loose blocks of weathered gray dolomite. 20'
10. Sandstone and layers of flinty dolomite, may be float. No sample taken. 10'

Oneota dolomite:

9. Dolomite, hard, cherty, gray, no sample. 15'
8. Dolomite, hard, cherty, gray with quartz geodes. Sample #10g. 10'
7. Dolomite, hard, medium to thick bedded, gray. Sample #10f. 10'
6. Dolomite, hard, thick bedded, gray. Sample #10e. 10'
5. Dolomite, hard, massive, gray. Sample #10d. 10'
4. Dolomite, hard, massive, gray. Sample #10c. 10'
3. Dolomite, massive, gray. Sample #10b. 10'
2. Dolomite, hard, gray, somewhat sandy. Sample #10a. 10'

Jordan sandstone:

1. Sandstone, yellow to white, well exposed. 100'±

Milwaukee Railroad only 300 yards distant.

Location #11

Section of W. P. A. Quarry, (Sec. 25-107-10), 4 miles southeast of Elba, Winona County.

- | | |
|--|------|
| 9. Drift covered to field above. | 40'± |
| Oneota dolomite: | |
| 8. Dolomite, hard, massive, gray. Sample #11g. | 10' |
| 7. Dolomite, hard, massive, gray with chert and some calcite filled cavities. Sample #11f. | 10' |
| 6. Dolomite, hard, gray, thick bedded. Sample #11e. | 10' |
| 5. Dolomite, hard, gray, with some quartz geodes. Sample #11d. | 10' |
| 4. Dolomite, compact, gray. Sample #11c. | 10' |
| 3. Dolomite, hard, thick bedded, gray, vesicular and fossiliferous. Sample #11b. | 10' |
| 2. Dolomite, thin to thick bedded, soft to hard, gray to buff. | 10' |
| 1. Covered interval to level of Creek. | 1'6" |

Truck transportation only. The material from this quarry has been used in various W. P. A. projects of the region.

Location #12

Section of the old dolomite quarry along the hill road west from town of Dresbach, Minnesota.

- | | |
|--|-----|
| 7. Covered into woods above. | 40' |
| Oneota dolomite: | |
| 6. Dolomite, thick bedded, gray, somewhat weathered at top of quarry. Sample #12e. | 10' |
| 5. Dolomite, thick bedded, gray. Sample #12d. | 10' |
| 4. Dolomite, thick bedded, gray. Sample #12c. | 10' |
| 3. Dolomite, thick to massive, gray. Sample #12b. | 10' |
| 2. Dolomite, medium to thick, gray. Sample #12a. | 10' |
| 1. Dolomite, sandy, gray and yellowish sandstones from | |

floor of quarry to Jordan-Oneota contact. Not sampled. 26'

Location #13

Section of Old Quarry (Sec. 15-104-4), along hill road 1 1/2 miles northwest of La Crescent.

- | | |
|---|-----|
| 11. Covered to top of hill above. | 25' |
| 10. Loose rock, no samples. | 3' |
| Oneota dolomite: | |
| 9. Dolomite, hard, even bedded, gray. Sample #13g. | 10' |
| 8. Dolomite, hard, somewhat cherty, gray. Sample #13f. | 10' |
| 7. Dolomite, even bedded, gray. Sample #13e. | 10' |
| 6. Dolomite, hard, gray, with some chert near base. Sample #13d. | 10' |
| 5. Dolomite, gray to buff, with some glauconite near middle and <u>Cryptozoons</u> at top. Sample #13c. | 10' |
| 4. Dolomite, medium to thick bedded, gray to buff. Sample #13b. | 10' |
| 3. Dolomite, gray, somewhat sandy. Sample #13a. | 10' |
| Jordan sandstone, good contact. | |
| 2. Sandstone, hard, gray to white. | 25' |
| 1. Sandstone, coarse to fine, yellow to white, well exposed along road. | 50' |

Location #14

Section of the Oneota dolomite near top of Stockton Hill, at Winona, Minnesota.

- | | |
|--|-----|
| Oneota dolomite: | |
| 15. Dolomite, massive, rough, cherty, gray. Sample #14o. | 12' |
| 14. Dolomite, massive, rough, gray. Sample #14n. | 10' |
| 13. Dolomite, rough, cherty, gray, with calcite crystal aggregates. Sample #14m. | 10' |
| 12. Dolomite, rough, gray. Sample #14l. | 10' |

11. Dolomite, rough, vesicular, cherty, calcite bearing, Sample #14k. 10'
10. Dolomite, massive, rough, gray, with some chert and calcite crystals. Sample #14j. 10'
9. Dolomite, medium bedded, fine textured, gray, with chert and calcite. Sample #14i. 10'
8. Dolomite, medium to fine textured, even bedded, gray. Sample #14h. 10'
7. Dolomite, fine textured, even bedded, gray, with a few chert nodules. Sample #14g. 10'
6. Dolomite, medium bedded, gray. Sample #14f. 10'
5. Dolomite, thick bedded, rough vesicular, gray. Fossiliferous. Sample #14e. 10'
4. Dolomite, thick bedded, gray. Sample #14d. 10'
3. Dolomite, soft, vesicular, gray, medium to thick layers, fossiliferous. Sample #14c. 10'
2. Dolomite, coarse, sandy, glauconitic, gray in color. Sample #14b. 10'
1. Dolomite, coarse, sandy, gray, with calcite crystals, and Cryptozoons. This extends down to the Jordan-Oneota contact. Sample #14a. 10'

This is the upper part of the Stockton Hill section, published in Geological Survey of Minnesota Bulletin 29. The samples were taken for analyses of the Oneota only and do not include some of the higher weathered beds. Transportation by truck, but it is not far from the railroad outlet at Winona.

Location #15

Section of the Oneota dolomite, (Sec. 2-104-8), along Highway #43 about 2 1/2 miles north of the town of Rushford, Minnesota.

Oneota dolomite:

14. Dolomite, weathered, cherty, gray. Not sampled. 25'
13. Dolomite, weathered, cherty, gray to buff or brown. Sample #15m. 10'
12. Dolomite, rough bedded, massive, gray, with some chert and occasional geodes. Sample #15l. 10'

11. Dolomite, massive, hard, gray, with clusters of calcite crystals and some chert bands. Sample #15k. 10'
10. Dolomite, gray, with some chert and occasional calcite crystals. Sample #15j. 10'
9. Dolomite, compact, gray. Sample #15i. 10'
8. Dolomite, mostly thick bedded, gray fossiliferous. Sample #15h. 10'
7. Dolomite, fine textured, hard, rough, massive, gray. Sample #15g. 10'
6. Dolomite, fine textured, hard, massive, rough, gray, with crystals of calcite showing. Sample #15f. 10'
5. Dolomite, fine textured, massive, rough, gray. Sample #15e. 10'
4. Dolomite, even bedded, hard, gray, fine textured, compact, Somewhat fossiliferous. Sample #15d. 10'
3. Dolomite, medium to thin bedded, hard, rough, gray, with some nodules of chert. Sample #15c. 10'
2. Dolomite, hard, gray to greenish-gray. Top layer is the green shale of section in Bulletin 29. Sample #15b. 10'
1. Dolomite, rough, irregular beds, gray. Lower beds oolitic arenaceous and with a few pebbles. Middle and upper beds with Cryptozoons. Sample #15a. 10'

Jordan-Oneota contact.

Truck transportation only. Railroad 2 1/2 miles distant.

Location #16

Section of the Oneota along Highway #16 at Lanesboro, Minnesota.

Platteville limestone

McGregor member:

25. Limestone, even bedded, gray to bluish, fossiliferous. No samples taken. 12'6"

Glenwood member:

24. Shale, soft, blue to green, part arenaceous. No samples taken. 8'3"

St. Peter sandstone:

23. Sandstone, white to yellow, only upper part showing balance covered. No samples. 100'

Shakopee dolomitic limestone:

22. Limestone, dolomitic, gray, rough bedded, with some calcite crystals. Sample #16s. 10'
21. Limestone, dolomitic, rough bedded, gray with calcite crystals. Sample #16r. 10'
20. Limestone, dolomitic, rough, irregular, gray layers, with Cryptozoons. Sample #16q. 10'
19. Limestone, dolomitic, thick bedded, sandy, gray, with calcite crystals and Cryptozoons. Sample #16p. 10'

Root Valley sandstone:

18. Sandstone, gray to white, medium to fine grain. No samples taken. 28'

Oneota dolomite:

17. Dolomite, hard, rough, sandy, gray. Sample #16o. 12'
16. Dolomite, compact, hard, gray, thick bedded. Sample #16n. 10'
15. Dolomite, thick bedded, gray, with a little chert. Sample #16m. 10'
14. Dolomite, thick bedded, gray. Sample #16l. 10'
13. Dolomite, partly covered and a long hand level shot to cliff in town. Sample #16kk. 15'
12. Dolomite, massive, gray, with chert nodules and masses of calcite crystals. Sample #16k. 10'
11. Dolomite, massive, gray, cherty, fossiliferous. Sample #16j. 10'
10. Dolomite, thick bedded, gray, with masses of calcite crystals and some chert, fossiliferous. Sample #16i. 10'
9. Dolomite, irregularly bedded, gray with calcite crystals and chert. Sample #16h. 10'
8. Dolomite, medium to thick beds, gray. Sample #16g. 10'
7. Dolomite, medium to thin bedded, gray, with a little chert. Sample #16f. 10'

6. Dolomite, thick bedded, gray. Sample #16e. 10'
5. Dolomite, even bedded, gray to buff. Sample #16d. 10'
4. Dolomite, thick, even bedded, gray, fossiliferous. Sample #16c. 10'
3. Dolomite, medium to thin bedded, somewhat arenaceous, gray to yellow, with calcite crystals. Sample #16b. 10'
2. Dolomite, coarse, thick, sandy beds, gray in color and with calcite crystals. Sample #16a. 10'

Jordan sandstone:

1. Sandstone, yellow to white, medium to fine grain. 3'

Although this set of samples was taken along the highway #16, the section is repeated in the high bluff along the river in town where the Milwaukee Railroad is available for transportation.

Location #17

Section of the John Henry hill at Egbert, Houston County. (Sec. 16-T102N-R5W):

Oneota dolomite:

14. Dolomite, weathered, cherty, gray, to top of hill. No sample taken. 12'
13. Dolomite, rough, cherty, gray to buff. Sample #17l. 10'
12. Dolomite, hard, massive, gray, with nodules and clusters of calcite crystals. Sample #17k. 10'
11. Dolomite, thick bedded, sandy, buff. Sample #17j. 10'
10. Dolomite, thick bedded, fine textured, buff. Sample #17i. 10'
9. Dolomite, thick to thin beds, gray to buff, fine grained, has sand pockets. Sample #17h. 10'
8. Dolomite, thick bedded, gray to buff, with a little chert and masses of calcite crystals. Sample #17g. 10'
7. Dolomite, thick bedded, fine textured, light gray to buff. Sample #17f. 10'
6. Dolomite, thin bedded, buff. Sample #17e. 10'

5. Dolomite, thin bedded, gray to buff, with fucoids. Sample #17d. 10'
4. Dolomite, gray to buff, somewhat arenaceous. Sample #17c. 10'
3. Dolomite, hard, gray to buff, thin bedded, with sandy streaks. Sample #17b. 10'
2. Dolomite, even bedded, gray, arenaceous. Sample #17a. 10'

Jordan sandstone:

1. Sandstone, white to yellow, with hard layers. Extends to level of creek at Egbert flag station. No sample taken. 20'

Milwaukee Railroad for transportation available.

Location #18

Section of G. P. Armstrong quarry, Spring Grove, Houston County, Minnesota.

7. Loess and soil. No sample taken. 2'

St. Peter sandstone:

6. Sandstone, yellow to white, much of it hard, typical basal St. Peter. No samples taken. 4'
5. Limestone, dolomitic, hard, gray. Sample #18d. 2'
4. Sandstone, cross-bedded, ripple marked, white to yellow. No sample taken. 5'

Shakopee dolomitic limestone:

3. Limestone, dolomitic, hard, gray, slightly sandy. Sample #18c. 5'
2. Limestone, dolomitic, thick bedded, grading into arenaceous beds with clusters of calcite crystals. Sample #18b. 10'
1. Limestone, dolomitic, hard, massive, rough, gray, beds with calcite crystals common, singly or in clusters. Sample #18a. 10'

Truck transportation only.

Location #20

Section of E. Vanderbosch Quarry, (Sec. 30-102-12), East of Etna.

7. Covered interval to woods above. 3'

Cedar Valley limestone:

6. Limestone, dolomitic, buff to yellow, fossiliferous.
Sample #20c. 7'

5. Limestone, dolomitic, thick bedded, cavernous, gray to
buff, fossiliferous. Sample #20b. 10'

4. Limestone, dolomitic, massive, gray to buff, fossilifer-
ous, Sample #20a. 10'

Maquoketa shale:

3. Shale and limestone, light gray, contains Lingula
iowaensis and Plectambonites kankakeensis. No sample
taken. 5'

2. Shales and limestone, partly covered. No sample
taken. 15'

1. Covered interval to creek level below. No sample
possible. 13'

Truck transportation only.

Location #21

Larson Quarry, (Sec. 33-103-13), in southwest part of Spring Valley,
Minnesota.

4. Soil covered. 2'

Cedar Valley limestone:

3. Limestone, dolomitic, somewhat weathered, rough,
cavernous, buff to yellow, fossiliferous. Sample #21b. 7'

2. Limestone, dolomitic, thick bedded, rough, buff to yellow,
very fossiliferous, the Prostuctella zone. Sample #21a. 10'

1. Covered from bottom of quarry to level of creek at bridge
on Hudson Avenue. 31'

The Milwaukee Railroad is convenient.

Location #22

Section (Sec. 1-103N-14W) at Hamilton, Minnesota.

This is on the south bank of Bear Creek and is very poor at the present time. There is perhaps 40 feet of the Cedar Valley limestone here. Sample #22a is a general sample, representing the whole Devonian outcrop.

Location #23

Section of the Beach Quarry (Sec. 28-101-18) on the west bank of Cedar River, 3 miles west of Lyle, Minnesota, and one north of the state line.

4. Covered interval. 4'

Cedar Valley limestone:

3. Limestone, dolomitic, rough, medium to thin bedded, buff, hard, a few fossils. Sample #23b. 10'

2. Limestone, dolomitic, thick bedded, hard, rough, cavernous, gray to buff, with numerous fossils. Sample #23a. 10'

1. Covered interval to level of Cedar River. 9'

Transportation by Chicago, Great Western Railway is one half mile distant.

Location #24

Sample #24 was taken at the old mill dam on Dobbins Creek at the corner of Slavin and Bank Streets. Only about 8 feet of the dolomitic beds were sampled. The upper part of the outcrop is displaced and the lower beds grade downward into impure shaly limestone. The rock is also faulted here and the exact amount in the outcrop is not known.

There is undoubtedly an abundance of rock available here for any purpose for which it is suited. Stripping is light and both rail and highway easily accessible.

Location #25

Section at Highway #52 bridge over Zumbro River at Cronoco, Minnesota.

4. Covered interval. 5'

Shakopee dolomite:

3. Dolomitic limestone, hard, gray, medium bedded, with occasional sand lenses. Sample #25b. 13'

2. Dolomitic limestone, hard, gray, medium bedded.
Fossiliferous. Sample #25a. 10'
1. Covered interval to level of Zumbro River. No samples
taken. 16'6"

Location #26

Section along the Cannon River, in the town of Cannon Falls, Minnesota.

7. St. Peter sandstone 30'
6. Covered interval. 103'
- Shakopee dolomitic limestone:
5. Dolomitic limestone, thin to thick bedded, cavities with
crystals of calcite. Sample #26d. 10'
4. Sandstone, white to yellow. No samples. 3'6"
3. Dolomitic limestone, hard, gray, with Cryptozoons.
Sample #26c. 14'
2. Dolomitic limestone, hard, gray. Sample #26b. 10'
1. Dolomitic limestone, rough, gray, to level of Cannon
River at the Great Western Railway bridge. Sample #26a. 10'

Rail and truck transportation available. The section extends up to and including the Platteville limestone, but there is plenty of Shakopee available along the railroad with little or no stripping.

Location #27

Section of J. B. Contre Quarry in Shakopee, Minnesota.

4. Covered by soil and river fill. 1'
- Shakopee dolomitic limestone:
3. Limestone, dolomitic, hard, rough, gray to pink, sandy
at bottom. Sample #27b. 8'
2. Limestone, dolomitic, rough, irregular beds of gray to
pink, sandy at the top. Sample #27a. 10'
1. Covered interval from Minnesota River to base of old
quarry. 34'

This quarry is part of a rock terrace in which other openings have been

made within the next half to one mile. The rock is fairly good except for the sandy beds near the top. These quarry pits are all adjacent to the railroad and rock is easily available.

Location #28

Section of Halverson Bros. Quarry, (Sec. 21-115-13), at Merriam Junction, Minnesota.

4. Soil covering. 1'

Oneota dolomite:

3. Dolomite, thin to medium bedded, pink or red to gray, some beds sandy and sand filling old mud cracks. Some pebbles or pebble beds at the top, and some oolite. Sample #28c. 10'
2. Dolomite, rough, hard, pink or red to mottled, small quartz crystals showing and beds oolitic at top. Sample #28b. 10'
1. Dolomite, pink or red to mottled, thick bedded. Some cavities quartz lined, small. This extends to the bottom of the quarry which is about ten feet below the level of the Chicago and Milwaukee tract at the junction. Sample #28a. 10'

This is a new quarry opened in April, 1942. It is near the Milwaukee and St. Louis Railroad where transportation is available.

Location #29

Section of the old Louisville Quarry, (Sec. 22-115-13), at Merriam Junction, Minnesota.

6. Stripping. 0'

Shakopee dolomitic limestone:

5. Dolomitic limestone, hard, gray, some layers very compact. Sample #29d. 7'
4. Dolomite, hard, gray, with some pink beds. Sample #29c. 10'
3. Dolomite, or dolomitic limestone, rough, gray, dolomite with pink tinge, cavities with fine rhombs. Sample #29b. 10'
2. Covered interval, no samples 20'
1. Dolomite, hard, gray to pink, exposed along the railroad track, lowest beds 3 feet below the railroad. Sample #29a. 10'

This quarry was once worked on a rather large scale and burned for lime. It is adjacent to the Northwestern Railroad tracks.

Location #30

Section of the Breen Stone Co. quarry at Kasota, Minnesota.

3. Drift and river fill. 4'

Oneota dolomite:

2. Dolomite, thick to thin bedded, pink to buff. Sample #30b. 10'

1. Dolomite, thick bedded, pink to buff, some fucoids.
Sample #30a. 10'

This quarry is an active producer of fine building stone. It has adequate railroad facilities.

Location #31

Section along Highway #14 at edge of North Mankato, Nicollet County, Minnesota.

5. Covered to fields above. Remnants of several drifts showing. 15'±

Oneota dolomite:

4. Dolomite, thick bedded, gray to buff and brown. Sample #31d. 12'

3. Dolomite, thick to shaly, gray to buff or brown. Sample #31c. 10'

2. Dolomite, thick bedded to shaly, buff to pink or purple in the shale. Sample #31b. 10'

1. Dolomite, thick layers, gray to buff and brown, fossiliferous. 10'

Transportation by truck only. The railroad is across the river.

Location #32

Section from Hebron quarries at the north end of the bridge, southward through Judson along the road south from the Northwestern depot.

5. Covered interval to the fields on the old river terrace. 5'

St. Lawrence formation:

Lodi shale member:

4. Siltstone, shaly, gray to buff, fossils rare. Sample #32d (not analyzed). 6'6"

Nicollet Creek member:

3. Limestone, dolomitic, weathered, gray to buff. Sample #32c. 10'
2. Limestone, dolomitic, hard, gray to pink, glauconitic, medium to shaly layers. Sample #32b. 10'
1. Covered interval with some ledges not certainly in place to level of Minnesota River. Sample #32a not analyzed, probably loose material. 21'

Railroad transportation available. The analyses of this rock suggest material suitable for rock wool.

Location #33

Samples of the Nicollet Creek member, St. Lawrence formation at type section (Sec. 33-109-28) opposite Judson, Minnesota.

5. Covered interval to adjacent fields. 2'

St. Lawrence formation:

Nicollet Creek member:

4. Limestone, dolomitic, hard, gray to pink, glauconitic. Some fossils. Sample #33b. 5'
3. Limestone, dolomitic, thick bedded, rough, gray to pink, some sandy lenses. Sample #33a. 10'
2. Sandstone, a sandy glauconitic dolomitic rock of dark gray color. No sample. 9'
1. Covered to level of Minnesota River. 10'

Railroad transportation is on the opposite side of the river and runs on the same rock terrace, here cut through by Nicollet Creek.

Location #34

Section of the Oneota dolomite at the Coughlin Quarry in Mankato, Minnesota.

Shakopee dolomitic limestone:

10. Limestone, dolomitic, oolitic, gray to brown, some chert. No sample. 10'

Root Valley sandstone:

9. Sandstone, white to yellow. No sample. 5'6"

Oneota dolomite:

8. Dolomite, hard, gray, sandy towards top. Fossiliferous. Sample #34h. 10'
7. Dolomite, thick bedded, buff to pink, some calcite geodes. Fossiliferous. Sample #34g. 10'
6. Dolomite, thick bedded, buff to pink, an important building stone now being quarried. Sample #34f. 10'
5. Dolomite, thick bedded, gray to buff, the Bridge Ledge. Sample #34e. 10'
4. Shale or shaly dolomite, purple. Sample 34d. 2'6"
3. Dolomite, thick bedded, gray, a fine gray building stone. Sample #34c. 3'6"
2. Dolomite, gray, containing Cryptozoons. This is the curly layer. Sample #34b. 3'6"
1. Dolomite, thick bedded, gray, extending down to contact with the Jordan sandstone. Sample #34a. 8'6"

This quarry is along the railroad and hence with convenient transportation. Its present use is supplying building stone. However, a similar rock from Mankato is being used for cement and for manufacture of rock wool.

Location #35

Section (Sec. 20-109-26) four miles north of Mankato, north bluff of Wita Creek.

Oneota dolomite:

4. Dolomite, thick beds of gray to buff color. Sample #35c. 7'
3. Dolomite, thin to thick beds, gray to buff, weathered. Sample #35b. 10'
2. Dolomite, thin bedded, gray, weathered. Sample #35a. 10'
1. Covered with sod and loose rock down to level of Wita Creek at Milwaukee Railroad culvert. No sample. 25'

This was a very poor and unsatisfactory place to sample the Oneota. The value of the few samples is therefore negligible.

Location #36

A single sample, #36, was taken from an eight foot wall of the Nicollet Creek member, St. Lawrence formation, in the old abandoned Hewitt and Beason Quarry (Sec. 21-114-24) at St. Lawrence, a flag stop on the Omaha Railway.

This region is easily accessible to the Omaha Railway and requires very little stripping. It is located on an old rock terrace of the River Warren and nearly a half mile from the present channel of the Minnesota River.

Analyses

The analyses of these samples of dolomite and dolomitic limestones were made at the University of Minnesota, Mines Experiment Station under the direct supervision of Henry H. Wade, Metallurgist. As suggested by Dr. Oliver Bowles of the U. S. Bureau of Mines, only R_2O_3 , SiO_2 , and MgO were determined, but if desired, the CaO can be determined readily from these. The percentage of $MgCO_3$ can be determined by multiplying the percentage of MgO by the factor 2.09. Hence, a sample showing 20 percent or more MgO will have more than 40 percent of the carbonate and therefore, will fall within the range of those rocks interesting as a possible source of magnesium.

An examination of the analyses of Minnesota dolomitic samples indicates that portions of both Oneota and Shakopee are probably suitable for the recovery of magnesium, by a process such as the Ferro-silicon, but that the layers of high magnesium content might have to be mined by tunneling under much overburden of worthless rock since they are seldom at the surface. The Cedar Valley limestone is generally the more suitable and the more accessible of those high in magnesium. This is particularly true at Spring Valley where at least 17 feet are available almost at the surface.

Some of the more favorable localities are the Oneota at Zumbro Falls, Lake City, and Millville; the Shakopee at Zumbro Falls; and the Cedar Valley at Spring Valley and Etna. At many other places where the percentages of MgO is fairly high, the SiO_2 runs high or the rock thickness carrying the higher percentage does not seem so favorable to exploitation.

Geol. Surv. No.	% R ₂ O ₃	% SiO ₂	% MgO	Horizon	Locality
1	2.34	3.03	19.75	Oneota dol.	Soo Line high bridge
2A	2.20	5.66	19.45	Oneota dol.	McNaughton Q., Stillwater
2B	2.13	7.90	19.47	Oneota dol.	McNaughton Q., Stillwater
2C	1.96	3.72	19.47	Oneota dol.	McNaughton Q., Stillwater
2D	2.26	6.28	19.09	Oneota dol.	McNaughton Q., Stillwater
3	1.94	1.53	19.54	Oneota dol.	Gray Cloud Island
4A	1.44	3.54	20.45	Oneota dol.	Hastings Stone Co. Q.
4B	1.12	2.16	20.72	Oneota dol.	Hastings Stone Co. Q.
4C	1.82	8.56	18.89	Oneota dol.	Hastings Stone Co. Q.
4D	2.06	2.76	19.95	Oneota dol.	Hastings Stone Co. Q.
4E	2.12	2.62	19.92	Oneota dol.	Hastings Stone Co. Q.
4F	1.33	12.98	18.04	Oneota-Shak.	Hastings Stone Co. Q.
4G	2.00	12.60	17.82	Shakopee dol.	Hastings Stone Co. Q.
4H	2.20	27.86	14.51	Shakopee dol.	Hastings Stone Co. Q.
4I	1.82	1.88	20.12	Shakopee dol.	Hastings Stone Co. Q.
4J	1.74	3.33	20.00	Shakopee dol.	Hastings Stone Co. Q.
5A	3.12	14.68	17.32	Oneota dol.	Mem. Park, Red Wing, Minn.
5B	1.62	3.84	20.09	Oneota dol.	Mem. Park, Red Wing, Minn.
5C	1.36	3.34	19.81	Oneota dol.	Mem. Park, Red Wing, Minn.
5D	1.13	3.22	19.98	Oneota dol.	Mem. Park, Red Wing, Minn.
5E	0.98	1.90	19.86	Oneota dol.	Mem. Park, Red Wing, Minn.
5F	1.06	2.10	20.45	Oneota dol.	Mem. Park, Red Wing, Minn.
6A	0.88	3.33	20.42	Oneota dol.	Frontenac Quarry
6B	1.18	3.00	20.26	Oneota dol.	Frontenac Quarry
6C	1.28	3.20	20.22	Oneota dol.	Frontenac Quarry
6D	1.02	12.03	18.21	Oneota dol.	Frontenac Quarry
6E	1.32	4.00	19.73	Oneota dol.	Frontenac Quarry
7A	0.96	3.02	20.54	Oneota dol.	Zumbro Falls, Minnesota
7B	1.46	2.58	20.22	Oneota dol.	Zumbro Falls, Minnesota
7C	1.96	2.36	20.02	Oneota dol.	Zumbro Falls, Minnesota
7D	2.34	4.94	18.91	Oneota dol.	Zumbro Falls, Minnesota
7E	2.66	11.73	17.34	Root Valley	Zumbro Falls, Minnesota
7F	2.18	26.26	14.43	Root Valley	Zumbro Falls, Minnesota
7G	1.86	15.96	17.27	Root V. -Shak.	Zumbro Falls, Minnesota
7H	1.54	8.26	19.11	Shakopee dol.	Zumbro Falls, Minnesota
7I	1.18	4.14	19.86	Shakopee dol.	Zumbro Falls, Minnesota
7J	0.98	2.23	20.21	Shakopee dol.	Zumbro Falls, Minnesota
7K	0.86	1.74	20.68	Shakopee dol.	Zumbro Falls, Minnesota
7L	1.40	5.70	19.63	Shakopee dol.	Zumbro Falls, Minnesota
7M	1.56	2.04	18.66	Shakopee dol.	Zumbro Falls, Minnesota
8A	1.90	2.33	19.55	Oneota dol.	Hy. #63, Lake City, Minn.
8B	1.36	1.52	20.37	Oneota dol.	Hy. #63, Lake City, Minn.
8C	1.74	1.42	19.47	Oneota dol.	Hy. #63, Lake City, Minn.
8D	1.04	1.36	20.63	Oneota dol.	Hy. #63, Lake City, Minn.
8E	1.02	2.14	19.86	Oneota dol.	Hy. #63, Lake City, Minn.
8F	1.20	2.30	19.31	Oneota dol.	Hy. #63, Lake City, Minn.
8G	1.54	0.74	19.76	Oneota dol.	Hy. #63, Lake City, Minn.

Geol. Surv. No.	% R ₂ O ₃	% SiO ₂	% MgO	Horizon	Locality
8H	1.50	1.30	18.97	Oneota dol.	Hy. #63, Lake City, Minn.
8I	1.02	3.92	20.50	Oneota dol.	Hy. #63, Lake City, Minn.
8J	1.16	10.38	20.25	Oneota dol.	Hy. #63, Lake City, Minn.
8K	1.26	5.92	20.25	Oneota dol.	Hy. #63, Lake City, Minn.
9A	1.08	2.78	20.33	Oneota dol.	Schwartz Q., Sec. 36-110-13
9B	1.04	2.18	20.45	Oneota dol.	Schwartz Q., Sec. 36-110-13
9C	1.04	1.98	20.42	Oneota dol.	Schwartz Q., Sec. 36-110-13
9D	1.12	4.68	20.16	Oneota dol.	Schwartz Q., Sec. 36-110-13
10A	3.00	10.34	18.34	Oneota dol.	Wabasha, Minnesota
10B	2.40	7.74	19.02	Oneota dol.	Wabasha, Minnesota
10C	1.70	5.28	19.97	Oneota dol.	Wabasha, Minnesota
10D	1.36	3.74	19.82	Oneota dol.	Wabasha, Minnesota
10E	1.42	4.14	19.92	Oneota dol.	Wabasha, Minnesota
10F	1.06	3.58	20.15	Oneota dol.	Wabasha, Minnesota
10G	2.04	18.64	16.63	Oneota dol.	Wabasha, Minnesota
11A	1.50	3.64	20.24	Oneota dol.	Elba, Minnesota
11B	1.04	2.54	20.62	Oneota dol.	Elba, Minnesota
11C	1.62	5.28	19.88	Oneota dol.	Elba, Minnesota
11D	1.02	5.48	19.63	Oneota dol.	Elba, Minnesota
11E	1.34	3.30	19.97	Oneota dol.	Elba, Minnesota
11F	1.28	4.04	19.40	Oneota dol.	Elba, Minnesota
11G	1.12	4.38	20.13	Oneota dol.	Elba, Minnesota
12A	2.20	7.04	18.97	Oneota dol.	Dresbach, Minnesota
12B	2.12	6.04	19.31	Oneota dol.	Dresbach, Minnesota
12C	1.96	7.84	19.04	Oneota dol.	Dresbach, Minnesota
12D	1.44	4.78	20.08	Oneota dol.	Dresbach, Minnesota
12E	1.58	4.76	19.73	Oneota dol.	Dresbach, Minnesota
13A	1.96	19.40	16.77	Oneota dol.	La Crescent, Minnesota
13B	1.22	14.24	18.07	Oneota dol.	La Crescent, Minnesota
13C	1.28	8.10	18.90	Oneota dol.	La Crescent, Minnesota
13D	1.72	4.72	19.65	Oneota dol.	La Crescent, Minnesota
13E	1.36	3.92	19.80	Oneota dol.	La Crescent, Minnesota
13F	1.50	4.40	18.23	Oneota dol.	La Crescent, Minnesota
13G	1.50	5.58	19.53	Oneota dol.	La Crescent, Minnesota
14A	1.72	19.96	15.63	Oneota dol.	Stockton Hill, Winona, Minn.
14B	1.14	18.22	16.82	Oneota dol.	Stockton Hill, Winona, Minn.
14C	1.44	11.26	18.14	Oneota dol.	Stockton Hill, Winona, Minn.
14D	1.58	5.90	19.16	Oneota dol.	Stockton Hill, Winona, Minn.
14E	1.72	7.00	19.16	Oneota dol.	Stockton Hill, Winona, Minn.
14F	1.22	3.88	19.83	Oneota dol.	Stockton Hill, Winona, Minn.
14G	1.08	3.20	20.30	Oneota dol.	Stockton Hill, Winona, Minn.
14H	1.06	3.56	20.23	Oneota dol.	Stockton Hill, Winona, Minn.
14I	0.92	3.08	18.56	Oneota dol.	Stockton Hill, Winona, Minn.
14J	0.92	5.52	19.74	Oneota dol.	Stockton Hill, Winona, Minn.
14K	0.84	2.96	20.06	Oneota dol.	Stockton Hill, Winona, Minn.
14L	0.76	3.32	20.49	Oneota dol.	Stockton Hill, Winona, Minn.
14M	1.36	29.94	13.09	Oneota dol.	Stockton Hill, Winona, Minn.

G. S. No.	R ₂ O ₃	SiO ₂	MgO	Horizon	Locality
14N	0.84	2.96	20.15	Oneota dol.	Stockton Hill, Winona, Minn.
14O	0.84	4.70	19.05	Oneota dol.	Stockton Hill, Winona, Minn.
15A	1.44	31.54	13.43	Oneota dol.	Rushford, Minnesota
15B	1.28	16.64	16.08	Oneota dol.	Rushford, Minnesota
15C	1.46	20.24	14.97	Oneota dol.	Rushford, Minnesota
15D	1.00	3.36	18.91	Oneota dol.	Rushford, Minnesota
15E	0.90	3.00	19.77	Oneota dol.	Rushford, Minnesota
15F	0.76	2.80	20.39	Oneota dol.	Rushford, Minnesota
15G	0.92	3.34	19.86	Oneota dol.	Rushford, Minnesota
15H	0.78	3.60	19.02	Oneota dol.	Rushford, Minnesota
15I	0.94	4.18	19.97	Oneota dol.	Rushford, Minnesota
15J	0.84	3.90	19.74	Oneota dol.	Rushford, Minnesota
15K	0.92	7.00	17.47	Oneota dol.	Rushford, Minnesota
15L	0.78	2.64	19.26	Oneota dol.	Rushford, Minnesota
15M	0.86	10.38	18.39	Oneota dol.	Rushford, Minnesota
16A	1.66	14.14	16.96	Oneota dol.	Lanesboro, Minnesota
16B	1.60	4.20	19.77	Oneota dol.	Lanesboro, Minnesota
16C	1.28	3.52	19.99	Oneota dol.	Lanesboro, Minnesota
16D	1.78	6.66	19.37	Oneota dol.	Lanesboro, Minnesota
16E	1.08	9.64	19.84	Oneota dol.	Lanesboro, Minnesota
16F	1.26	2.80	19.71	Oneota dol.	Lanesboro, Minnesota
16G	1.04	8.56	20.14	Oneota dol.	Lanesboro, Minnesota
16H	1.16	3.68	18.03	Oneota dol.	Lanesboro, Minnesota
16I	1.04	3.98	19.60	Oneota dol.	Lanesboro, Minnesota
16J	1.00	25.28	19.46	Oneota dol.	Lanesboro, Minnesota
16K	1.24	7.24	18.11	Oneota dol.	Lanesboro, Minnesota
16KK	1.00	2.08	13.77	Oneota dol.	Lanesboro, Minnesota
16L	0.88	5.10	18.53	Oneota dol.	Lanesboro, Minnesota
16M	0.66	20.42	18.94	Oneota dol.	Lanesboro, Minnesota
16N	0.80	4.08	18.89	Oneota dol.	Lanesboro, Minnesota
16O	1.46	4.98	13.13	Oneota dol.	Lanesboro, Minnesota
16P	1.06	4.92	19.10	Shakopee dol.	Lanesboro, Minnesota
16Q	1.02	3.66	18.59	Shakopee dol.	Lanesboro, Minnesota
16R	1.70	1.66	19.23	Shakopee dol.	Lanesboro, Minnesota
16S	1.30	1.74	18.79	Shakopee dol.	Lanesboro, Minnesota
17A	1.34	11.84	18.15	Oneota dol.	Egbert, Minnesota
17B	1.30	9.34	19.15	Oneota dol.	Egbert, Minnesota
17C	1.50	4.34	19.66	Oneota dol.	Egbert, Minnesota
17D	1.40	4.96	20.01	Oneota dol.	Egbert, Minnesota
17E	1.32	3.64	20.02	Oneota dol.	Egbert, Minnesota
17F	1.20	3.10	19.99	Oneota dol.	Egbert, Minnesota
17G	1.12	2.54	18.57	Oneota dol.	Egbert, Minnesota
17H	1.96	7.28	19.56	Oneota dol.	Egbert, Minnesota
17I	1.34	3.06	20.57	Oneota dol.	Egbert, Minnesota
17J	1.32	4.12	19.95	Oneota dol.	Egbert, Minnesota
17K	1.26	3.92	20.21	Oneota dol.	Egbert, Minnesota
17L	1.04	2.48	19.71	Oneota dol.	Egbert, Minnesota
18A	0.60	6.62	19.83	Shakopee dol.	Spring Grove, Minnesota
18B	0.54	3.34	19.67	Shakopee dol.	Spring Grove, Minnesota
18C	0.68	5.96	19.57	Shakopee dol.	Spring Grove, Minnesota

<u>G. S.</u> <u>No.</u>	<u>R₂O₃</u>	<u>SiO₂</u>	<u>MgO</u>	<u>Horizon</u>	<u>Locality</u>
18D	1.40	8.74	18.21	Shakopee dol.	Spring Grove, Minnesota
19A	0.54	0.72	21.02	Cedar Valley	Etna, Minnesota
19B	0.68	0.96	20.78	Cedar Valley	Etna, Minnesota
19C	0.68	0.72	14.47	Cedar Valley	Etna, Minnesota
19D	0.52	0.60	3.72	Cedar Valley	Etna, Minnesota
20A	1.32	1.72	20.52	Cedar Valley	Vanderbosch farm, Etna, Minnesota
20B	1.48	2.28	20.35	Cedar Valley	Vanderbosch farm, Etna, Minnesota
20C	1.06	1.24	19.58	Cedar Valley	Vanderbosch farm, Etna, Minnesota
21A	0.96	0.62	20.83	Cedar Valley	Larson Q., Spring Valley, Minnesota
21B	1.14	1.40	20.66	Cedar Valley	Larson Q., Spring Valley, Minnesota
22A	1.14	1.44	21.07	Cedar Valley	Hamilton, Minnesota
23A	1.56	8.72	20.10	Cedar Valley	Lyle, Minnesota
23B	1.24	7.24	20.73	Cedar Valley	Lyle, Minnesota
24A	3.84	12.14	5.05	Cedar Valley	Austin, Minnesota
25A	1.60	5.90	19.36	Shakopee dol.	Oronoco, Minnesota
25B	1.30	2.96	18.45	Shakopee dol.	Oronoco, Minnesota
26A	1.76	4.14	19.48	Shakopee dol.	Cannon Falls, Minnesota
26B	1.68	6.82	19.59	Shakopee dol.	Cannon Falls, Minnesota
26C	1.56	3.10	20.08	Shakopee dol.	Cannon Falls, Minnesota
26D	2.56	12.00	17.71	Shakopee dol.	Cannon Falls, Minnesota
27A	2.08	4.78	19.21	Shakopee dol.	Shakopee, Minnesota
27B	2.60	7.82	18.42	Shakopee dol.	Shakopee, Minnesota
28A	2.64	4.86	19.29	Oneota dol.	Halverson Q., Merriam Junction
28B	2.72	8.24	18.56	Oneota dol.	Halverson Q., Merriam Junction
28C	2.22	13.74	17.15	Oneota dol.	Halverson Q., Merriam Junction
29A	2.74	5.92	18.28	Shakopee dol.	Louisville Q., Merriam Junction
29B	2.84	2.10	19.03	Shakopee dol.	Louisville Q., Merriam Junction
29C	2.66	4.68	18.74	Shakopee dol.	Louisville Q., Merriam Junction
29D	2.52	6.46	18.65	Shakopee dol.	Louisville Q., Merriam Junction
30A	2.52	9.68	18.33	Oneota dol.	Kasota, Minnesota
30B	2.62	11.62	17.77	Oneota dol.	Kasota, Minnesota
31A	4.68	14.90	15.85	Oneota dol.	Hy. #14 cut, No. Mankato, Minnesota
31B	4.16	11.04	17.37	Oneota dol.	Hy. #14 cut, No. Mankato, Minnesota
31C	3.70	10.32	17.19	Oneota dol.	Hy. #14 cut, No. Mankato, Minnesota

<u>G. S.</u> <u>No.</u>	<u>R₂O₃</u>	<u>SiO₂</u>	<u>MgO</u>	<u>Horizon</u>	<u>Locality</u>
31D	2.92	9.40	17.75	Oneota dol.	Hy. #14 cut, No. Mankato, Minnesota
32A	No sample taken			Bad Axe	Judson, Minnesota
32B	5.18	18.00	15.58	Nicollet Creek	Judson, Minnesota
32C	5.04	14.18	16.11	Nicollet Creek	Judson, Minnesota
33A	7.34	27.34	11.82	Nicollet Creek	Type Section, Judson, Minn.
33B	6.50	22.22	14.11	Nicollet Creek	Type Section, Judson, Minn.
34A	4.66	13.24	17.15	Oneota dol.	Coughlan Quarry, Mankato
34B	2.28	5.60	19.51	Oneota dol.	Coughlan Quarry, Mankato
34C	3.14	8.80	18.21	Oneota dol.	Coughlan Quarry, Mankato
34D	5.78	16.96	15.85	Oneota dol.	Coughlan Quarry, Mankato
34E	3.00	10.02	18.11	Oneota dol.	Coughlan Quarry, Mankato
34F	2.24	8.34	18.94	Oneota dol.	Coughlan Quarry, Mankato
34G	2.16	9.18	18.74	Oneota dol.	Coughlan Quarry, Mankato
34H	2.00	9.08	18.76	Oneota dol.	Coughlan Quarry, Mankato
35A	4.06	10.04	17.68	Oneota dol.	Coughlan No. Q., Mankato
35B	4.60	14.90	15.64	Oneota dol.	Coughlan No. Q., Mankato
35C	2.12	4.466	19.51	Oneota dol.	Coughlan No. Q., Mankato
36A	4.96	9.28	17.74	Nicollet Creek	St. Lawrence, Minnesota

Note: R₂O₃ in the above table is chiefly Fe₂O₃ but includes all other insolubles except SiO₂.