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THE HIGH CALCIUM LIMESTONES OF MINNESOTA

by

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Introduction

The requests for high-grade or high calcium limestones for use in the various industries in Minnesota, particularly those connected with the war effort, made it necessary to re-evaluate the supplies of such materials within the state. To be of value to industries requiring this type of material it is necessary that the aluminum, iron, and magnesium content be very low. All sources known to be high in these impurities were therefore eliminated from consideration and the sources of available high-grade limestone were thoroughly checked and sampled during the summer of 1943. These samples were analyzed by the Mines Experiment Station and the results have been tabulated and incorporated into this report.

Age and Distribution

Limestones of high calcium content are rather limited in Minnesota. Thus, they occur in the rocks formed during middle and upper Ordovician, the upper Devonian, and the Cretaceous periods. Several of these occurrences are of such limited quantity that, for commercial purposes, they may be eliminated at once. That is true of those in the upper Ordovician and in the Cretaceous. The surface distribution of those that are left is limited to a few counties of the southeastern part of the state, chiefly in Fillmore, Olmstead, and Mower counties.

The Ordovician

The Ordovician of Minnesota is rather complete, but it contains great thicknesses of elastic material and dolomitic rocks that are of no interest in this study. The best limestone of this period lies in the middle of the Galena formation or in the Prosser member, which is particularly well-developed in central and northern Fillmore County. The name of this member is derived from a very good section in a small, deep gorge along a run or creek west of Wykoff on land formerly belonging to a Mr. Prosser. As a formational name, however, Prosser is very unfortunate since nobody living in that region knows the creek by that name and the land has passed into other hands. To make it more definite, therefore, it may be said that the type section is in about the center of section 20, Twp. 103 N., R. 12 W. The road formerly crossing the creek near the top of the Prosser limestone is now abandoned. Mahood Cave is located well down along the gorge towards the junction of Prosser Creek with the larger Spring Valley Creek. Other sections are more

accessible and have an abundance of fresh rock exposed, hence, the type section was not sampled.

One of the very good sections of the Galena, and showing some excellent rock belonging to the Prosser member, is that in Masonic Park, near Spring Valley (See Minnesota Geological Survey Bulletin 29, p. 151). The following section is a rearrangement of the same beds:

Sections in Masonic Park, secs. 11 and 12, 103-13:

- | | | |
|--|-----|----|
| 11. Covered to top of hill, largely loess and drift. | 43' | 0" |
|--|-----|----|

Galena formation. Stewartville member.

- | | | |
|---|--------|----|
| 10. Limestone, dolomitic, gray, rough, weathered surfaces pitted, <u>Macluriun cunesta</u> , <u>Hormatoma major</u> , etc., common. | 20' | 0" |
| 9. Limestone, dolomitic, gray, hard, rough. | 12' | 0" |
| 8. Limestone, gray, compact, hard, thin-bedded, with few fossils. | 16' | 8" |
| 7. Limestone, gray to ash colored, thin-bedded to massive, surface pitted. Contains <u>Hormatoma major</u> . Prosser member. | 7' | 0" |
| 6. Limestone, gray to bluish, hard compact. (Sample #44F) | 10' | 0" |
| 5. Limestone, gray to bluish, compact, medium to thin-bedded. (Sample #44E) | 10' | 0" |
| 4. Limestone, gray to bluish, hard, compact. (Sample #44D) | 10' | 0" |
| 3. Limestone, gray to bluish gray, with shaly partings near the top. Abundantly fossiliferous (Sample #44C) | 10' | 0" |
| 2. Limestone, gray to bluish gray, thick-bedded, compact to partly crystalline containing an abundant fauna which includes an occasional graptolite. (Sample #44B) | 10' | 0" |
| 1. Limestone, gray to bluish gray, thick-bedded, compact, hard, with thin shaly streaks. Some layers contain graptolites together with an abundance of other fossils. To level of Deer Creek. (Sample #44A) | To 10' | 0" |

Near the south line in the middle of section 9-104-12, about 8 miles north of the Prosser Creek section, the county has operated a quarry in the Prosser along Highway #74 where the following samples were taken:

Sections along State Highway #74, in the S. W. 1/4, section 9-104-12:

- | | | |
|------------------------------|---|-----|
| 10. | Drift cover. | 10' |
| <u>Stewartville dolomite</u> | | |
| 9. | Limestone, dolomitic, gray to drab, somewhat weathered and partly covered in upper part. | 21' |
| 8. | Limestone, somewhat dolomitic, gray to drab, varying from compact to porous. (Sample #46F) | 7' |
| 7. | Limestone, somewhat dolomitic, gray. (Upper half sample #46E). | 5' |
| <u>Prosser limestone</u> | | |
| 6. | Limestone, gray to drab, compact, weathering into thin beds from thick layers. (Lower half sample #46E) | 5' |
| 5. | Limestone, drab, thick-bedded, compact. (Sample #46D) | 10' |
| 4. | Limestone, compact, gray, thick-bedded to massive. (Sample #46C) | 10' |
| 3. | Limestone, hard, compact, gray, thick-bedded. Floor of quarry at base. (Sample #46B) | 10' |
| 2. | Limestone below quarry, gray to drab, compact. (Sample #46A) | 7' |
| 1. | Covered interval to level of Lost Creek at bridge | 10' |

One of the most promising localities, as far as availability is concerned, is that at Fountain, Fillmore County, where the following section is exposed and was sampled. It is a composite consisting of the Highway #52 out at the underpass and the quarry on a secondary road at the north-west corner of town.

7. Drift covered to level of rail at the underpass. 27'

Prosser limestone

6. Limestone, hard, gray (Sample #48C). 10'
5. Limestone, fine-grained, compact, hard, gray. (Sample #48B) 10'
4. Limestone, hard, gray, with some thin-bedded to shaly layers. This forms the bottom of quarry. (Sample #48A). 10'
3. Limestone, gray to drab, hard. (Sample #47C) 3'
2. Limestone, gray to drab, thick beds, hard, compact. Spring at base. (Sample #47A) 10'
Decorah shale member below.

The Patterson quarry on Thomas Walch's land at the underpass three miles west of Eyota shows a rather different phase of the Galena, although the upper part is definitely part of the Prosser. Most of this rock is unsuited to high calcium uses.

6. Drift and soil. 5'

Galena limestone. Prosser member.

5. Limestone, weathered, hard and gray where fresh. Fossils common. 4'
4. Limestone, hard, gray, thin-bedded due partly to weathering. (Sample #49C) 10'
3. Limestone, blue gray, medium to thin-bedded. Fossils common. (Sample #49B) 10'
2. Limestone, impure, shaly, blue. This is the lowest portion of the quarry. (Sample #49A) 10'
1. Covered interval below bottom of quarry to creek level. 3'

The Prosser member is thicker and the quality is apparently somewhat better in the south central part of Fillmore County. In the vicinity of Harmony it is well exposed along streams and in quarries, but the lower part runs into shale that may render it useless. Transportation here would be a factor in its use if present openings were used. The same rock might be developed nearer the railroad. The following quarry is located one and a quarter miles off the railroad:

Highway Quarry in S. W. 1/4, section 9-101-10:

5. Covered by soil and weathered rock to field above. 8'

Galena limestone. Prosser member.

4. Limestone, thin-bedded, gray, with few fossils. (Sample #50C) 10'
3. Limestone, compact, hard, gray, showing few fossils. (Upper 4'5 of sample #50B) 8'
2. Limestone, argillaceous, blue, similar to beds below and probably low grade. (lower 1/5 of sample #50B) 2'
1. Limestone, argillaceous, blue, showing a few specimens of R. oweni. (Sample #50A) 10'

Another section along the road to the east of Harmony and three miles east of the one just given is probably a little higher in the formation and shows better appearing rock.

Section of roadside quarry in N. W. 1/4, section 12-101-10!

3. Covered interval to field above. The lowered part of this is weathered limestone. 8'

Galena limestone. Prosser member.

2. Limestone, hard, gray, full of fossils and with a little flint. (Sample #51B) 10'
1. Limestone, hard, gray, very fossiliferous to bottom of quarry. (Sample #51A) 10'

In the vicinity of Canton, or about four miles farther to the east, are some large old quarries showing a fair grade of limestone, although inclined to be shaly. The following is typical. Section of the highway quarry in the S.E. 1/4, section 15-101 N. -9.

6. Covered interval, soil and weathered limestone. 5'

Galena limestone. Prosser member.

5. Limestone, thin-bedded to shaly, hard, gray. 11'

4. Limestone, shaly, gray and shale. 2'

3. Limestone, hard, gray, with an eight inch shale layer near the top. (Sample #52C) 10'

2. Limestone, hard, gray, typical Galena fossils. (Sample #52B) 10'

1. Limestone, hard, gray, with some flint. Receptaculites oweni common. (Sample #52A) 10'

The water works hill at Chatfield, which formerly showed an interesting exposure of the Prosser, is badly covered at the present time and impossible to sample satisfactorily.

In the Chase Quarry, about two miles south of Simpson, Olmsted County, there is a good exposure of the Prosser limestone although the rock is probably not suited to uses for which this sampling was done. The following section and samples are probably characteristic of the formation in Olmsted County.

Section of the Chase Quarry in N. 1/2, section 20-105-13:

6. Soil and loess covered interval. 10'

Galena limestone. Prosser member.

5. Limestone, weathered, gray. 5'

4. Limestone, partly weathered, gray to drab. (Sample #53D) 10'

3. Limestone, gray, hard, thick to shaly beds. (Sample #53C) 10'

2. Limestone, thick bedded, hard, gray. (Sample #53B) 10'

1. Limestone, hard, gray. The lower half is thin-bedded to shaly and below quarry floor. This extends down to water level in North Branch of Root River. (Sample #53A) 10'

Another good exposure of the Prosser limestone was sampled in the quarry at the Stone Arches Bridge, six miles south of Wykoff in the S. 1/2 of section 22, T. 102 N., R. 12 W. The quarry is in the south bank of the South Branch Root River, several hundred feet downstream from the bridge where the quarry face is 20 feet high. The rock is continuous downstream in the river bank, but the overburden thickens toward the south. There is no railroad near the quarry and the highway has a long, steep hill from the river to the upland. The following section is condensed from the lithological section in Bulletin 29, pages 153 and 154. Divisions 1 and 2 are exposed in the quarry.

- | | | |
|----|---|-----|
| 2. | Limestone, compact, hard, thin-bedded, gray, very fossiliferous. Prosser member.
(Sample #45B) | 6' |
| 1. | Limestone, thin-bedded, hard, light gray.
To level of river. Prosser member.
(Sample #45A) | 16' |

To the west the Prosser passes under cover of the Stewartville dolomite and in the vicinity of Rockdell, where the rotten yellow limestone occurs along the south branches of Zumbro River, the old quarries are in that rock. Typical fossils may be found in most any quarry or outcrop.

The purest limestones are those of the Devonian in the vicinity of Le Roy, Mower County, but to some extent these are inter-bedded with impure brown dolomitic layers which must be rejected in any enterprise that requires an exceptionally high grade limestone. While this might be done in the quarry and still recover a large quantity of excellent rock, it adds to the expense and may make that source prohibitive. The high grade layers of the Devonian or Cedar Valley limestone are a hard, compact, light gray limestone that weathers white. Over a limited area around Le Roy it is thinly drift covered and both the Milwaukee and the Chicago Great Western Railroads cross it at this point. The following section is of the Hickok Quarries at the northeast corner of town:

Section of the Hickok Quarries in the S.E. 1/4
section 27-101-14W.:

10. Soil and limestone boulders.	2'	0"
<u>Devonian, Cedar Valley limestone.</u>		
9. Limestone, gray to white, probably somewhat displaced.	2'	0"
8. Limestone, hard, compact, gray to white, the top part of the east quarry. (Sample #42G)	5'	0"
7. Limestone, brown to gray-brown. (Sample #42F)	5'	6"
6. Limestone, light gray to white, hard, laminated. (Sample #42E)	4'	2"
5. Limestone, impure, gray to brown, variable thickness. (Sample #42D)	1'	0"
4. Limestone, hard, gray, with thin blue shale partings in the lower part and middle. The limestone shows laminations on weathering. (Sample #42C)	3'	4"
3. Limestone, brown to yellow, sandy, but with a few layers of hard gray limestone. (Sample #42B)	3'	4"
2. Covered interval from the spring to the bottom of the west quarry pit.	1'	0"
1. Limestone, brown to yellow, arenaceous, dolomitic, thin-bedded, with thin layers of higher grade gray limestone. These beds dip downstream about 1 in 50. The whole exposed to river level at the spring. (Sample #42A)	10'	0"

Across the river, a mile and a quarter to the southeast, Fowler and Pay have a small quarry at the state line in section 35, T. 101 N., R. 14 W. The lower beds of this quarry were sampled.

Sections of Fowler and Pay Quarry in section 35:

5. Soil cover which varies in thickness from place to place.	1'	0"
<u>Devonian, Cedar Valley limestone.</u>		
4. Limestone, thin-bedded, sun-cracked beds of gray to white compact limestone.	1'	7"
3. Limestone, brown, arenaceous, much weathered.	2'	6"
2. Limestone, gray, compact, hard, gray to buff weathering to brown. (Sample #43B)	1'	3"
1. Limestone, thick-bedded, hard, compact, light gray, with partings of sticky green clay shale of which there are three about an inch thick. The top layer contains stromtoporella and some poorly preserved brachiopods. These beds extend to the bottom of the quarry.	7'	6"

Lower beds of the Cedar Valley limestone crop out and have been quarried around Spring Valley. These have a high magnesian content and may be suitable for uses requiring a dolomite. Along Bear Creek, southwest of Racine, Mower County, the Hovda Quarry is one of the best in the Cedar Valley limestone, although much of the rock is dolomitic. It lies at a lower horizon than the quarries at Le Roy. A few samples were taken at that place.

Section, Hovda Quarry, N. W. 1/4, section 9-103-14:

6. Soil cover.	2'	0"
<u>Devonian, Cedar Valley limestone.</u>		
5. Limestone thin-bedded, weathered to hard, compact, gray.	6'	0"
4. Limestone, hard, gray, medium to thin-bedded, fossiliferous. (Sample #40A)	8'	0"
3. Limestone, thick layers, compact, gray, calcite geodes common, fossils fairly abundant. (Sample #40B)	5'	0"
2. Limestone, compact, gray, slightly fossiliferous, calcite geodes common.	5'	0"
1. Limestone, thick rough beds of buff to gray, highly fossiliferous, forming overhanging cliff to water edge. This extends down to level of Bear Creek.	7'	0"

Sample #40C was taken from the stock pile of crushed rock, thus giving general composition for the quarry.

Another set of samples was taken from another quarry directly west of the Hovda property where the following section is exposed.

Section of quarry in N. W. 1/4, section 8, T. 103 N., R. 14 W. :

6. Covered by soil and weathered rock.	3'	0"
<u>Devonian, Cedar Valley limestone.</u>		
5. Limestone, thin-bedded, brown weathered.	2'	0"
4. Limestone, massive, gray to buff, fossiliferous. (Sample #41C)	5'	0"
3. Limestone, thin-bedded, hard, compact, gray. (Sample #41B)	5'	0"
2. Limestone, hard, compact, gray to drab, Irregular to thick-bedded, contains a few fossils chiefly <u>Favosites</u> and <u>Acervularia</u> . (Sample #41A)	5'	0"
1. Covered interval to level of water in Bear Creek.	19'	6"

The following table gives the composition of the limestones sampled in the quarries and other outcrops mentioned above:

Location of Samples

Cedar Valley Limestone Formation:

No. 40, A-C

Hovda Quarry, N.W. 1/4, sec. 9, T. 103 N., R. 14 W.
Northwest of Spring Valley.

- A. From 8 to 18 feet from top of quarry wall.
- B. From 18 to 25 feet from top of quarry wall.
- C. Composite sample from stock pile of crushed rock.

No. 41, A-C

Quarry in N.E. 1/4, sec. 8, T. 103 N., R. 14 W.
Directly west of the Hovda Quarry.

- A. Lower 5 feet of quarry face.
- B. 5 to 10 feet from floor of quarry.
- C. 10 to 15 feet from floor of quarry.

No. 42, A-G

Hickok Quarry near Le Roy. S.E. 1/4, sec. 27,
T. 101 N., R. 14 W.

- A. Lower 10 feet above river level at spring.
- B. 10 to 12 1/2 feet above A.
- C. Stratum 3 1/2 feet thick over B.
- D. Stratum 1 foot thick over C.
- E. Stratum 4 feet thick over D.
- F. Stratum 5 1/2 feet thick over E.
- G. Upper 5 feet of east quarry.

No. 43, A-B

Fowler and Pay Quarry near the state line in
sec. 35, T. 101 N., R. 14 W.

- A. Lower 7 1/2 feet of quarry wall.
- B. Upper 6 feet of quarry wall.

Galena Formation, Prosser Member:

No. 44, A-F

Masonic Park, northeast of Spring Valley,
secs. 11 and 12, T. 103 N., R. 13 W.

- A. Lower 10 feet from level of Deer Creek
- B. 10-20 feet above base of A.
- C. 20-30 feet above base of A.
- D. 30-40 feet above base of A.
- E. 40-50 feet above base of A.
- F. 50-60 feet above base of A.

No. 45, A-B

Quarry in bank of South Branch Root River at
Stone Arches Bridge 6 miles south of Wykoff.
Sec. 22, T. 102 N., R. 12 W.

- A. Lower 10 feet above river level.
- B. 10 to 20 feet above river level.

No. 46, A-F

Near the S. 1/4 corner of sec. 9, T. 104 N., R. 12 W.

From wall of quarry operated by County Highway Department

A. From road ditch exposure below floor of quarry.

B. Lower 10 feet of quarry wall.

C. 10-20 feet above floor of quarry.

D. 20-30 feet above floor of quarry.

E. 30-35 feet above floor of quarry.

F. 35-42 feet above floor of quarry.

No. 47, A-C

Wall of cut at underpass on Highway #52 at Fountain.

A. Lower 10 feet of wall of cut.

B. 10-20 feet above bottom of cut.

C. 20-30 feet above bottom of cut.

No. 48, A-C

Quarry on south side of secondary road a short distance northwest of Fountain, Fillmore County.

A. Lower 10 feet of quarry wall.

B. 10-20 feet above floor of quarry.

C. 20-30 feet above floor of quarry.

No. 49, A-C

Patterson Quarry at the railroad underpass in W. 1/2, sec. 8, T. 106, R. 12 W. 3 miles west of Eyota.

A. Lower 10 feet of quarry wall.

B. 10-20 feet above floor of quarry.

C. 20-30 feet above floor of quarry.

No. 50, A-C

Quarry northwest of Harmony in S. W. 1/4 sec. 9, T. 101 N., R. 10 W.

A. Lower 10 feet of quarry wall.

B. 10-20 feet above floor of quarry.

C. 20-30 feet above floor of quarry.

No. 51, A-B

Roadside quarry east of Harmony, N. W. 1/4 sec. 12, T. 101 N., R. 10 W.

A. Lower 10 feet of quarry wall.

B. 10-20 feet above floor of quarry.

No. 52, A-C

Quarry northeast of Canton in the S.E. 1/4 sec. 15, T. 101 N., R. 9 W.

A. Lower 10 feet of quarry wall.

B. 10-20 feet above floor of quarry.

C. 20-30 feet above floor of quarry.

No. 53, A-D

In Sec. 20, T. 105 N., R. 13 W. The Chase Quarry about 2 miles south of Simpson in Olmsted County.

A. Lower 10 feet of outcrop. From level of North Branch of Root River.

B. Lower 10 feet of wall of quarry.

C. 10-20 feet above floor of quarry.

D. 20-30 feet above floor of quarry.

ANALYSES OF LIMESTONE SAMPLES

Geol. Survey No.	% R ₂ O ₃	% SiO ₂	% CaO	% MgO	% CaCO ₃
40A	0.88	1.32	44.50	9.17	79.64
40B	1.18	1.72	35.04	16.83	62.72
40C	0.86	1.30	43.20	10.33	77.32
41A	1.16	1.94	35.12	16.68	62.85
41B	0.70	0.94	50.42	4.56	90.25
41C	0.68	1.04	49.96	4.90	89.42
42A	1.16	2.82	37.56	14.16	67.23
42B	2.24	4.90	36.48	13.26	65.29
42C	0.52	1.00	54.96	0.74	98.36
42D	1.70	2.08	41.83	10.62	74.85
42E	0.66	1.36	54.86	0.63	98.19
42F	2.00	2.88	37.72	13.34	67.53
42G	0.62	1.24	55.66	0.35	98.63
43	0.60	1.24	55.54	0.35	98.42
44A	2.00	5.68	50.68	1.09	90.71
44B	2.00	4.54	50.32	1.74	90.07
44C	1.60	4.22	51.22	1.83	91.65
44D	1.74	5.34	50.00	2.11	89.50
44E	2.10	6.86	46.20	4.22	82.65
44F	1.70	5.06	49.40	3.11	88.45
45A	1.46	4.96	50.12	2.31	89.71
45B	1.58	5.54	48.28	3.66	86.42
46A	4.12	14.28	41.66	3.44	74.57
46B	1.96	5.06	49.10	2.63	87.92
46C	1.94	4.90	49.68	2.82	88.63
46D	2.32	8.04	46.86	3.09	83.83
46E	2.32	7.60	42.86	6.72	76.71
46F	2.28	7.22	44.50	5.77	79.64
47A	1.80	2.76	53.38	0.57	95.55
47B	1.30	2.54	54.12	0.51	96.87
47C	1.68	4.04	52.78	0.49	94.45
47D	2.40	8.38	48.12	2.11	86.13
48A	1.60	4.34	52.22	0.83	93.44
48B	1.46	4.52	52.48	0.67	93.91
49A	6.20	22.74	36.72	1.58	65.72
49B	2.92	7.34	47.40	2.30	84.54
49C	2.46	5.98	49.22	1.94	88.13
50A	3.62	12.32	45.24	1.33	80.95
50B	1.96	6.16	51.10	0.74	91.44
50C	1.28	3.82	53.24	0.41	95.30
51A	1.22	4.06	52.98	0.49	94.80
51B	1.04	3.88	52.18	1.40	93.37
52A	1.08	7.26	51.20	0.46	91.61
52B	1.24	3.30	52.76	0.88	94.53
52C	1.98	6.24	51.18	0.43	91.58
53A	3.20	12.50	44.94	11.61	80.42
53B	2.16	5.92	49.02	2.06	87.78
53C	2.50	6.48	48.40	2.01	86.63
53D	2.22	6.22	47.76	2.83	84.77



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