1932

The Cedar Valley Limestone at Glory and at Waterloo, Iowa

L. W. Wood
Iowa State Highway Commission
THE CEDAR VALLEY LIMESTONE AT GLORY AND AT WATERLOO, IOWA

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Recent quarry operations at Glory (N. E. ¼ Sec. 36 Spring Creek Twp., Black Hawk County, about 6 miles east of La Porte City) and in the north part of Waterloo (N. W. ¼ N. W. ¼ Sec. 14 East Waterloo Twp.) have brought to view excellent sections of the Cedar Valley Stage of the Devonian System of rocks. This paper describes the succession of strata found in each, and briefly summarizes the results of a considerable number of physical tests made on samples from them.

Following is a general section for the quarry opening in N. W. ¼ N. W. ¼ Sec. 14 East Waterloo Twp., and a few smaller abandoned workings in N. ½ Sec. 14:

<table>
<thead>
<tr>
<th>No.</th>
<th>Feet Thickness</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
<td>Limestone, dark gray, weathering buff along exposed surfaces, somewhat variable in hardness and soundness, medium to fine of grain, massive when fresh, but when weathered splitting out along closely spaced horizontal lamination planes. With a few chert nodules, and a number of small geodic cavities lined or filled with calcite.</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Limestone, light gray, weathers white, very fine-grained, hard, almost brittle, usually somewhat brecciated and in places slightly folded.</td>
</tr>
<tr>
<td>3</td>
<td>1½</td>
<td>Limestone, buff, earthy, very soft.</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>Limestone, buff to brown, medium-grained, variable in hardness, but probably sound. Usually seen to be much weathered, but when fresh, part of it may be suitable for road or concrete work.</td>
</tr>
</tbody>
</table>

The same succession of beds, but reaching about 15 feet lower, is seen at the Glory Quarry. Following is the section:

<table>
<thead>
<tr>
<th>No.</th>
<th>Feet Thickness</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>4</td>
<td>Limestone, buff, soft, shaly, unsound, granular texture, fossiliferous in the upper portion. In places shows curving or twisted lamination.</td>
</tr>
<tr>
<td>8</td>
<td>3(max.)</td>
<td>Limestone, drab, weathers buff, laminated, fossiliferous, granular texture, rather soft, but may be sound. In two or three beds where present in full thickness. At east end of quarry removed by erosion.</td>
</tr>
<tr>
<td>9</td>
<td>2½</td>
<td>Clay, glacial and residual, with limestone fragments.</td>
</tr>
</tbody>
</table>
Shale and shaly limestone, in alternating thin beds. Limestone, light gray, fine-grained, hard, sound, non-fossiliferous, in places distinctly laminated, locally showing a finely conglomeratic structure. In several regular beds, including locally a thin shale seam near the top and about 1 foot of granular hard drab stone near the bottom. Scattered chert nodules totaling about 1 percent, and a few small nodular inclusions of pyrite, were noted.

Limestone, drab, weathers yellow, soft, granular, massive, non-fossiliferous. This zone grades downward into the member below, becoming in places as much as 7 feet thick.

Limestone, bluish-gray, weathered yellow along joints, in heavy and regular beds, fairly hard and generally sound, of granular to sub-crystalline texture. This member is characterized by oblique joint planes, which cut clear through it or even into the member above. Chert is present in a persistent seam 2 inches to 4 inches thick about 1 foot from the top, and also in discontinuous nodules and thin bands totaling about 3 percent of the exposed face. Sparingly fossiliferous, most of the forms being found preserved in the chert nodules. There are also present a few small nodules of crystalline quartz, or of calcite. To 1928 quarry floor. W. C. F. & N. track level is about midway in this member.

Limestone similar to the above, but locally with as much as 10 percent of chert, and with oblique joint planes less conspicuous. Fossil forms more numerous than in the above. To 1931 quarry floor.

Limestone, gray, massive, hard, with frequent large corals and other fossil forms. Surrounding these fossils are thin dark shaly films on which the stone splits when weathered, to irregular-shaped masses.

The following species have been collected from the beds at Glory:

**Bed No. 1**
- *Favosites alpenensis?*
- *Cystophyllum?* sp.
- *Cladopora iowensis*
- Segments of crinoid stems
- Small undeterminable brachiopods

**Bed No. 2**
- One fish tooth

**Bed No. 3**
- *Atrypa reticularis*
- Numerous small undeterminable brachiopods

**Bed Nos. 7 and 8**
- *Atrypa reticularis*

In both of these quarries, three zones are readily recognized. The upper consists of yellow to buff limestone, often rather soft and earthy, the middle consists of hard light-gray, fine-grained limestone of almost lithographic texture, and the lower consists of a massive gray or drab granular limestone with nodules of chert or calcite. In addition, the bottom of the Glory quarry shows 2 feet of a limestone which bears numerous corals. These zones are readily

1 For identification of these fossils the writer is indebted to Professor A. K. Müller, of the State University at Iowa City.
correlated with those described by Arey in his sections for the Cedar Valley Limestone in Black Hawk County.

A large number of physical tests on samples of stone from these quarries have been run in the past few years at the Iowa State Highway Commission laboratory at Ames. These include the abrasion test, the soundness test, and determinations of specific gravity and absorption.

In the abrasion test, fifty pieces of approximately cubical shape and weighing about 100 grams each are placed in a cast-iron cylinder which revolves at about 33 R.P.M. on an axis at an angle of 30 degrees with the main axis of the cylinder. After 10000 revolutions the sample is removed and reweighed, and from its loss in weight as a result of the abrasion in the cylinder, there is computed the percent of wear. The abrasion test is thus an approximate measure of the hardness and toughness of the stone.

Two types of soundness test are run; that by repeated immersions in sodium sulfate and that by alternate freezings and thaws. Precipitation of sodium sulfate in well developed crystals from supersaturated solutions, has an effect very similar to that of the growth of ice crystals in freezing, either process causing disruption of the rock which they are able to penetrate. The soundness test is thus an approximate measure of the ability of the stone to withstand weathering agencies.

The percentage of absorption and the specific gravity bear a somewhat obscure relationship to soundness and hardness, but are run in the State Highway Commission laboratory principally for the purpose of aiding in more accurate proportioning of the material when used in concrete.

Three tests on the upper zone at Glory and Waterloo (yellow rather soft limestone) show the average specific gravity to be 2.45, the average percent of absorption 5.4, the average percent of wear in the abrasion test 15.2, and the average percent of soundness 62.

Seven tests on the middle zone (white hard fine-grained limestone) show the average test results to be, on specific gravity 2.65, on absorption 1.6 percent, in the abrasion test 4.8 percent of wear, and in the soundness test 100 percent sound.

Twenty-five tests have been run on the lower zone (massive granular limestone with chert nodules, Beds No. 2, 3 and 4 at Glory). The following table shows maximum, minimum, and average results:

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On account of the evident unsoundness of the lower coral-bearing limestone at Glory, no physical tests on it have been run by the State Highway Commission.

The Highway Commission specifications for crushed stone for use as concrete aggregate require that the percent of wear on at least 95 percent of the stone shall be not more than 8.0, and that at least 95 percent of the stone shall pass the soundness test. For Class A surfacing stone, the requirement is that at least 85 percent shall show not over 8.0 percent of wear, and shall be sound. For Class B surfacing stone, the requirement is that at least 85 percent shall show not over 12.0 percent of wear, and shall be sound. It will be noted that the upper brown stone is usually not satisfactory, either for aggregate or for surfacing, though some parts of it are locally suitable for those purposes. The white stone is of good quality for either purpose. The lower massive stone, constituting the bulk of the faces of the two quarries, is partly suitable and partly unsuitable. It has been found, that by avoiding the softer and more weathered parts of the quarry ledge, a product can be made whose properties will fall within the specification limits given.

Maximum, minimum, and average test results on the massive granular limestone which constitutes the bulk of the two quarry faces are given in order to point out the variation in strength and durability of a bed of stone which, to the eye, shows considerable uniformity. Ordinarily it is found that variations in physical test results are accompanied by variations in color or texture which are readily visible to the experienced eye, but at these points, such is not the case; even with test results in hand it is often difficult or impossible to go to the quarry face, and by visual examination, to distinguish the good stone from the questionable. This fact is of importance to those who propose to use stone from this horizon for permanent structures, especially those subject to severe conditions of stress and exposure.

IOWA STATE HIGHWAY COMMISSION,  
AMES, IOWA.