

“Indiana Oölitic Limestone Geology, Quarries, Methods”

By George D. Hunter, Bloomington, Indiana

Mine and Quarry

Vol. V, No. 1, July 1910, pp. 410-419

The article begins:

“The Indiana Oölitic limestone district extends from a point near Greencastle on the north, to the Ohio River, and ranges from two to 14 miles in width. The deposits are from 25 to 100 feet thick. The active quarries are confined to a comparatively small area called the Oölitic belt, embracing Romona, in Owen County, Stinesville, Ellettsville, Bloomington, Clear Creek and Saunders, in Monroe County; Oölitic, Dark Hollow and Bedford, in Lawrence County, Salem, Washington County, and Corydon, Harrison County.”

This article, which begins on the next page,
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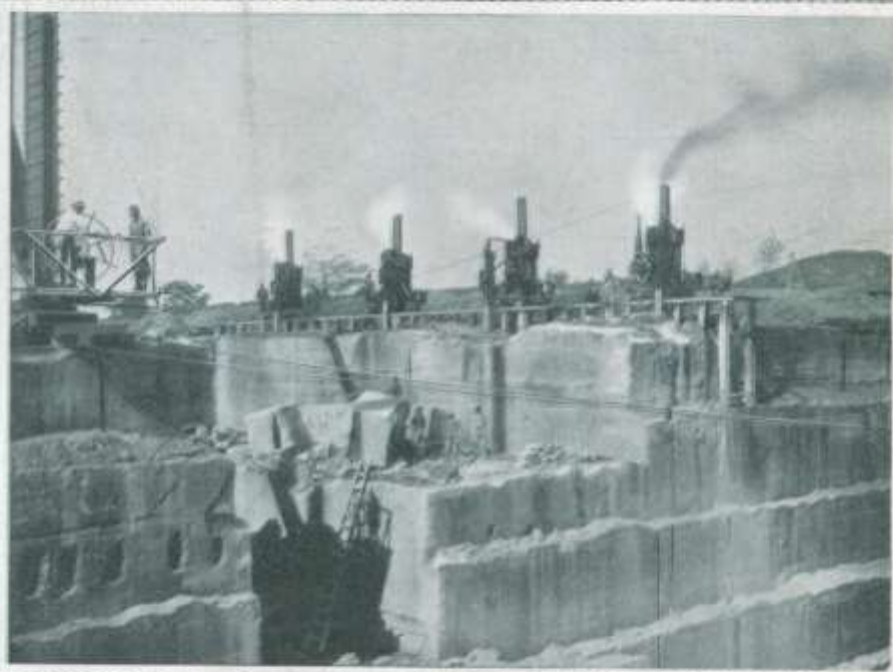
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August 2015

MINE AND QVARRY

VOL. V. No. 1

JULY, 1910



SULLIVAN CHANNELERS QUARRYING BLOCKS 20 FEET THICK IN INDIANA LIMESTONE



INDIANA OOLITIC LIMESTONE
A TENNESSEE COAL MINE
A PORTABLE DRILLING OUTFIT



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INDIANA OÖLITIC LIMESTONE

GEOLOGY, QUARRIES, METHODS

By GEORGE D. HUNTER¹

The Indiana oölitic limestone district extends from a point near Greencastle on the north, to the Ohio River, and ranges from two to 14 miles in width. The deposits are from 25 to 100 feet thick. The active quarries are confined to a comparatively small area called the oölitic belt, embracing Romona, in Owen County, Stinesville, Ellettsville, Bloomington, Clear Creek and Sanders, in Monroe County; Oölitic, Dark Hollow and Bedford, in Lawrence County, Salem, Washington County, and Corydon, Harrison County.

TOPOGRAPHY

The White River and its branches, Salt Creek, and numerous smaller streams, have worn what would otherwise be a plateau into gullies, ravines, and valleys, with an occasional gloomy hollow. The area is well wooded, except where, here and there, a bluff of limestone crops boldly out, or a knob of the original plateau shows at the summit of a hill. The quarries are usually opened on the slope of a hill, where natural drainage will carry off water.

Bloomington, one of the two headquarters points for oölitic stone, is a city

¹ Bloomington, Indiana.

of about 11,000 inhabitants. Here is located the Indiana State University, comprising a number of fine oölitic stone buildings. The town has several beautiful churches, also built of oölitic stone, and has recently erected a handsome Court House from oölitic stone quarried in Monroe County.

Bedford, the other leading city of the district, has a population of one more, or one less, than Bloomington (the writer refuses to say whether this refers to thousands or hundreds). Like Bloomington, Bedford has employed oölitic stone for numerous distinctive public buildings. Bedford is progressive. It owns more automobiles than Bloomington and takes more pride in its fine oölitic stone sidewalks, than Bloomington does in her paved streets (to be).

"Indiana oölitic limestone is one of the six great geological horizons which in that state comprise the lower carboniferous strata or Mississippian Period."

"The dip of these rocks over the region is from 50 to 60 feet to the mile, in a general southerly direction, making a larger area of stone accessible than if the structural position were more highly inclined.



the Indiana oölitic district.

"Oölitic limestone is the thinnest of the subcarboniferous formations. It usually appears as a narrow outcrop from 100 to 400 yards in width, forming the flanks of low hills. But where it forms the surface rock over any extent of territory, as sometimes when it caps a wide ridge, the topography is gently undulating.

"Overlying most of the oölitic stone in the quarry region is a series of impure limestone, calcareous shales, and fossiliferous limestone, known as Mitchell limestone, from the town of that name, in Lawrence County. Its lower layers, just above the real oölitic stone, constitute 'bastard limestone stripping.'

"In all outcrops and in many quarries there is at least one system of vertical joint seams and in most places two systems, one having a general east and west direction, the other north and south. Joint seams are rarely abundant, and in general range between 20 and 45 feet apart. Where solid rock covers the oölitic stone, the seams are seldom more than regular inconspicuous cracks in the rock mass and in nearly all places where the oölitic stone is not covered by solid rock, the weathering agencies have penetrated along the joint planes, forming irregular crevices generally two or three feet across. Most of these fissures are filled with clay and debris from the surface, and they are a great source of waste

and annoyance to quarrymen, for the waste is not limited to the cavity. Irregular walls cause much waste in quarrying, and the closer together the cavities, the more waste, for it is seldom that irregular blocks can be broken to advantage. Where the quarry happens to be blue there is further waste, because along the joint planes the stone is oxidized irregularly, forming a strip of buff, varying in thickness on the two adjacent faces.

ANALYSIS AND CHARACTER

"An analysis of oölitic stone by average shows: Calcium carbonate, 97.62 per cent; magnesium carbonate, .61 per cent; iron oxide and alumina, .36 per cent; insoluble residue, .91 per cent. Approximately its specific gravity is 2.47, its crushing strength 7000 pounds per square inch, and its weight 152 pounds per cubic foot, though quarrymen, while calculating with reference to car capacities, give the stone a value between 170 and 180 pounds per cubic foot according as it is well seasoned or very 'green.'

"The physical tests show oölitic stone to be more porous than the average limestone, yet in crushing and transverse strength it is much above the average. Its flexibility permits it to withstand sudden changes in temperature of about 1,000 degrees without injury, a test which at first blush seems incredible.

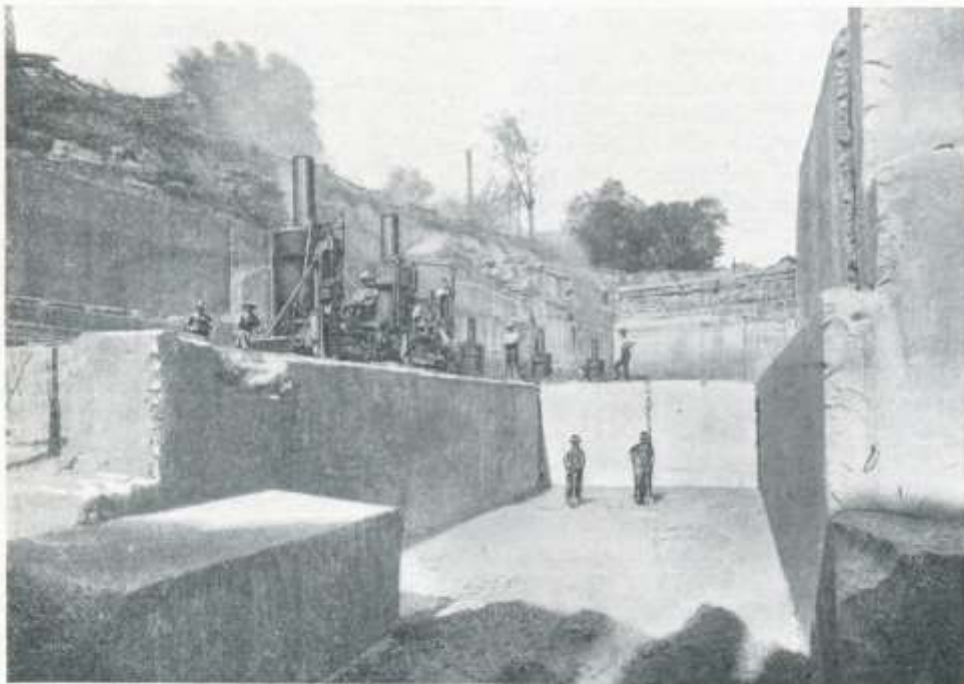


One of the great stone plants in the Indiana oolitic district.

(photo caption) “One of the great stone plants in the Indiana oolitic district.” (pp. 410-411)



Several "Y" channelers on one track—a characteristic practice in the district.



Five Sullivan channelers on the second lift.

(photo captions) (top) "Several 'Y' channelers on one track – a characteristic practice in the district"
(bottom) "Five Sullivan Channelers on the second lift." (pp. 412)

"Like freestones, Indiana stone is softer and much more readily worked before than after it is seasoned, because it hardens with age. Yet it never becomes as hard or as difficult to cut as gritty siliceous rocks of equal strength, nor does it ever become as hard as marble. The lack of grit is a saving on tools and machinery. Besides, in the ease with which oölitic stone can be split diagonally and across the grain, it excels the average building stone. These properties make quarrying from a massive solid bed profitable, when harder stone or one more difficult to work would be an expense."

"How any stone of such softness when quarried, of such an even grain, so capable of being cut and carved almost with an ordinary jackknife, a stone which one commonly thinks of as being unusually easy to convert into lime and one which looks the part, could survive the severe fire tests put upon it, is a matter hard for the layman to understand. These qualities alone should commend oölitic stone to the architect no less forcefully than they surprise the layman."

SELECTION OF QUARRY LAND

The first step towards opening up an oölitic stone quarry, before making any great outlay of money, is to test the stone land with a core drill. Oölitic stone is so variable in formation, that several years' acquaintance are necessary to grade it properly. To the experienced eye, the core sample shows many characteristics, color, grain, and hardness, or defects of various kinds. Cores are taken out at divers places and as deep as the stone continues to be of good quality. The showing from the cores generally determines the location of a new quarry opening.

OPENING UP

When a new opening is decided on, a small space is stripped and one or two channelers put to work, cutting channels to a depth of four, six, or eight feet, as

indicated by the core to be good stone. A derrick is raised to lift out the blocks.

Conditions in opening a quarry are so variable that it will be best to assume a floor already established by nature. The first channel may be termed a wall cut. Then another channel parallel with the first is made, say six feet away.

Cross cuts are next channeled, perhaps 18 inches apart, usually for a distance equal to the width between the two first channels. Large steel "bull" wedges with flat feathers, are driven in the first cross channel, and the block of stone broken off at the bottom. Steel derrick dogs are then made fast to the broken block in "dog-holes" cut at the opposite ends of the block with a hand pick, and the block is lifted out. This block is called a "key-block" and is carefully examined for imperfections. Spalls are broken from the edges of the block with a spalling hammer, for further examination. If the result is favorable, the next block is removed in the same manner, and when enough of these smaller blocks are removed to give working room for a small steam drill, the distance between cross channels is increased, and horizontal holes $\frac{1}{2}$ inches in diameter are drilled seven inches deep and six inches apart at the foot of the block. The block is then split off by plug and feather wedges, and removed with the derrick. Key blocks channeled on four sides are difficult to lift, even after being freed on the bottom, on account of the fact that water and sludge in the cuts prevents air from getting beneath the stone, causing a vacuum. To prevent undue strain on the derrick, in such cases, a long pipe is attached to the steam or air hose and the sludge blown out from the cut, thus eliminating the suction or vacuum.

After the cross cuts have all been put down, long cuts are next channeled parallel to the first two cuts, and usually four feet two inches from the center of the first cut. This work continues until the whole floor is channeled.



A hydraulic stripper at work.

After the row of key blocks is removed cross channeling may be unnecessary. Oolitic stone as a rule has mud seams that run from east to west, and the long cuts should be at right angles to these mud seams, thus permitting the stone to separate at different lengths, 20, 30, 40 or more feet, which obviates cross cutting. These mud seams are generally from a few inches to several feet wide at the surface, but narrow as the stone is removed, until they become mere cracks in the stone.

FREING THE BLOCKS

To remove the stone after it has been channeled into strips, it is first drilled by baby steam drills ("UA" Sullivan) along the bottom line of the channel, and plugs and feathers are used to break the stone. The stone is now turned over, to be broken up to the desired sizes (see page 418). Derrick "dog-holes" for hitches are made along the top of the channeled stone with hand picks. The

hook ends of the dogs are placed carefully in the notches or holes, and one or more dogs are connected to a cable by loose sheaves with a clevis and pin to equalize the strain on all the fastenings. Power is then applied through the main fall cable, and with the assistance of bull-wedges, the large block of stone is freed and easily turned over. The floor on which it falls is bedded with small stones, which keep the block from breaking.

After the stone has been turned over it should be inspected by the quarry foreman, before any attempt is made to drill and break it to standard dimensions. When the stone is found free from defects, it is usually broken into large blocks, to be stacked; but for hurry orders, it will be broken to sizes to meet the order, lifted out of the quarry and at once loaded on a car for shipment.

ENLARGING THE QUARRY

This operation is repeated until the limit in depth of salable stone is reached,

over the area stripped. In enlarging the quarry area, the walls are examined closely for defects or changes in the stone. The location of these governs the depth of the channeling.

This may call for channels anywhere from 7 to 15 or even 20 feet deep. If the stone is uniform for 20 feet in depth, there will be a loss of one foot of stone for the entire length and width of the quarry, if removed by two 10-foot cuts, whereas if channeled at one cut, much valuable stone is saved, for the blocks may be broken into three widths if desired, and there is a further saving in setting channeler track, and in the additional labor of cleaning up an extra floor. The thickness of stone of a given grade is exceedingly variable, and to avoid waste, it is most important to establish a depth of channeling suitable to the quarry. For this reason a channeler such as the Sullivan "Y-S" is desirable, which can cut to any desired depth with speed and economy.

HYDRAULIC STRIPPING

The economical management of oolitic stone quarries demands constant planning and study, to meet changing conditions, as the quarries are enlarged. Stripping becomes an important factor, and should be kept ahead of actual requirements.

The soil in the Bloomington-Bedford district usually consists of hard red clay, frequently interlaced with roots and spalls. Stripping has until recently been performed with horse scrapers, but in the last year or two a large amount of this work has been done hydraulically, with water pumped to the location under pressure and played on the soil through special nozzles. A nozzle in general use fits a four-inch pipe and has a 1½-inch discharge tip. With it, the stream may be pointed in any direction, and a special form of play pipe enables it to be handled readily by one man, and to remain fixed without the use of anchors or fastenings.

The photograph on page 414 shows one

of these nozzles at work. The hydraulic process has done much to reduce the cost of quarrying, and is bringing into operation valuable areas of stone hitherto neglected owing to the expense of stripping.

HANDLING APPARATUS

Another important factor is that of the addition of derricks and derrick power. The most economical power for this purpose is electricity, with a separate motor at each derrick. This secures a large saving in wire rope, and dispenses with many signal boys, as the power attendant can see at all times the work being done by the derrick crew. With the modern power rig is combined a power derrick turner. This enables the power man to operate the derrick, both for lifting and for turning, taking his signals direct from the head derrick man.

An interesting device is employed to handle the channelers, when out of reach of a derrick. This consists of a wire cable, made fast to a tree or stump, or any solid footing beyond the channelers, with the other end connected to the derrick boom. On this cable is a carriage, running on two pulley wheels, and having a swivel hook on which the channeler chains or slings are hung. When the channeler is to be handled, the boom is lowered until the sling can be connected to the swivel hook. The boom is then raised, bringing the cable taut, thus lifting the channeler, to permit turning it around, or removing it to another track set ready to receive it. A wire rope is fastened at one end to the carriage, and the other end is attached to the main derrick fall, with which the carriage is moved along the suspended cable. This aerial tramway is also used at times for carrying blocks of stone to a suitable dumping ground, or for other like purposes, out of reach of the derrick. (See photograph on page 416.)

CHANNELING

The channeler question is also a most important factor. Practice in oolitic stone



Handling channelers outside derrick radius.

quarries differs in this regard from that in other building stone quarries. Overlying rock must be channeled, as blasting of this cap rock is seldom permissible. If there is to be any shooting or blasting for stripping purposes, only black powder should be used, and with great care, to avoid injury to the underlying oolitic stone.

POWERFUL MACHINES ESSENTIAL

Aside from the varying hardness of the overlying stone, the depth to be channeled also varies. If it were always possible to have a free or open end cut for the slush to run out of, the depth cut by the channeler would hardly require mention. But at times, particularly when starting a new quarry, the cut is closed, or has a blind end, affording no outlet for the slush. Channeling from 8 to 15 feet deep in blind cuts requires power to lift the long steels sufficiently to give blows of proper force.

It is not the weight of the long steels alone that requires power, but in lifting the steels through the stiff slush, a vacuum or suction pulls against the engine, retarding the blow.

The power must be ample to lift the drills quickly and drive them through the slush onto the solid rock, with sufficient force to cut the rock economically.

The illustrations on page 412, and 418, show a feature, which, while perhaps not now peculiar to this district, at least had its origin here, viz., the operation of two or more channelers in gangs or batteries, on one long track. This practice secures a rate of cutting considerably higher than can be attained ordinarily by a single machine, since the action of the cutting bits of the battery tends to keep the slush at the bottom of the cut churned up, and prevents it from forming a cushion on top of the uncut stone.

CHANNELERS IN USE

Two general types of channeler are used in this field, the old-fashioned double gang pattern, with locomotive boiler and cam drive, and the direct acting, single gang machine, with vertical boiler.

In oölitic stone, for the reasons stated above, the best channeler is the one that can strike the hardest and fastest blow, and put in the deepest cuts without loss of efficiency. In the past few years the machines employed have been replaced by heavier and more powerful types, to meet increasing demands for speed in production.

The most modern channeler in the field, based on and designed particularly for these conditions, is the Sullivan "Y-8." This machine has an eight-inch cylinder on its main or chopping engine, as compared with the seven-inch cylinder of the Sullivan "Y," the most powerful machine previously employed.

The chopping engine on these channelers is of the straight line or direct acting type, thus eliminating all cross strains at the instant of delivering the blow or lift. It has a 24-inch run or feed on the standard, against 18-inch in other makes. This is an important factor in economy of time and labor in changing the drill steels, as well as saving two sets of gang steels, in cutting to a depth of only 12 feet. The engine has an exceptionally large and heavy cross head, running at all times "within the guides" (a feature not offered in any other channeler). These guides are of the best bronze, having the greatest amount of bearing surface possible. The chopper engine is thus able to withstand heavy service without trouble, and the momentum given to the blows by the weight of the cross head adds power to make the steels cut the stone under the most severe conditions.

For running over mud seams or broken stone, the machine runner cushions the blow by a single movement of a cushion valve within easy reach.

CUTTING SPEED

The cutting efficiency of all channelers in oölitic stone is remarkably variable. The medium hard oölitic stone chips nicely when the steel strikes the rock, and with open-end cuts these particles are carried away by the water, and the cutting speed is good. Some of the softer stone may rightly be termed "tough." Sink the steels deep into this stone, and it has a tendency not to chip or break away but to "rag" away. The fine particles (practically dust) settle at once in the open space made by the gang steel points in the soft rock, and do not wash out of the channel readily, even when the cut has a free end, thus retarding the cutting efficiency.

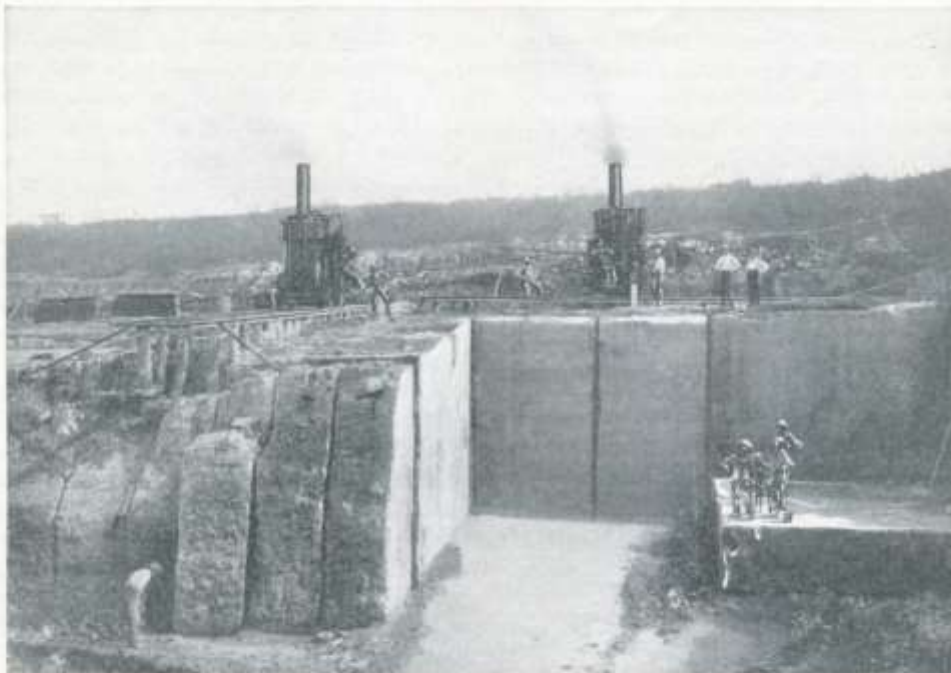
There are other soft oölitic stones that break away as nicely as the medium hard, and here the cutting efficiency is equal to or better than that in the medium hard.

An average day's cutting (10 hours) for a Sullivan "Y-8" machine will range from 300 to 600 square feet, month in and month out, depending upon the local quarry conditions mentioned. There are of course, higher records for individual machines and shorter periods.

CHANNELER BITS

The manner of forming the steel points, or teeth, is of interest here, as it differs from the arrangement used in hard stones, such as marble. For the oölitic field the accepted standard is to sharpen the diagonals right and left thus, \backslash/\backslash ; for marble the diagonals are the same, thus, $/\backslash/$. (In marble, if the diagonals were made right and left, there would be too much tendency to twist, their cutting edges not remaining at the same angle.) The right and left diagonals cause the oölitic stone to break away more readily, rather than "rag" away from the blows.

The quarrying of oölitic stone demands constant watching of every channeled block; when the stone is "turned over," to be broken in dimension sizes, the foreman of the quarry must exercise great



Sullivan Y-8 channelers cutting 20 feet deep: this view shows a quarry block turned over and being split with drill and wedges.



Ten Sullivan channelers in a well developed quarry.

(photo captions) (top) "Sullivan Y-8 channelers cutting 20 feet deep; this view shows a quarry block turned over and being split with drill and wedges." (bottom) "Ten Sullivan channelers in a well developed quarry." (pp. 418)

care; must learn the location of every defect, and be governed by it, otherwise great loss of good stone will be the result. When the quarry runs free from defects, such as "glass seams," invisible "drys," irregular sizes of grain, or unnatural spots or marks (such conditions *do* exist), it may rightly be called a "gold mine." It takes such finds to overbalance the amount of stone sent to the grout pile, and other losses, to make a showing at the end of the year on the right side of the ledger.

QUARRYING SEASON

Oölitic stone for building purposes is quarried from March to November first (eight months of the year). Earlier or later quarrying involves great risk against loss of stone from freezing, as the stone is full of sap or water.

Again, there are some quarries in the oölitic stone territory that permit channeling in freezing weather, since for some known or unknown cause the stone is practically seasoned before being quarried. It only takes a day or two, in mild weather, for oölitic stone to season sufficiently to avoid danger from freezing. When oölitic stone freezes, no parts of the stone are left solid. It just crumbles up. If seasoned, the openings that held the sap or water close and seal up as the water evaporates, and the weather has no disturbing effect if the atmosphere is free from sulphur gases.

No attempt will be made here to describe the cut stone industry, and the

methods employed at the mills. In this department the practice is as fully abreast of the times as in the quarries themselves, and a visit to the great cutting plants fills an outsider with wonder at the variety of the things done to the stone, and the facility and speed with which work is accomplished.

The photograph on this page shows a train of six cars, each containing a single block of oölitic stone weighing 70,000 pounds. These were recently sent to a Paris sculptor, to be carved into six groups and returned to this country to adorn the new residence of one of America's wealthiest men. A list of important and beautiful structures in which this wonderfully durable, but wonderfully compliant stone has been used, would fill several issues of this magazine.

The writer is indebted to many friends in the Bloomington-Bedford district for numerous courtesies rendered in connection with the preparation of this article. Space has forbidden the use of many interesting illustrations, and the mention of individual quarries and companies. Much friendly rivalry exists between sections of the district, but when it is "oölitic against the field" all pull together.

The writer acknowledges indebtedness for portions of the geological description to the very complete reports of the state geologist, Mr. W. S. Blatchley, and his assistants, R. S. Blatchley, C. E. Siebenthal, and T. C. Hopkins.

