6/9/57

The PALIMPSEST

BEALER QUARRY, CEDAR COUNTY (NIAGARAN LIMESTONE)

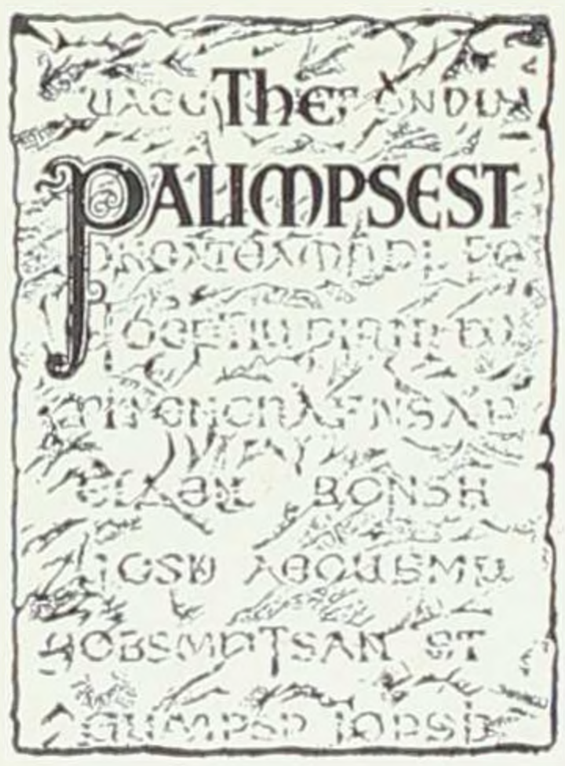
QUARRYING IN IOWA

Published Monthly by

The State Historical Society of Iowa

Iowa City, Iowa

MAY 1957



The Meaning of Palimpsest

In early times a palimpsest was a parchment or other material from which one or more writings had been erased to give room for later records. But the erasures were not always complete; and so it became the fascinating task of scholars not only to translate the later records but also to reconstruct the original writings by deciphering the dim fragments of letters partly erased and partly covered by subsequent texts.

The history of Iowa may be likened to a palimpsest which holds the record of successive generations. To decipher these records of the past, reconstruct them, and tell the stories which they contain is the task of those who write history.

Contents

Cover

Front — Bealer's quarry, Cedar County

Back — Geologic Map of Iowa; Generalized Structure Section of Iowa; General Geological Section of Iowa. The map was prepared by Professor C. S. Gwynne from the Iowa Geological Survey Geologic map of Iowa, 1947.

Pictures, courtesy of: Department of Geology, University of Iowa — early quarries and some structures; Charles S. Gwynne — figures of Iowa fossils, the Geologic Map of Iowa, and Botany Hall; Cornell College — Cornell College chapel; River Products Company; Schield Bantam Company; and the Dewees-Weber Company.

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The editor is indebted to Dr. Charles N. Brown of the Iowa Geological Survey and Professor A. C. Trowbridge of the Department of Geology (S. U. I.) for assistance in preparing this issue.

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THE PALIMPSEST

EDITED BY WILLIAM J. PETERSEN

VOL. XXXVIII ISSUED IN MAY 1957 No. 5

Quarrying in Iowa

Quarrying, the extraction of stone from the solid rock of the earth's crust, through surface workings, is certainly not "as old as the hills," but most of the material quarried is much older than the hills. Most rock solid enough to be quarried was formed as rock millions of years ago; the hills, on the other hand, have been carved out of the terrain — including the solid rock — by later weathering and stream erosion.

History of the Industry

But if quarrying is not "as old as the hills," it is at least an ancient industry, whose roots go back into antiquity. Earliest man used stone, but stone which, in a sense, had already been quarried by nature through the process of weathering. Tools, implements of various sorts, weapons, ornaments, all these were made from pieces of stone — pieces which had been freed from the solid rock of the earth's crust by weathering. Real quarrying must have developed gradually. As the desire arose for stone to be used in buildings and

Iowa Consistory
NEWS

Valley of Cedar Rapids — Orient of Iowa
Ancient and Accepted Scottish Rite

Volume XII JUNE 1957 Number 10

A MASONIC LODGE

It is, of course, a hall wherein the work of Masonry is carried on.

But it is more. It is brothers banded together by immutable ties, working, striving and learning to become better men, men more capable of contributing something of lasting value to society.

It is a place wherein brothers are engaged in the important work of preserving for posterity those unchanging principles which become lost to mankind unless they are kept alive in the hearts of men who can rightly appreciate their worth.

It is a room in which "The Furniture of the Lodge" symbolizes the solid and sacred foundation upon which all Masonry is erected.

It is a school where men come to learn the greatest of all lessons — lessons of Charity, Reverence, and of Brotherly Love and Kindness.

It is a room dedicated to God and lighted by the sacred fires of the Mason's devotion to the ideals of Freedom of Mind and of Conscience; and perpetuated by his constant awareness of his responsibilities to self and to others.

Iowa Consistory ...NEWS...

PUBLISHED monthly in the interests of Ancient and Accepted Scottish Rite masons in the Valley of Cedar Rapids, Orient of Iowa, by

KILWINNING LODGE OF PERFECTION—
Donald G. Isett, 32°, Venerable Master.

BRUCE CHAPTER ROSE CROIX—
H. James Bronson, 32°, Wise Master.

ST. ANDREW'S COUNCIL OF KADOSH—
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FLOYD PHILBRICK, 33°, Deputy of the Sovereign Grand Inspector General in Iowa for the Valley of Cedar Rapids.

MARION H. WILLIAMS, 32°, KCCH, Registrar. 616 A Avenue, N.E. Telephone EM 4-9926.

THE FALL REUNION

At a recent meeting of the Executive Committee of Iowa Consistory, the Fall Reunion dates were set for November 5, 6, and 7. This is earlier in November than the Reunion usually comes, which means we will have to begin getting our prospects rounded up and readied a little earlier than usual for this Fall's Class. The outlook is good for a large Class, and with your help we can make it so.

REUNION REMINISCENCES

As one contemplates our recent Reunion, many fine things come to mind. Among them was the splendid spirit in which the Degrees were dramatized and the deep interest in which they were received by the Class. Also deeply appreciated was the whole-hearted willingness of the brethren to voluntarily help at the times and places they were needed. Also, on this list was a co-operative effort to keep the Reunion in all its many interests up to the high standards of the Scottish Rite Spirit. Then, among the best was the all day visit of Brother William Koch, 33°, of Des Moines, the Sovereign Grand Inspector General in Iowa, and who so graciously and sympathetically spoke at the banquet hour Thursday evening. All those who were not at this Reunion missed all this and much more.

FOURTEENTH DEGREE RING

To our ancient Brethren, who were members of Knightly Orders, three things in this life were prized above all others — even above life itself — for with the loss of either, life's aim had failed.

These three things, so dear to the ancient Knight, were the purity of his honor, the integrity of his sword, and the spotlessness of his shield. Honor that never broke faith with anyone, whether man or woman; the integrity of the sword, in never failing to draw it in the defense of innocence and right; the shield never to be sullied by protecting oppression and wrong.

At the death of the Knightly owner, he bequeathed his sword and shield to one nearest and dearest to him, the one he believed would maintain both unblemished.

The Scotish Rite has adopted a symbol that represents the sword, shield and armor of our ancient brthren, and as clearly marks the profession of Knighthood as did those. This symbol is the Fourteenth Degree Ring, with its motto — "Virtus junxit, mors non separabit" — "Virtue has united, and death shall not separate" — to be honorably worn through life and at death, as was the custom of our ancient Brethren, to be handed down to one most dear, in the belief that it would be kept pure and unsullied. This ring is a plain flat band of gold, having imposed thereon an engraved or enameled plate in the form of an equilateral traingle and within the triangle the Hebrew word "Yod."

VACATION TIME

As this is the last issue of the "Consistory News" until September, the office, and the officers of the Co-Ordinate Bodies, are wishing for each member a pleasant summer vacation time. The Temple office will remain open thru this period as usual. Office hours are: 9-12; 1-4:30 except Saturday, which is 9-12. Remember, the summer months is a good time to sow the seeds of the Scottish Rite for a harvest in our Fall Reunion.

SCOTTISH RITE SPRING REUNION

During the Spring Reunion of Iowa Consistory, May 7, 8 and 9, fifty-four Master Masons were initiated into the Scottish Rite. The noon luncheons and evening dinners were served by the El Kahir Shrine Auxiliary, and music for the Degrees was furnished by the Scottish Rite Choir with Brother Norman Emerson, 32° KCCH, Director.

"The Ernest Robert Moore, 33°, Memoral Class" elected the following officers:

Harry Joseph Whitehead, Jr. ..... President
Dudley Royal Henderson ..... Vice-President
Edward Graves Lee ..... Secretary
Jack Kenneth Onstott .... Treasurer
Winfield Arthur White ..... Orator
Oscar Richard Gager .... Historian

Members of the Class were:

AMANA: Leonard Peter Graf.

CEDAR FALLS: Donald James Bashford.

CEDAR RAPIDS: Carl Howard Anderson, Gareth Huff Clift, John Frederick Cundiff, George Elmer Floyd, Archie Lavern Gardner, Will Goon, Robert Edward Johnson, Floyd Eugene King, Robert Lee Klinger, George Bert Knott, Michael George Kouri, Edward Graves Lee, Paul Lincoln Manchester, Robert Louis Maresh, Frederick Earl Miles, Kenneth John Miller, John Roy Mull, Slayman Hassan Murray, Robert Norbet Nejdl, Jack Kenneth Onstott, Albert Thomas Petsel, Duane Robert Platner, Robert Meredith Radle, Hugh Lewis Rick, Donald Earl Rose, Blake Merton St.Clair, Harry Joseph Whitehead, Jr.

CENTRAL CITY: Dudley Royal Henderson.

CHARLES CITY: Donald Elbert Dexheimer, Paul Oliver Hines.

CLARENCE: Myrl Bixler Sylvester, 30°.

DUBUQUE: Eldred John Sprague.

LISBON: Eugene Lee Miller.

MARION: Gordon Arthur Harstad, Harold Dale Klingler, Wineld Arthur White, Marion Lawrence Wood.

MASON CITY: Joel Charles Hanes, Roy James McEwen, Richard Elvor Setterberg.

MT. VERNON: Lester Frank Buresh,

NEW HAMPTON: Harley Henry Dothager, Stanley Morris Edson, Oscar Richard Gager.

SIGOURNEY: Laurence Earl Williamson.

TRAER: Paul Wesley Somerville.

WATERLOO: Wilbur Syrene Dimmitt, Carlton Hoffman, John Hornby Smith.

WAUKON: Albert Juneo Oelberg.

VILLA PARK, ILLINOIS: Bernard William Fuerst.

CHANGE OF ADDRESS

When you change your address, please notify the Registrar at once and mark it "Change of Address;" merely writing from a new address will not be considered a request for a change. We can know you have moved to a new location and wish to receive your mail there only when you tell us so. Thank you for helping us keep up with you.

FREEMASONRY NOT AN ORDER

Freemasonry is often spoken of as an order, and its ceremonies as a ritual. These terms are neither technically nor legally correct. Freemasonry is a craft and its ceremonies are "work." An order is an association of persons. A craft is something more, inasmuch as it inculcates or teaches a "mystery." The word "craft" is from the Saxon **croeft,** meaning power, skill or the unexplained ability, by long practice to produce a desired result.

IN MEMORIAM

HENRY FREDERICK KLEMME, 32°; April 1909; Belle Plaine, Iowa; April 13, 1957.

HERCHEL ROBERT GREER, 32°,; October 1944; Cedar Rapids, Iowa; April 15, 1957.

FRANK ROSS WINGERT, 32°; April 1920; Cedar Rapids, Iowa; April 25, 1957.

SAMUEL KENNETH WEIR, 32°; November 1918; Henderson, Nevada; April 28, 1957,

CHARLES SEBRIGHT WOODWARD, 32°; April 1922; Cedar Rapids, Iowa; May 13, 1957.

WENTZLE RUML, 32°
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CEDAR RAPIDS, IOWA

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IOWA CONSISTORY NEWS

MARK YOUR CALENDAR

for the

FALL REUNION

Tuesday, Wednesday, Thursday

NOVEMBER 5, 6 and 7

REGULAR MEETING

of the

4 CO-ORDINATE BODIES

Annual Meeting of Saint Andrew's Council

with

Election of Officers

WEDNESDAY, JUNE 19th – 8:00 p.m.

Scottish Rite Temple

Ladies' Social Hour — Refreshments

monuments, one can imagine that men of the Stone Age started working at a place where stone in slabs and blocks had been, and was being, freed from outcrops by frost action and plant roots. As time went on, however, it became necessary for man, by one means or another, to break the rock loose from its surroundings. Then it was that quarrying began.

Quarrying in Ancient Times

It must have been difficult at first, without the use of metal tools, but real quarrying of some sort developed as man became equipped with tools of copper and iron. Then he could drill holes in a row along a line where the rock was to be broken. The rock could be split along the line of holes in various ways. Water poured into the holes and allowed to freeze would be one method; driving plugs of some sort into the holes would be another.

In any case, all the people of the ancient world found out how to break or cut pieces of stone free from the solid surroundings. They probably took advantage of natural cracks in the rocks, just as is done today, but more about that later.

Quarrying became an active industry in the world of Greece and Rome. The temples and public building were made of stone, and much of this came from quarries. The same is true of the works of Egypt — the Sphinx, the Pyramids, and the obelisks. The Egyptians made great use of stone, particularly of limestone and sandstone, and the

quarries in the valley of the Nile are well known. In the New World, the Aztecs, Mayans, and other Indian groups did their share of quarrying, and probably without the use of metal.

Igneous Rock (Granite)

Now let us look into the nature of the materials that are quarried. The rocks of the earth's crust are grouped in three classes, on the basis of origin. The first, or fundamental class, one might say, is that of the igneous rocks. Igneous rocks are formed from the solidification of molten material. Originally, as the earth was first formed, there may have been none but igneous rocks. Granite is the most actively quarried igneous rock, widely used in monuments.

Sedimentary Rock (Limestone-sandstone)

But as time went on — and the rocks were weathered by atmospheric action, and the rain fell and the rivers flowed — sediments accumulated and were washed from the land surface into the growing seas and oceans. These sediments, subsequently hardened to rock, became the second class, the sedimentary rocks. With the withdrawal of the seas, they became part of the upper bedrock of the land areas. Limestone and sandstone are common sedimentary rocks.

Metamorphic Rock (Marble)

Either igneous or sedimentary rock through crustal movement might later find itself deep within the earth's crust. There it changed under

the new conditions of temperature and pressure, and became what is known as metamorphic rock — the third class. Marble is a common metamorphic rock.

Rocks of all three classes have been used by man, and much of the stone secured by quarrying. The ancients, of course, took what was nearby, so whether they quarried an igneous, sedimentary, or metamorphic rock depended upon what was within hauling distance. The Egyptians quarried limestone for the building of the Pyramids. The Romans and Greeks quarried great quantities of marble. The Mayans used enormous quantities of limestone, a sedimentary rock, in their extensive building.

The Geology of Iowa

Let us review the geology of Iowa before taking up the quarries. Most of Iowa, and of the upper midwest for that matter, is covered with a mantle of glacially deposited material — the glacial drift, which constitutes the bulk of the subsoil. Here and there above it lies a deposit of wind-blown silt — the loess. Along the valleys are stream-laid deposits. These three materials are only in the way of the quarryman wishing to get at the rock below. They form the "overburden" of the quarries; the less the better, from the standpoint of the quarry operator.

The drift, the loess, and the stream deposits average approximately 200 feet in thickness. Below

them lies the solid rock of the earth's crust, the bedrock; in places it is at the surface, particularly along valley-sides.

Sioux Falls Stone

In the extreme northwestern corner of the state, in Lyon County, the geologically oldest rock appears at the surface. This is a metamorphic rock called quartzite — a hard, brittle stone which is quarried at Sioux Falls, South Dakota. Geologists call it Sioux quartzite but it is commonly known as Sioux Falls stone. It has not been quarried in Iowa except on a very small scale.

Other Iowa Bedrock

Elsewhere in the state, the bedrock is entirely sedimentary. It is piled layer upon layer: limestone, shale, sandstone, conglomerate, coal, gypsum. In the eastern part of the state, these rocks have a gentle dip, or slope, ten or twelve feet to the mile, toward the southwest. Similarly, these same beds in the northern part of the state dip southward; and in the western part, southeastward. Thus, they have an arrangement like that of a pile of nested spoons with the tip toward the northern part of the state and extending up into Minnesota, and the bowl in the southwest corner and beyond. The land surface cuts right across the edges of these nested spoons.

The oldest of these sedimentary rocks outcrops around the outer part of the spoonlike structure, each succeeding horizon within, until finally the

youngest of the columns forms a large area in the southern and southwestern counties. In the northeastern corner, where only the older are present, these sedimentary rocks are a thousand feet in thickness; in the southwestern part, they are about 5,000 feet thick. Beneath them everywhere lie much older, presently inaccessible, so-called crystalline rocks, such as quartzite and granite.

In the northwestern counties, a rather thin deposit of younger bedrock lies almost horizontally upon the truncated beds of the spoon-like structure described above. It also extends toward the south in patches and broader areas. Most of it is sandstone, though conglomerate, clay, and chalk (a soft variety of limestone) are also present. It ranges up to about 400 feet in thickness.

Geologic Groups

Geologists have divided the long span of earth history into eras, and the eras into periods. The rocks corresponding to these are groups and systems respectively, and the systems are further subdivided into series and formations. The quartzite of the northwest belongs to the Proterozoic group; the rocks of the spoon structure to the next succeeding group, the Paleozoic; and the blanket of western counties to the still younger Mesozoic.

Geologic Systems

The systems of the Paleozoic are, from oldest to youngest: Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Per-

mian. All are represented in the bedrock of Iowa. Of the three systems of the Mesozoic, only one (called the Cretaceous) is present in Iowa. It forms the blanket above the Paleozoic rocks in the northwest and western areas. The geologic map on the back cover shows the distribution of these systems in the state, accompanied by the sketch cross-section to show the structure.

Rocks of all these systems have been quarried to some extent in Iowa. Some systems are almost entirely one kind of rock, as is the case with the Silurian — largely a variety of limestone. Others are composed of shale and sandstone, as well as of limestone. The conglomerates (coal and gypsum) make up only a small part of this sequence of sedimentary rocks.

Most of these rocks then are interpreted as the hardened deposits of sediments which were laid down in seas spreading over the continent in ages past, shallow seas which were connected with the broad oceans of their time. Sand deposits became sandstone, clay became shale, and limey mud, sea shells, or ooze became limestone.

Layers, or Beds of Rock

All of these rocks are in layers, or beds. Some of the beds are many feet thick, others only a few inches. In one quarry, the rock may be all limestone in beds of variable thickness. Below the quarry floor, there may be a bed of sandstone, and below that, layers of other sedimentary rocks. In

another quarry, there may be beds of limestone and shale, or of sandstone in addition. The quarry operator may be interested only in the limestone, so the other rocks really constitute a hindrance to his operation. Limestone, of one variety or another, is the rock which has been most widely quarried in Iowa. It makes up a large part of our geological column.

Joints

The fact that these sedimentary rocks are in layers instead of in great solid masses is an aid in their extraction. So, also, is the presence of joints. These are straight cracks — vertical or nearly so — variably spaced, which extend through the rock. Joints exist in sets, and there are frequently two or more sets in a single quarry. Obviously, if it were not for the bedding planes separating the beds, and for the joints, getting the rock out would be a much more difficult job than it is.

Wherever the country has been dissected by stream action so that there are many valleys and ridges, these layers of sedimentary rock may outcrop. By this, we mean that the beds actually stick out at the surface. In the northeastern part of the state, the terrain has been cut up by post-glacial erosion, and rock outcrops are very abundant. Over much of the north-central and northwestern parts of the state, covered by more recent glaciers, the drift is thicker and relatively undissected, so bedrock outcrops are few. Some counties have

none, and that usually means no quarries. Quarries are rather scarce in southern and southwestern counties.

Early Quarrying in Iowa

Quarrying in Iowa began when the first pioneers came into the state, and as settlement moved westward, it might almost be said that quarrying moved with it. At least it was an industry undertaken almost at the start wherever there was rock available — usually limestone, sandstone to a less degree. Some of the earliest forts were of stone. Stone for the buildings at Fort Atkinson, in Winneshiek County (constructed in 1840), came from a closely adjacent quarry. Stone was a natural material for foundations of houses and barns, and thence the use spread to the construction of entire buildings. There are many public buildings and churches of native stone in Iowa, dating back to early days.

Varied Uses of Stone

Stone was also used on the streets for curbing, gutters, and paving blocks. Even crushed or broken stone might be spread on the streets and roadways. Dams were made of it. Thinly bedded rock, "flagstone," was made into sidewalks. There was a wide use in bridges, particularly the piers, on both highways and railroads. The railroads needed broken rock as ballast and for the protection of embankments. All of these uses developed as the years went on.

Lime

Along with limestone for structural purposes came its quarrying and use in the manufacture of lime. Limestone when burned or calcined is converted to the substance commonly called quicklime. This was used in cement and mortar, and as agricultural lime. Lime made from Iowa limestone was consumed in considerable quantities in the early days, and there were lime kilns, large and small, widely scattered over the eastern part of the state. Ultimately the industry became concentrated in areas outside of the state and disappeared in Iowa.

Portland Cement

The introduction of Portland cement led to many changes which continue through the years. No longer were great quantities of stone quarried in Iowa for use in the building of houses, churches, and public buildings. No longer was it used as flagging, in the form of paving blocks, or as bridge piers. Concrete and brick took over where limestone had held sway. The quarrying of stone for the making of lime had decreased, and finally ceased. Only within the past few years has it been resumed.

As the population grew, along with the need for more and better roads, there arose the demand for road-surfacing material. Presently in various places stone, again mostly limestone, was being quarried, crushed, and used as roadstone. The

next step was in the use of Portland cement concrete for highway construction.

Portland cement concrete requires not only cement and water, it also requires coarse and fine rock particles, called respectively coarse and fine aggregate. So with the increasing use of Portland cement concrete came a great increase in the quarrying of limestone for aggregate. Aggregate was, and is, also used in the construction of asphalt pavements. And, of course, these types of concrete were used in sidewalks, and the Portland cement concrete for all sorts of construction.

Crushing plants producing aggregate turn out a large amount of "fines," material which has been removed from the aggregate by screening. Thus is produced our familiar agricultural limestone, spread on the fields for its beneficial effects in reducing soil acidity and contributing calcium. Its use was encouraged by the government as part of the conservation program, and in many places quarries were opened for the production of it alone.

Then plants for the manufacture of Portland cement came to Iowa, and presently were quarrying enormous tonnages of limestone and shale from locations in the vicinity of Winterset, at Mason City, and at Buffalo.

The Picture Today

So, here we stand today: only a few quarries in the state producing building stone, also called

dimension stone, for buildings and other structural purposes; one quarry producing stone for the manufacture of lime; large quarries producing limestone and shale for Portland cement manufacture; quarries throughout the state wherever limestone can be found — some large, some small — producing crushed or broken rock for its many uses: aggregate, roadstone, filter beds, riprap, and agricultural limestone. The production of crushed rock for use as railroad ballast has all but ceased, replaced by crushed slag, imported from outside the state.

Gypsum

Gypsum is quarried at Fort Dodge. The material is of excellent quality and lies directly beneath the subsoil, at a depth of about fifty feet. One use is as an additive to Portland cement concrete to slow the setting time. Another is in the manufacture of plaster, wall board, and building tile. At first, gypsum was quarried from the outcrops. Then drift and shaft mines developed. Finally, in the middle twenties, quarrying was again resorted to. Gradually, mining has been abandoned, and today the quarrying of gypsum in the vicinity of Fort Dodge is a large industry.

Quarrying Methods

Now, what can be said of quarrying methods? For the dimension or building stone, most important in the beginning, the method was much the same as it had been over the centuries. The sur-

face of the bed was cleared, holes were drilled by hand at intervals along a line, and then pressure was applied in the holes until finally the rock split along the line. The depth to which the holes were drilled depended upon the thickness of the bed. Large blocks were removed in this manner. As late as 1906 a directory of Iowa quarries shows that much of the work was still done by hand.

Mechanical Power Introduced

The introduction of mechanical power brought changes. The holes were no longer drilled by hand. A steam engine could supply the power. The use of compressed air for the operation of the drill came later. Also, there were other changes in the production of dimension stone. One was the introduction of the channeling machine. This had a row of rotating drills. The machine moved down a line on the cleared bed, cutting holes to the desired depth. After a line of holes to the appropriate length had been cut, and this might be a length of several rods, the long block would be wedged loose, tilted on its side, and then cut into smaller blocks.

Wire saws were introduced. Limestone is softer than steel, and is easily scratched with a knife. The saw, operating from a machine moving along a line on the cleared bed, actually cut a groove in the rock. Then the block, again several rods long, could be wedged loose, tilted and cut into smaller pieces.

Blasting

But with the decrease in the production of building, or dimension stone, and the increase in the demand for crushed and broken stone, came more changes. Careful cutting of the stone was no longer necessary. Holes were drilled to depth back of the rock face, and charges of powder set in the holes. A blast, and a pile of broken rock was produced. Pieces too large to be conveniently handled could be drilled and blasted with a small charge. The broken rock was hauled to the crusher for processing; i.e., for crushing, screening, and grading. Today, the holes are drilled mechanically, at various diameters and to various depths, depending upon the nature of the rock. Blasting methods have changed, the types of explosive have changed, but the process is fundamentally the same. A large pile of broken rock is produced, thrown back against the rock face. After removal of the broken rock, more holes are drilled and another blast is set off for the production of more broken rock, and so on.

Distribution of Iowa Quarries

Why has quarrying been more of an industry in some parts of Iowa than in others? For an answer to that, and related questions, we turn to a further consideration of the geology of the state. To begin with, it is safe to say that all over the state wherever rock is at or close to the surface, it has been quarried for one purpose or another.

All geologic formations except those exclusively of shale have served. A map of the "Mineral Resources of Iowa" printed by the Iowa Geological Survey (1947) shows the location of the great number of quarries, concentrated particularly in the eastern part of the state. Some of those may now be abandoned or inactive, but many others have since been opened. Others will be started in the years to come.

Cambrian Formations

Starting with the geologically oldest rock and looking again at the map on the back cover as we do so, we shall proceed upward in time. First are the Cambrian formations, outcropping in a limited area of northeastern Iowa. These are mostly sandstone, rather crumbly, not usable as building stone or in the form of crushed rock.

Ordovician Formations

Above the Cambrian lie the Ordovician formations, which contain useful beds of limestone. The Prosser, Stewartville, and Dubuque members of the Galena formation have found great use, wherever they can be quarried, in Allamakee, Winneshiek, and Dubuque counties. By way of explanation, formations and other geological units are commonly named from places where they are first studied, or where prominent. Thus Prosser and Stewartville are named from localities in Minnesota, the Dubuque of course from our own city of Dubuque, and the Galena from nearby Galena,

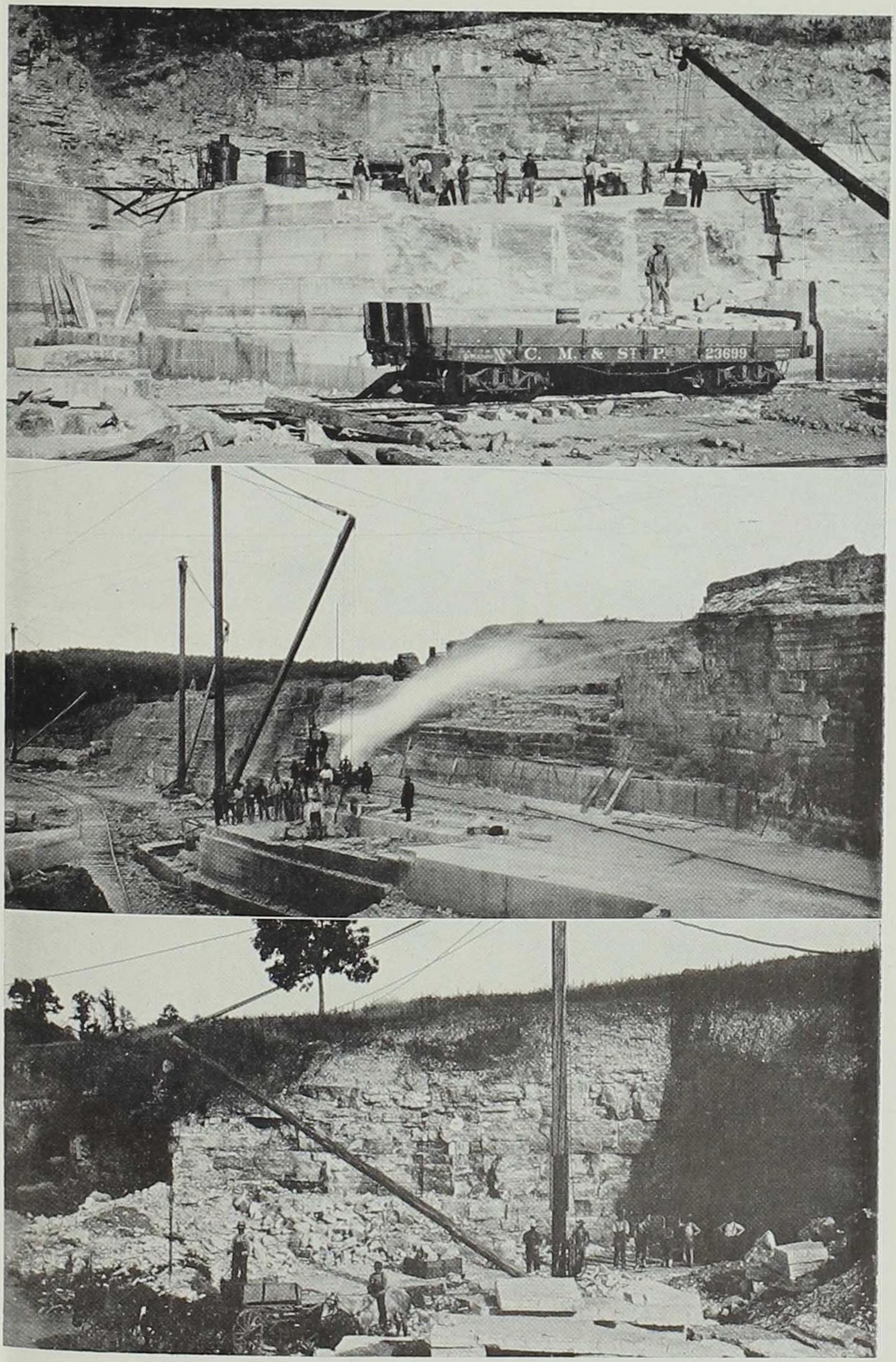
in Illinois. The St. Peter sandstone, also Ordovician in age, is at present being mined in Clayton County for use as a molding sand and in the manufacture of refractory brick; this operation started as a quarry on the river front, and developed into a drift mine, a tunnel into the side hill.

Silurian Formations

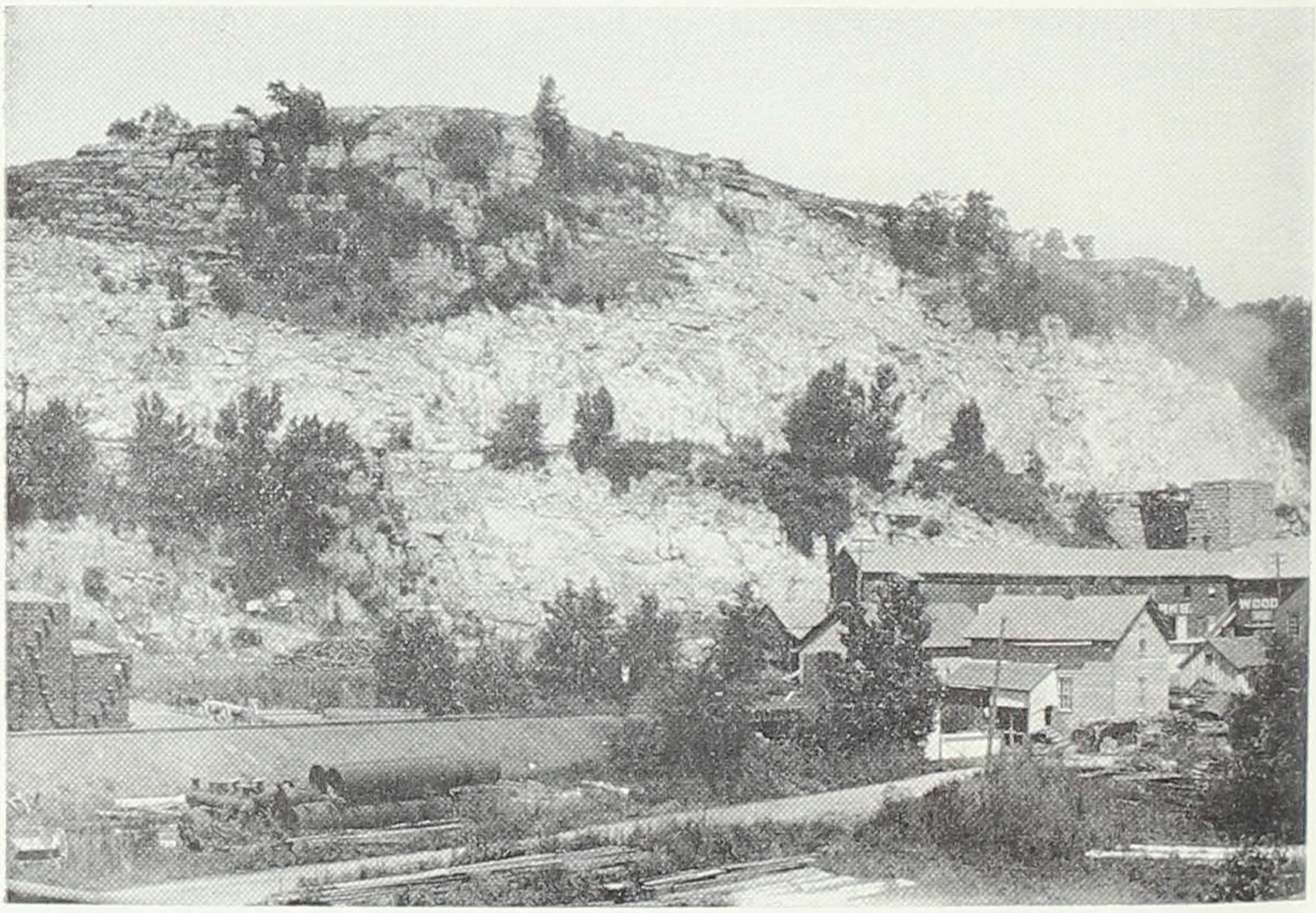
The next succeeding system, the Silurian, is also a variety of limestone. It forms all or a part of the surface bedrock in many eastern counties, including Jones, Delaware, Jackson, Cedar, Clinton and Scott. This has been one of the most actively quarried rocks of the state. Great quantities of building stone were secured from it, particularly from quarries in Jones County. Quarries were operated by penitentiary personnel at Anamosa for many years, and the stone widely used in public buildings, for walls and terraces. The lower courses of Botany Hall and Morrill Hall at Iowa State College are made of this stone, as are many buildings in state parks. Botany Hall bears the date of 1896. Wherever used, this so-called Anamosa stone can be recognized by its delicate stratification, which becomes particularly prominent upon weathering. It is still being quarried to some extent as a dimension stone, although its big use is in one of the crushed forms.

Devonian Formations

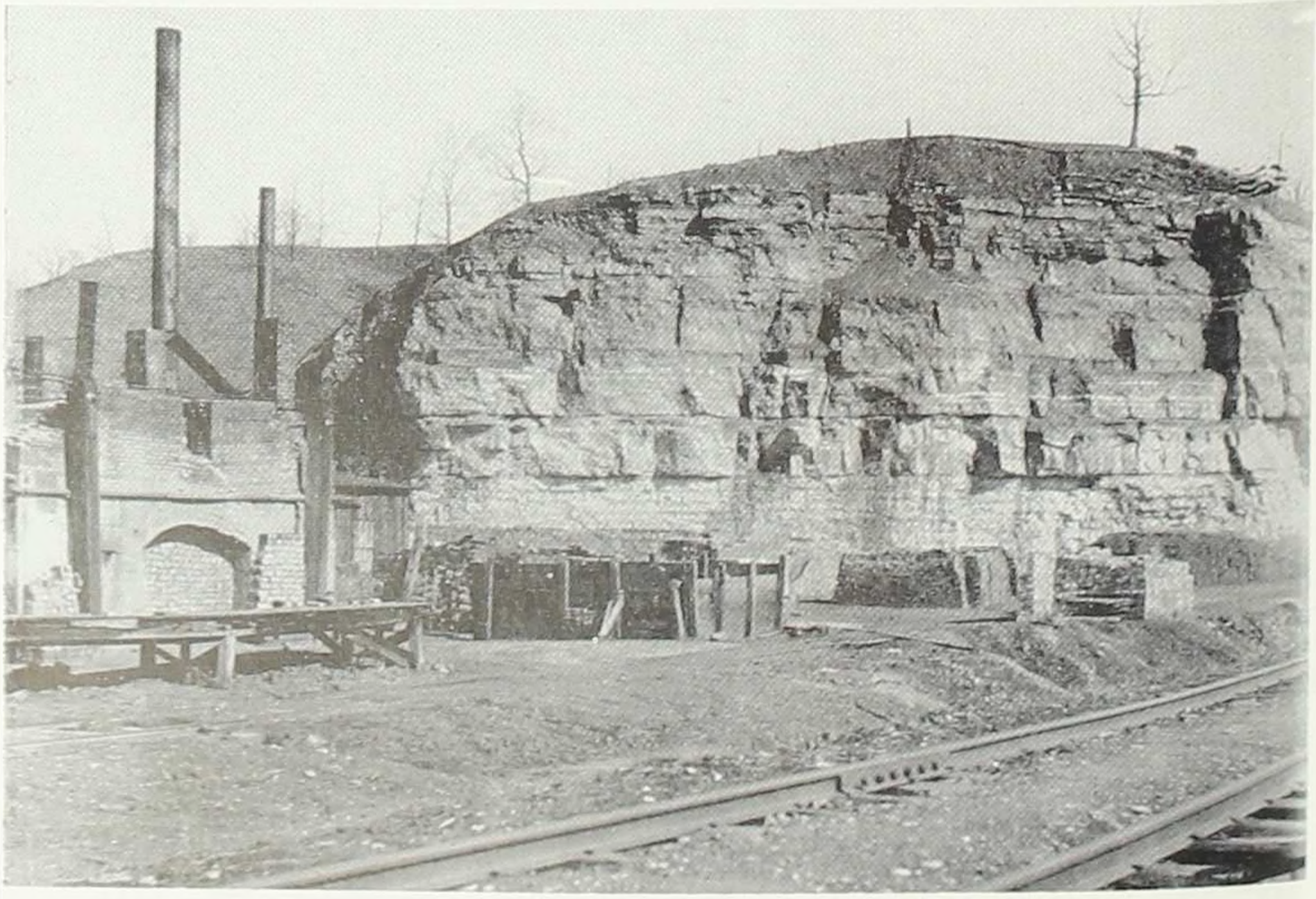
The formations of the Devonian system form the surface bedrock in a wide band, as much as



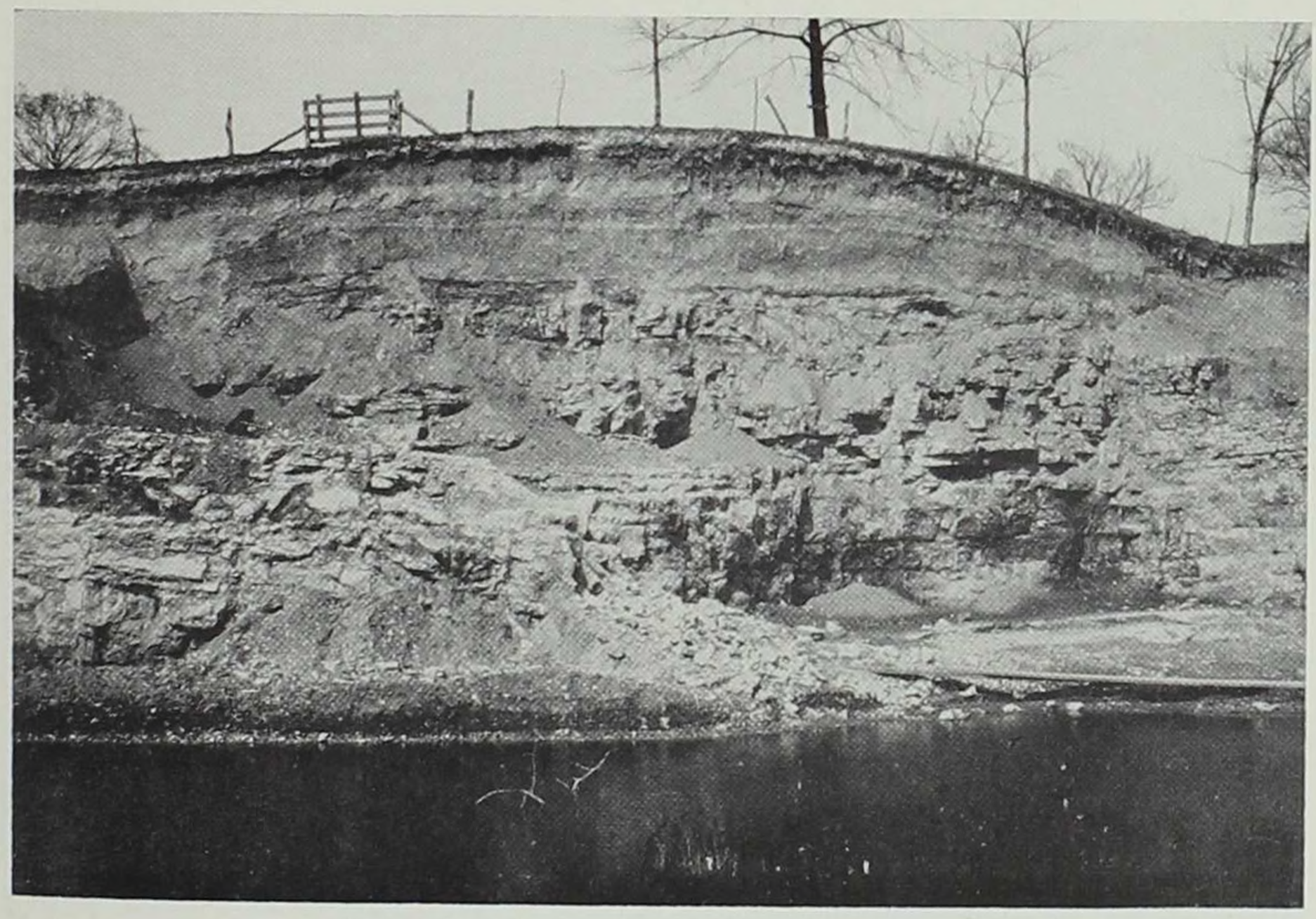
Top: Stone City quarry, Jones County (Niagaran limestone).
Center: Champion quarry, Jones County (Niagaran limestone).
Bottom: Farley quarry, Dubuque County, Niagaran limestone).



Eagle Point quarry, Dubuque County (Galena limestone).



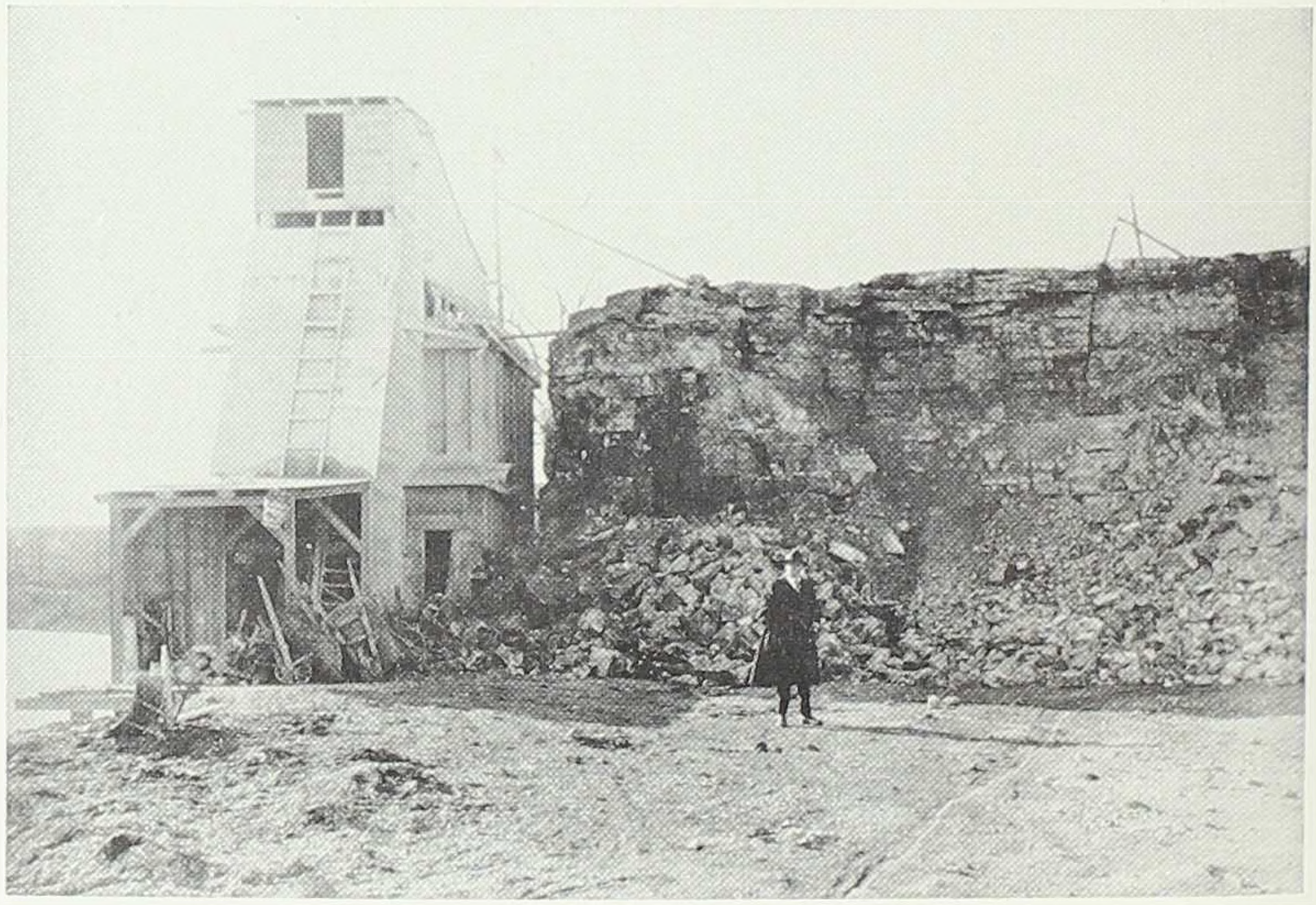
Quarry near Burlington (Burlington limestone).



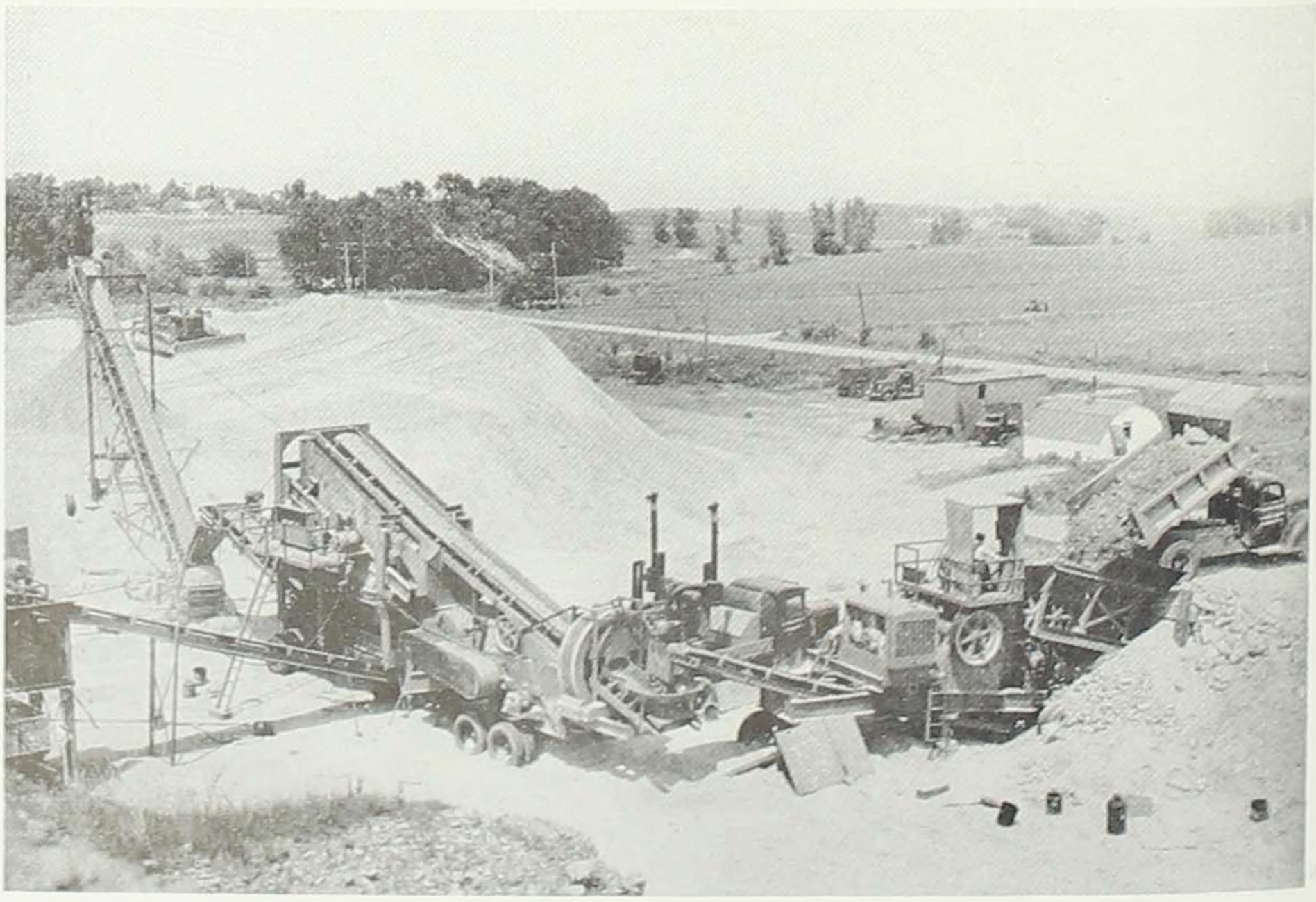
Hutchinson's quarry, Iowa City (Cedar Valley).

State quarry, Johnson County (State Quarry).

RIVER PRODUCTS COMPANY, IOWA CITY



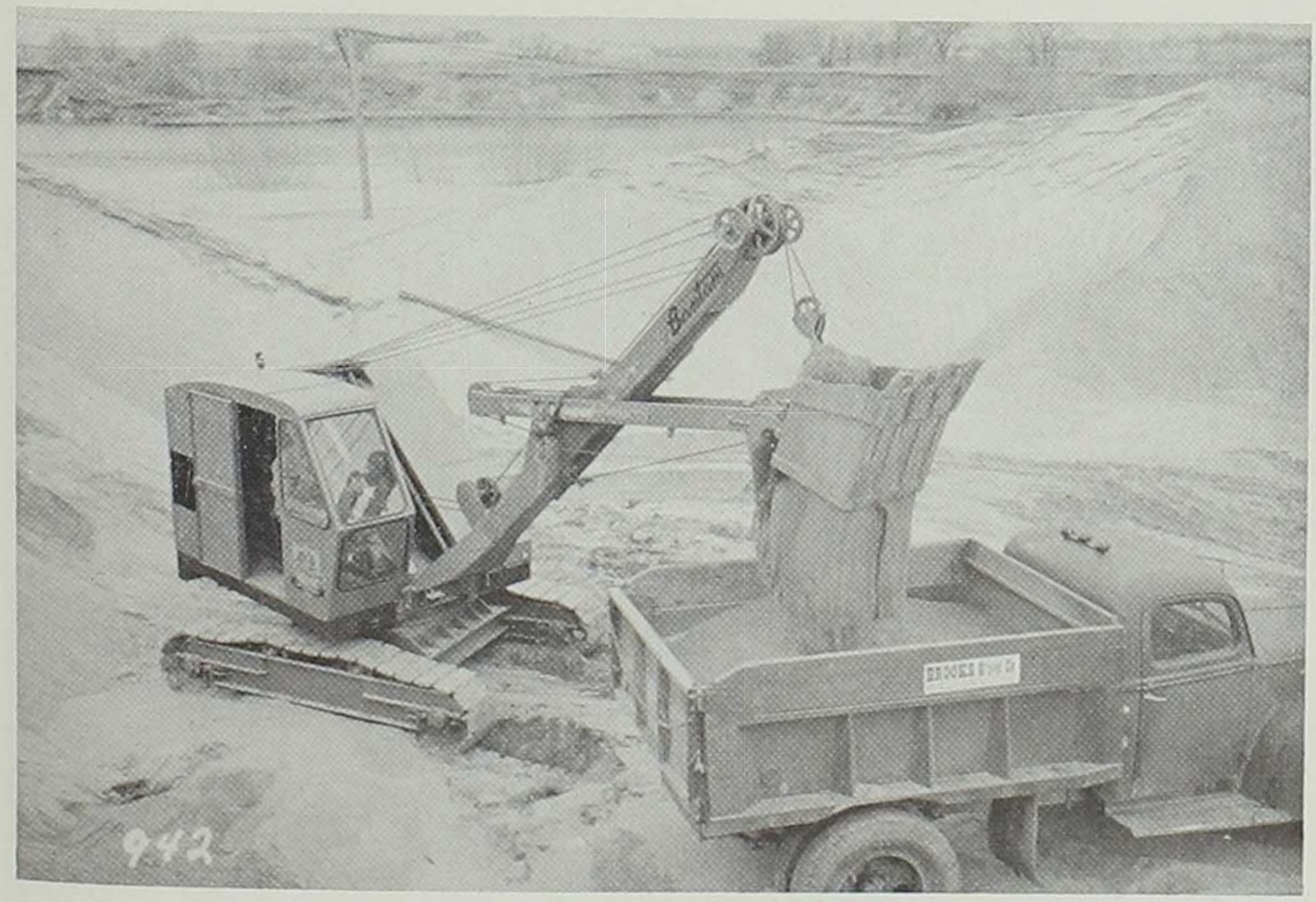
Old quarry when hand labor and wheelbarrows were in use.



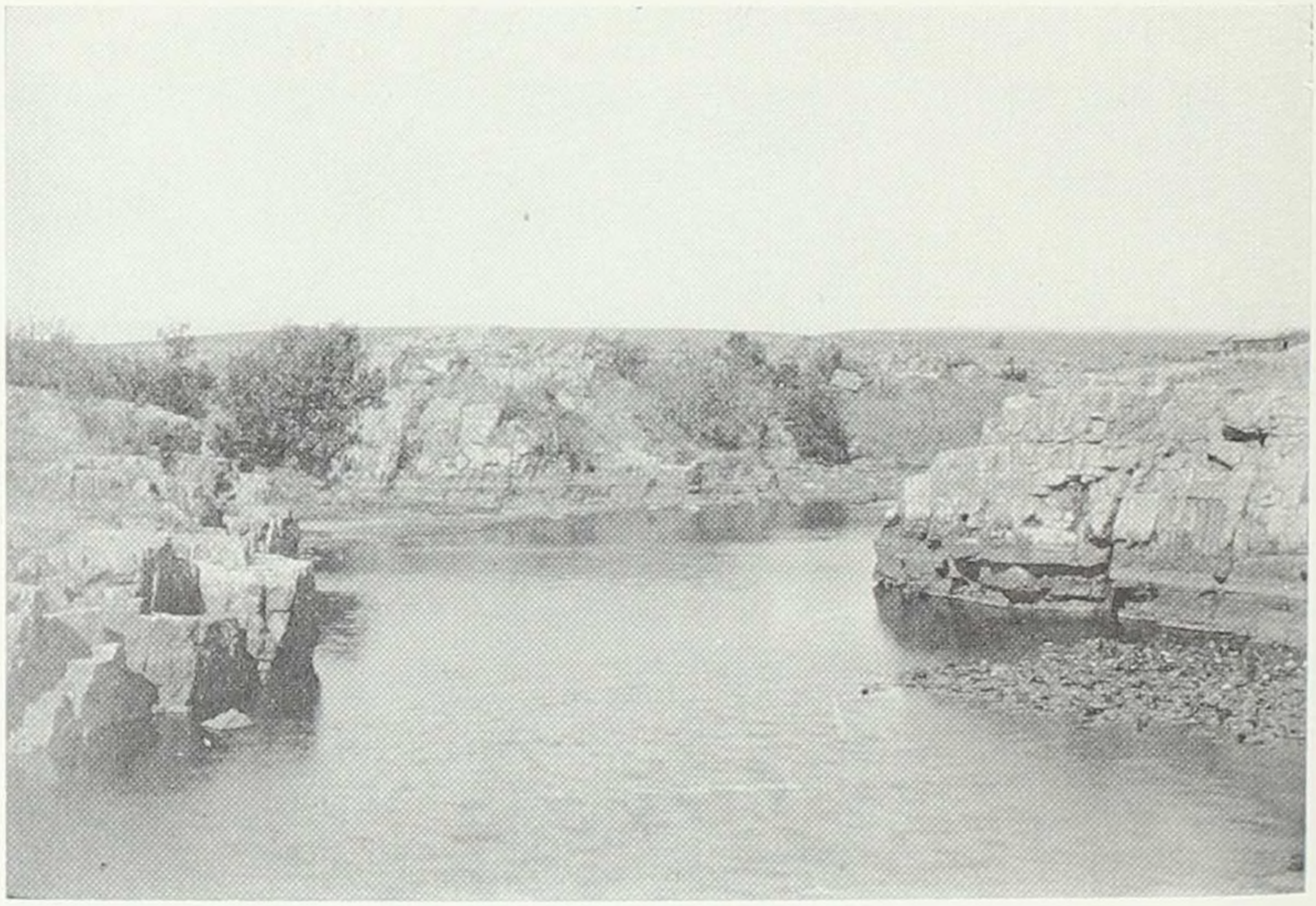
New quarry, showing modern mechanized equipment.

SCHIELD BANTAM COMPANY, WAVERLY

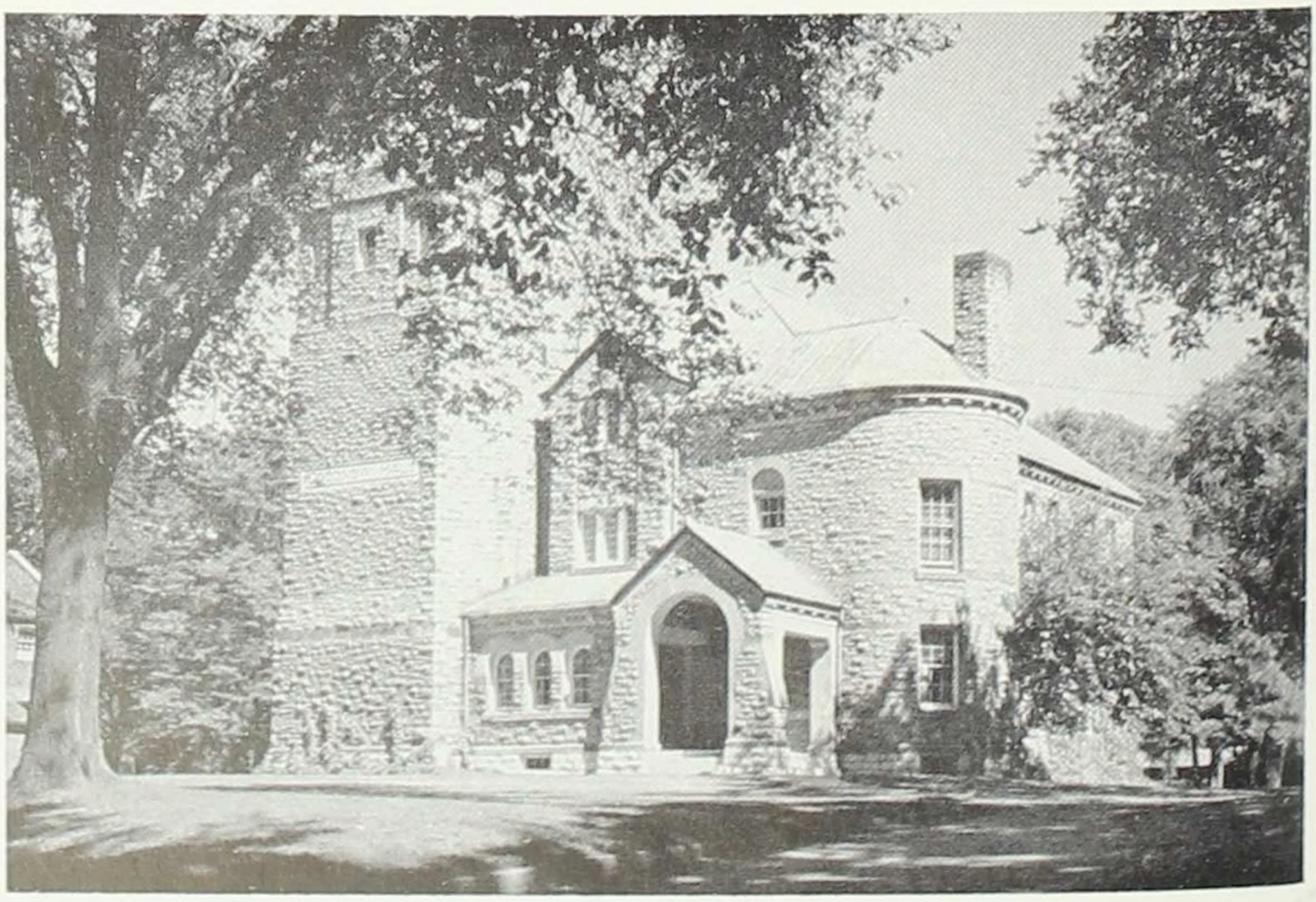
Excavator removing overburden on rock quarry.



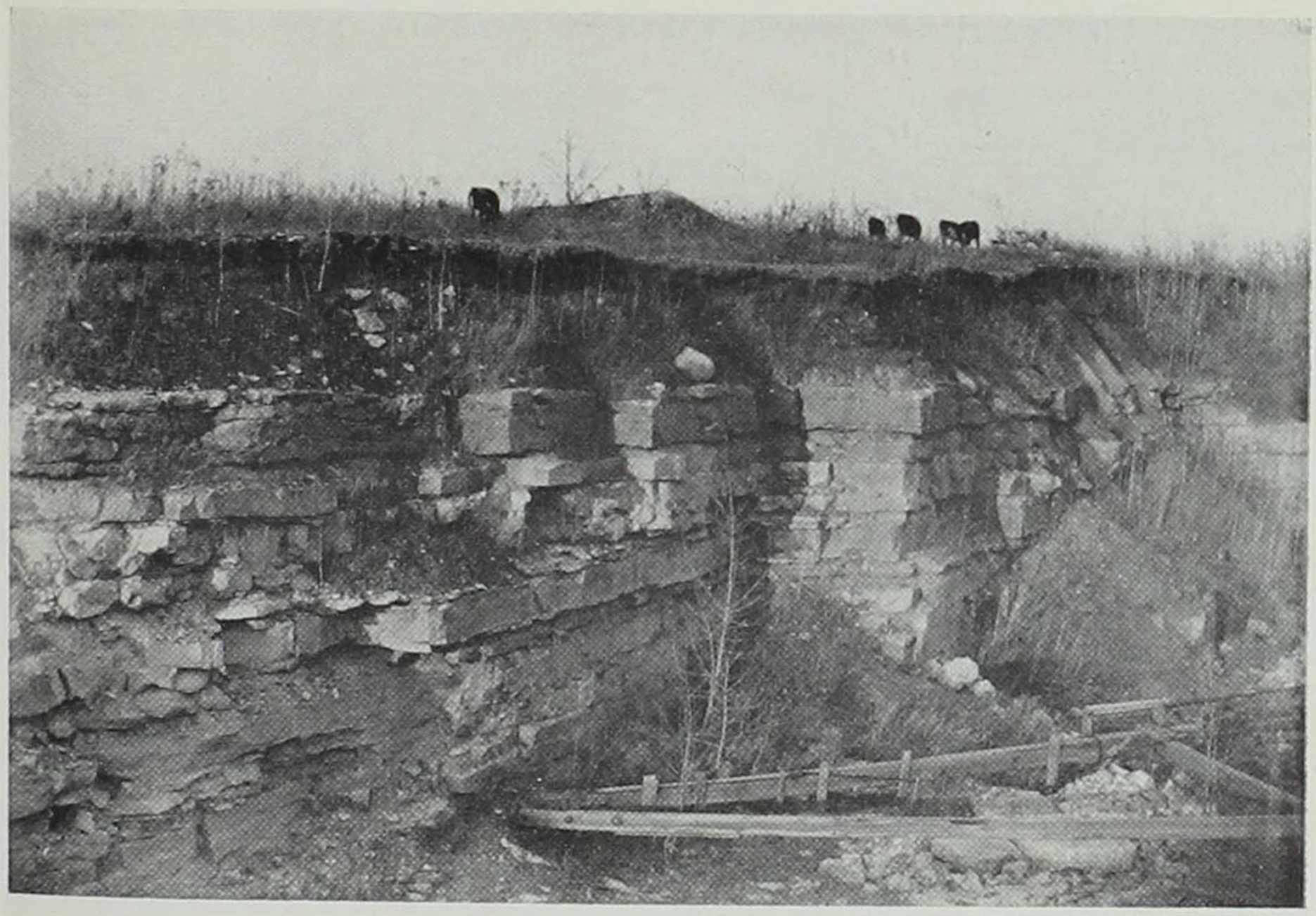
Shovel working in rock quarry loading stock-pile material.



Jasper Pool, Lyon County (Sioux quartzite).



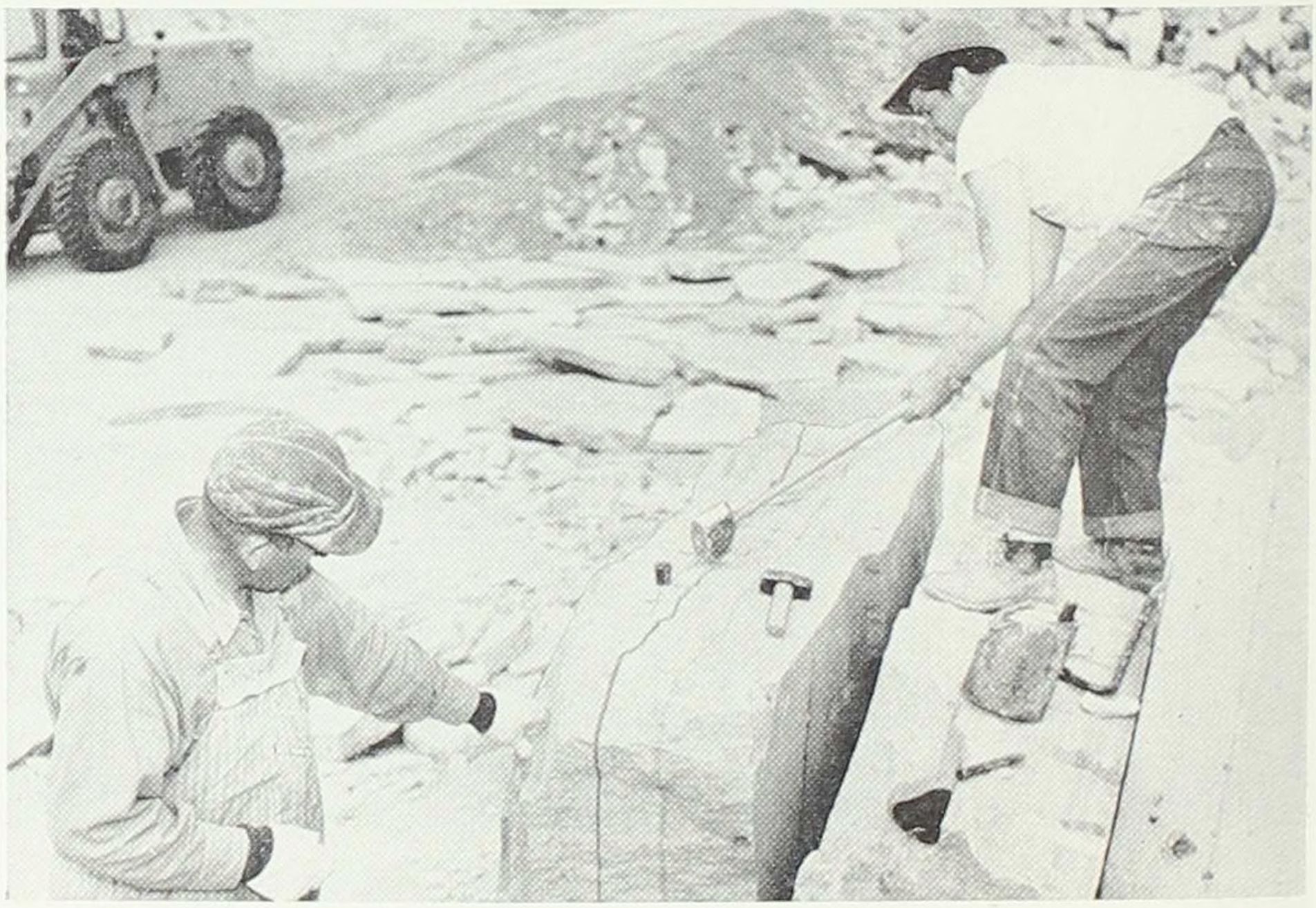
Goodnow Hall, Grinnell College, Grinnell (Sioux quartzite).



Quarry at Earlham, Madison County (Pennsylvanian).

Amana store, Amana (Pennsylvanian).

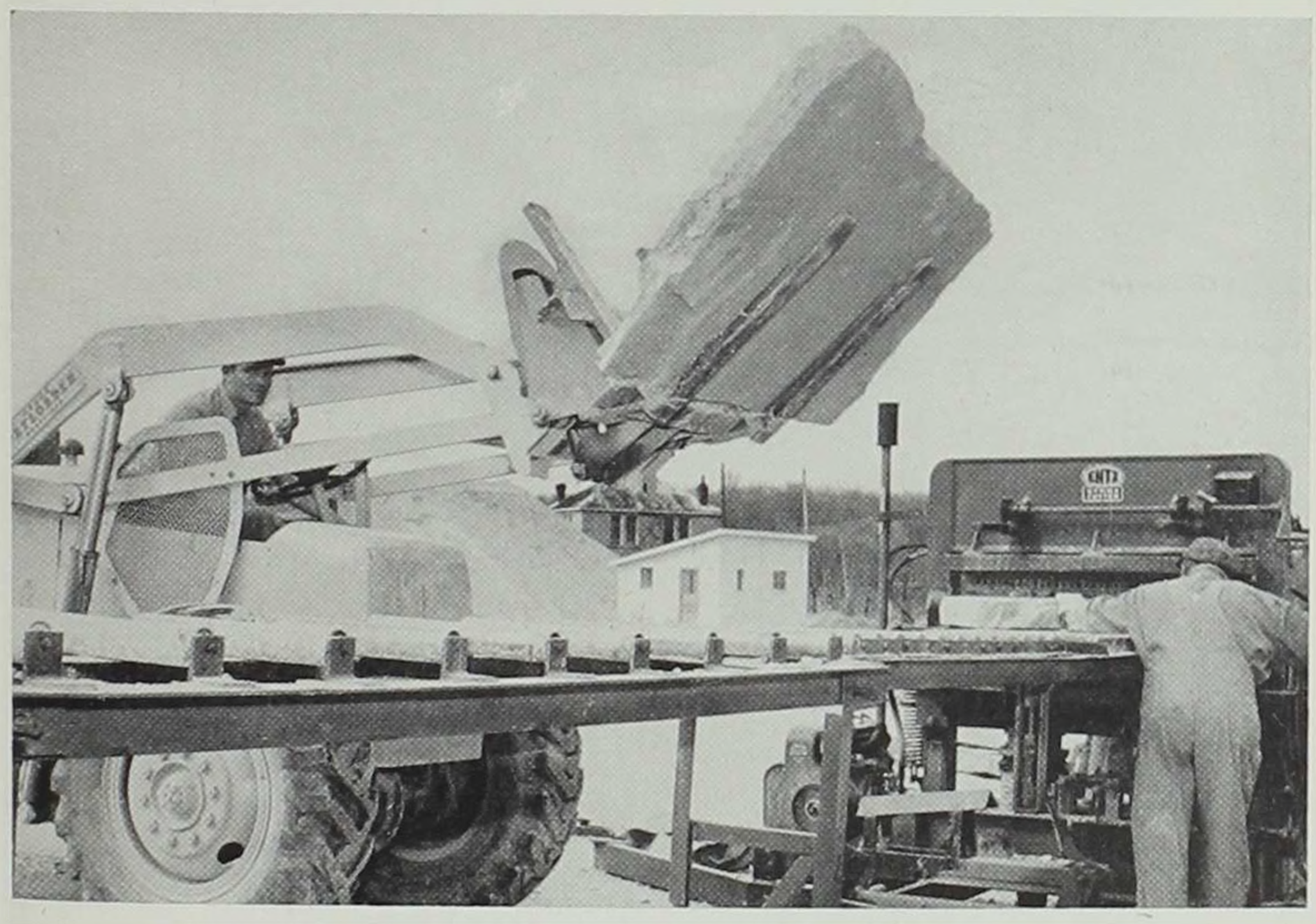
DEWEES-WEBER QUARRY, STONE CITY



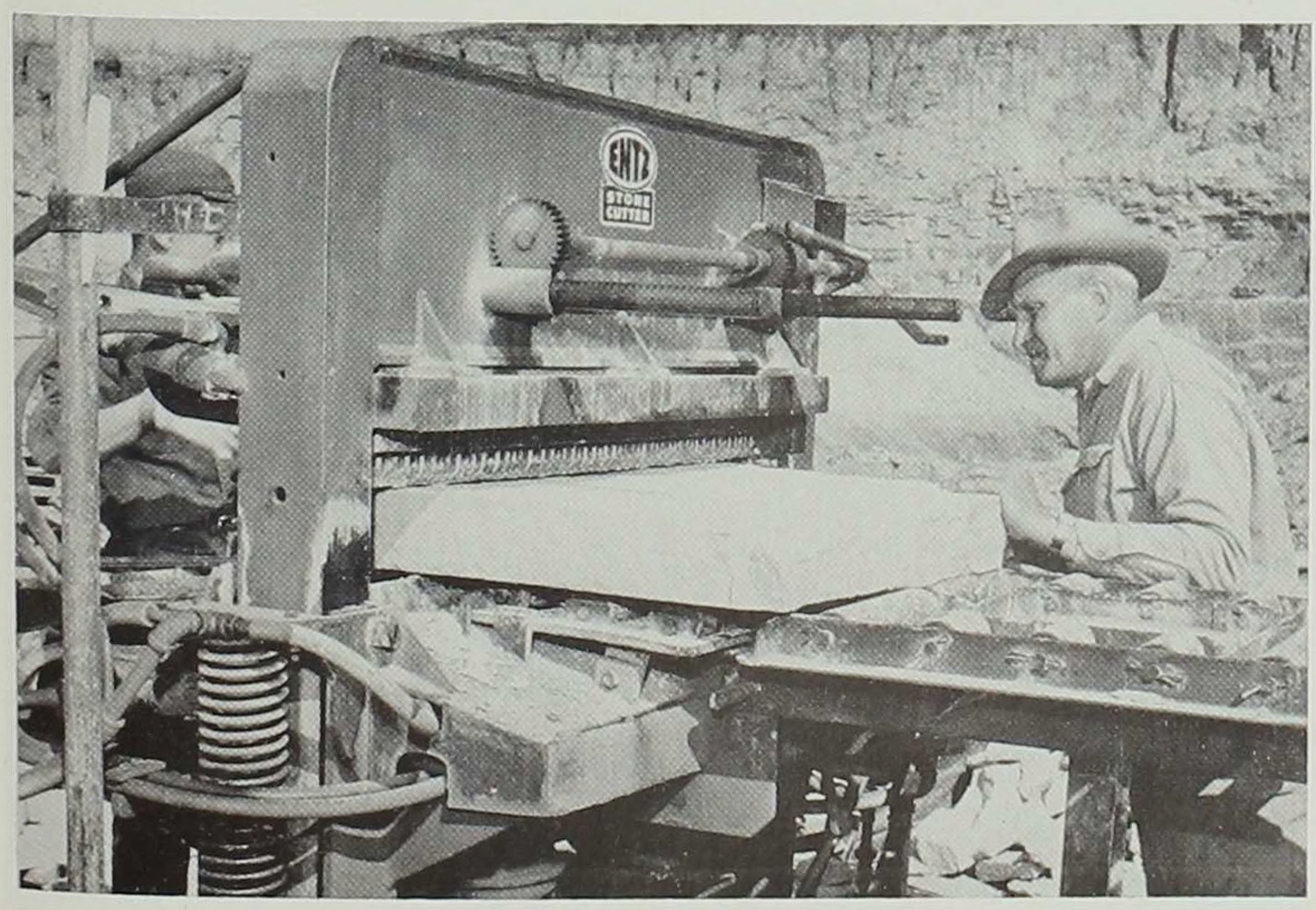
"Capping the rock." Chisels are driven into the soft layers of Anamosa limestone, breaking off the hard layers in a single slab.

Slab of Anamosa limestone being lowered onto a fork lift.

DEWEES-WEBER QUARRY, STONE CITY



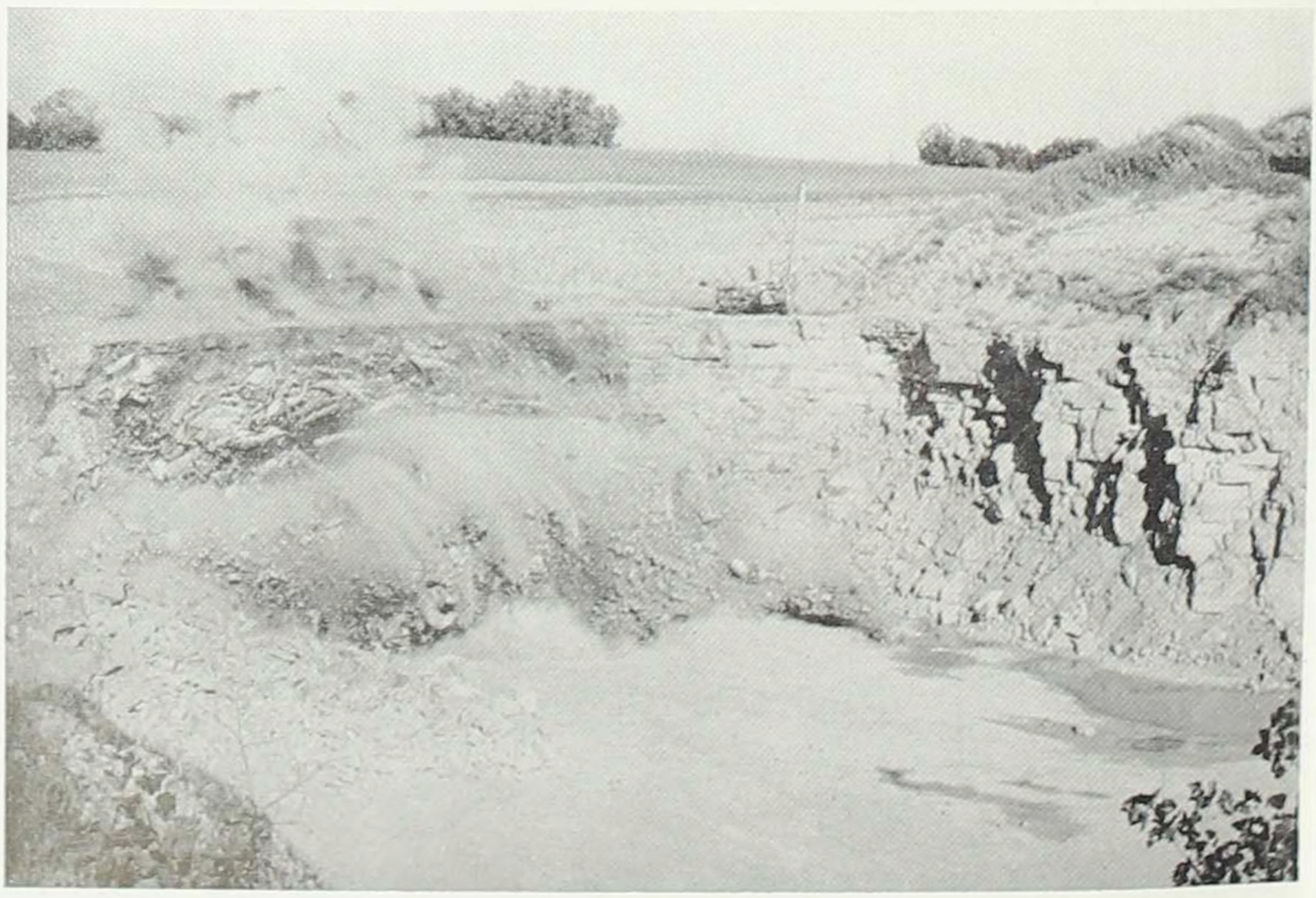
Stone being lowered from the fork lift to the conveyor belt.



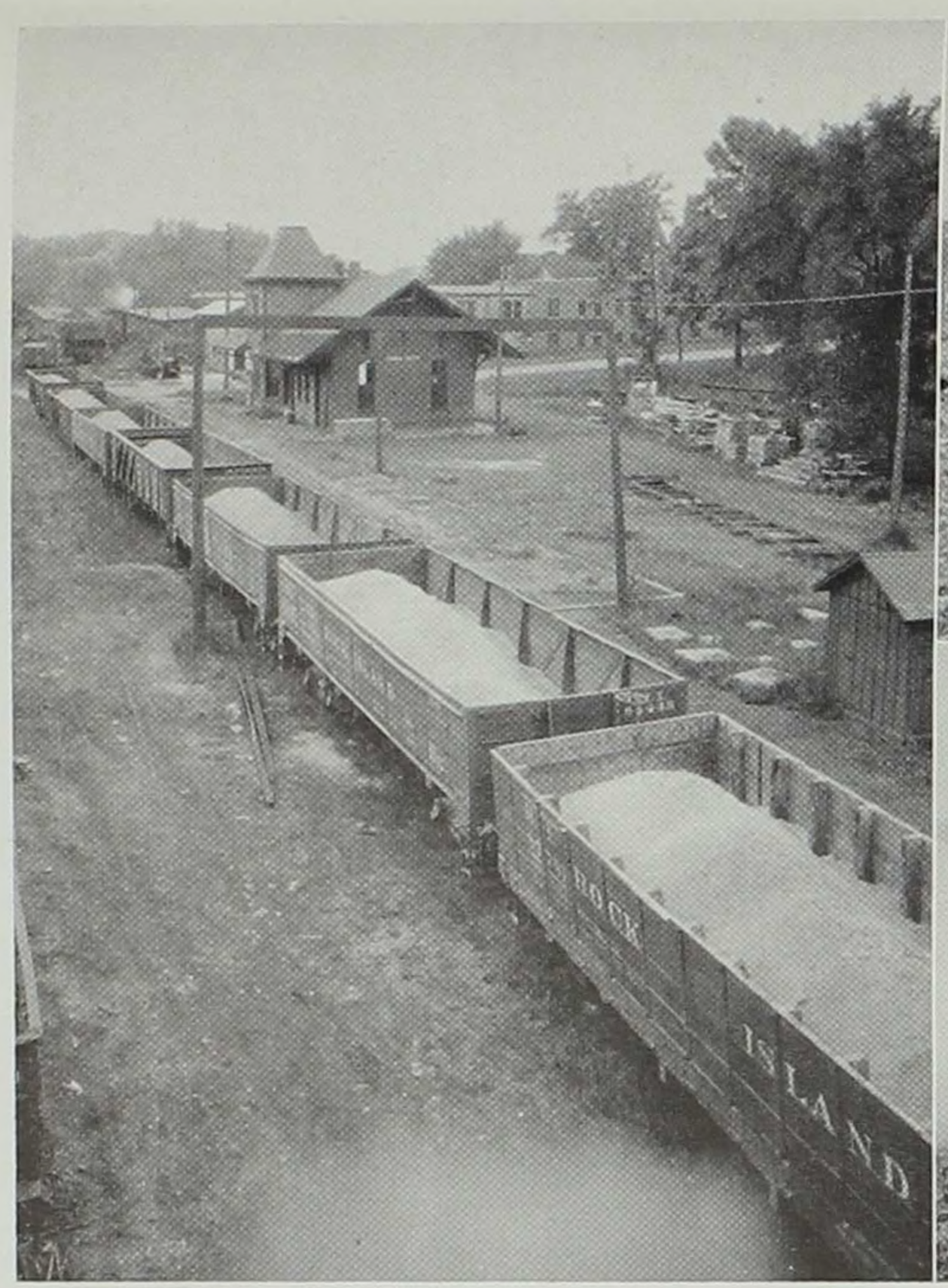
The conveyor carries the stone to this machine where it is cut into the desired size.

RIVER PRODUCTS COMPANY, IOWA CITY

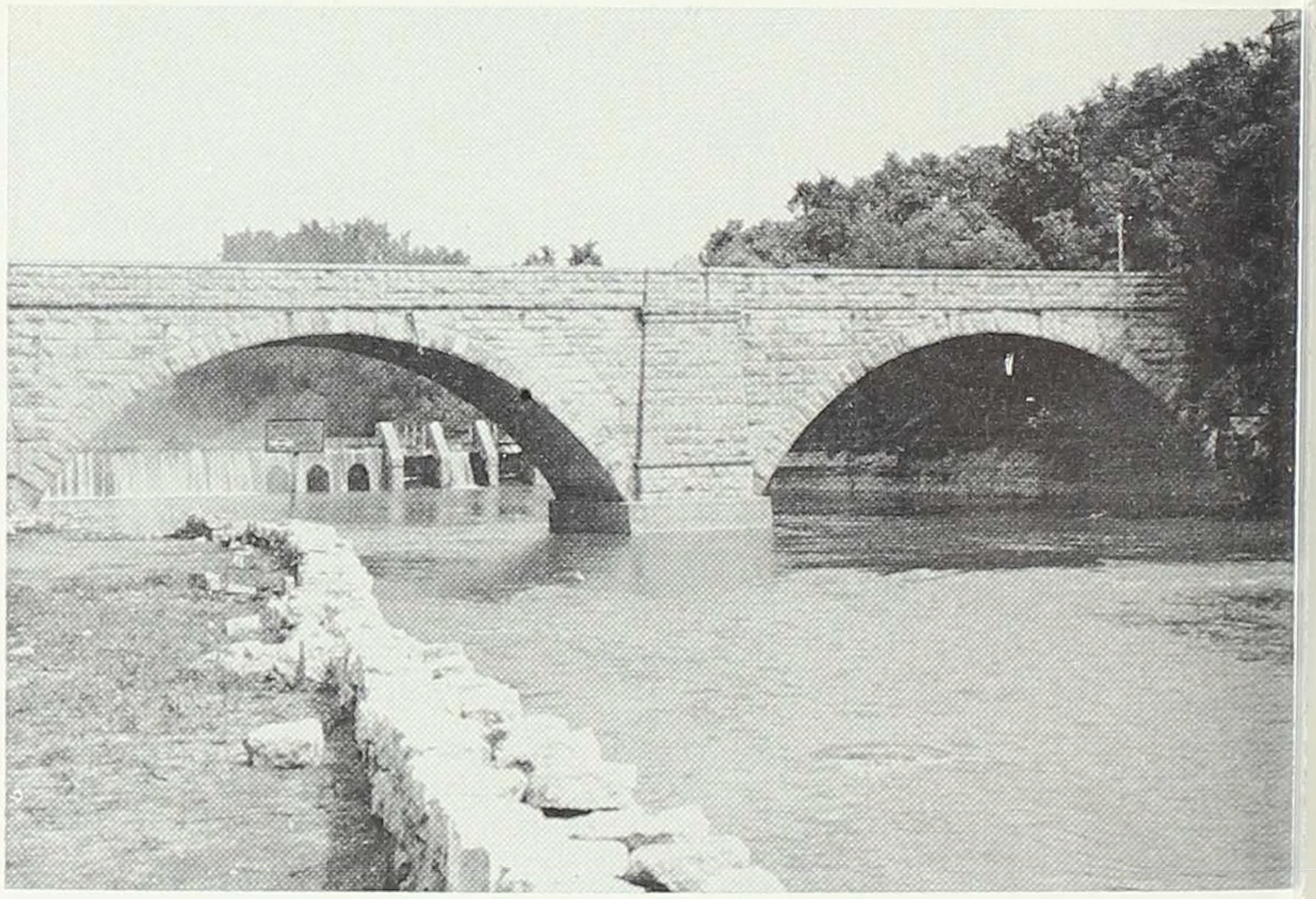
Explosives are set off in the rock; drilling machine at right of explosion.



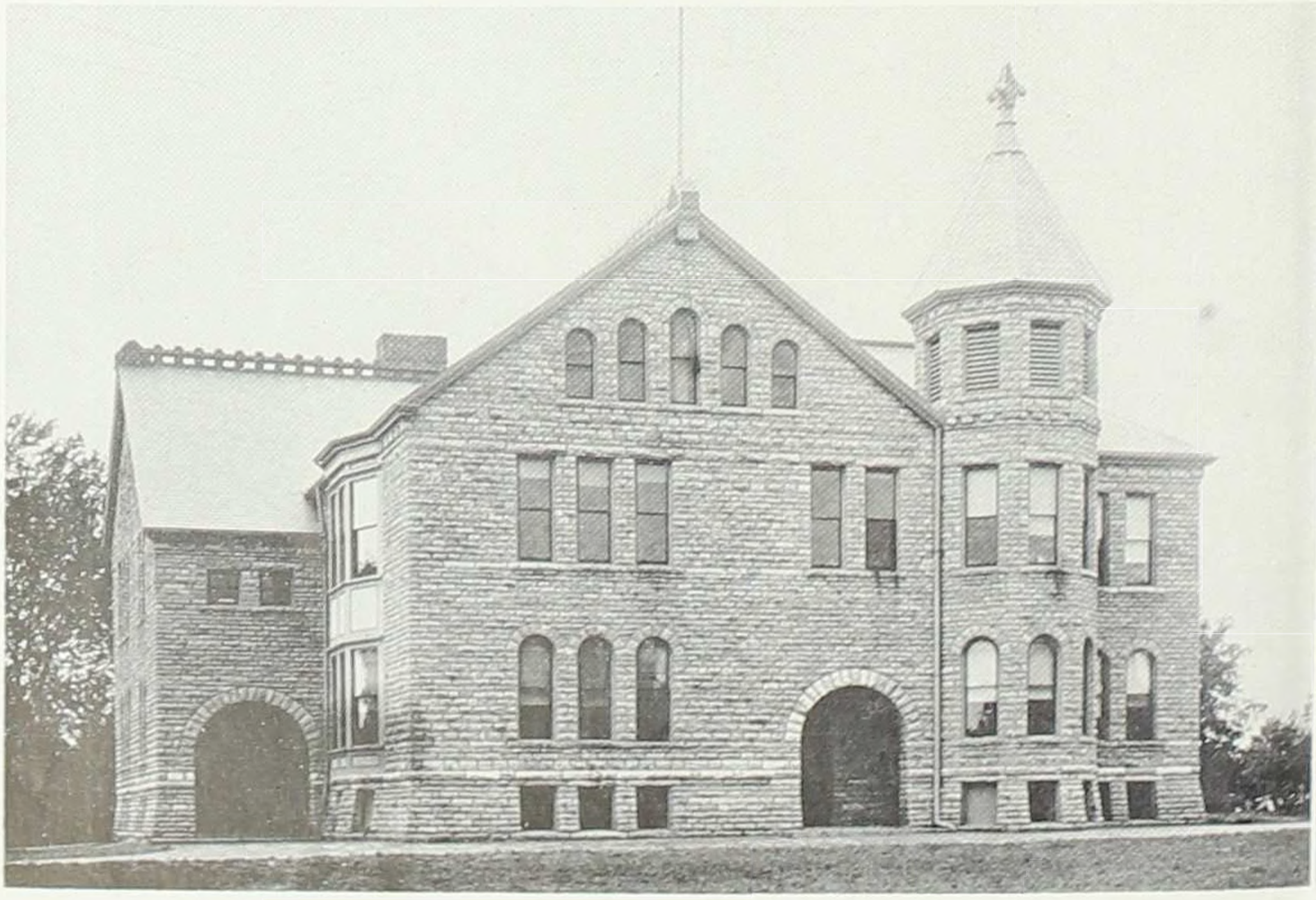
The results of the blast. Broken stone is used in highway construction and for other commercial purposes.



Left: Old method of transporting agricultural lime by rail.
Right, top: New method of conveying agricultural lime by truck to a spreader.
bottom: Spreading the lime on Iowa farm.

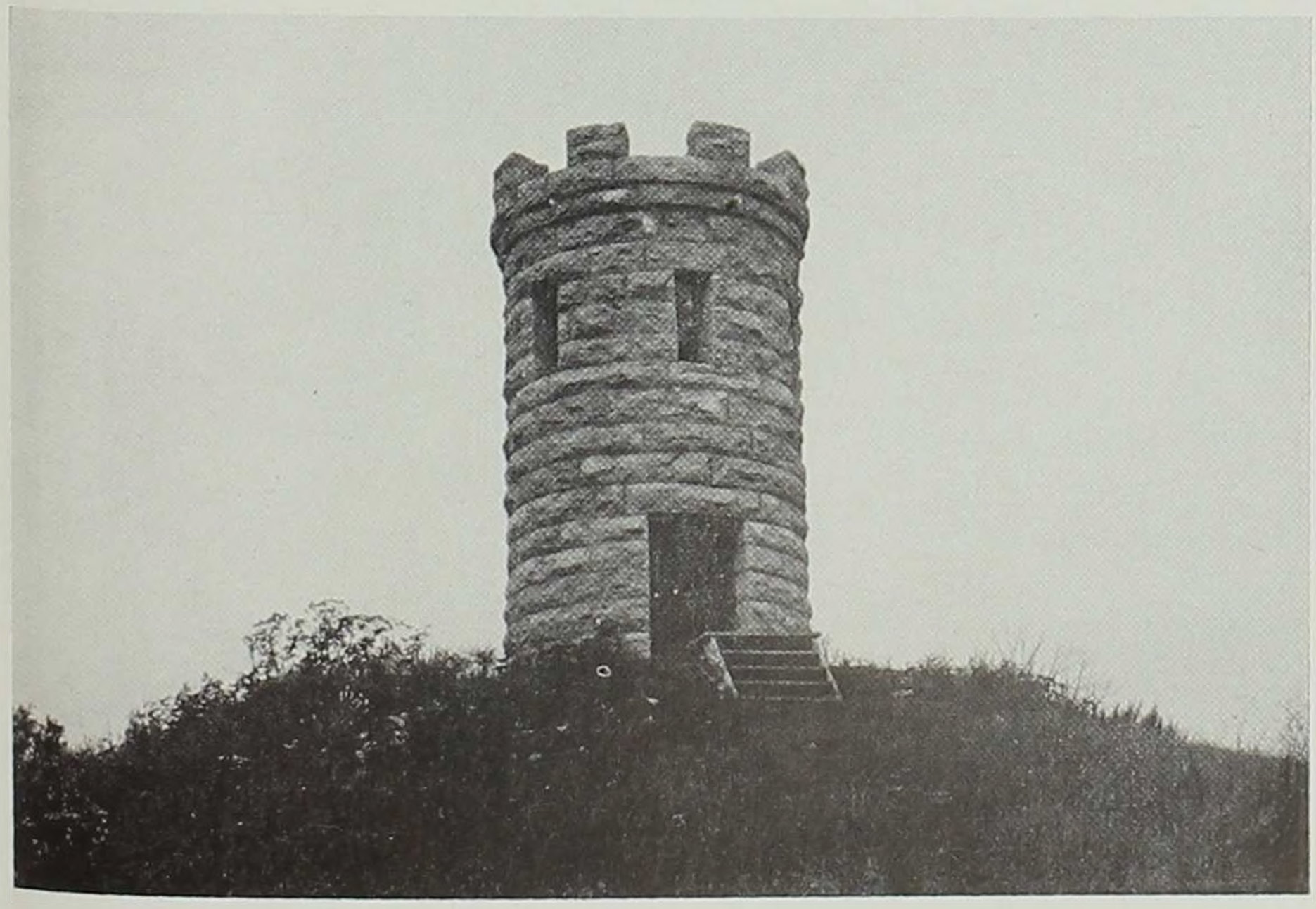


Elkader bridge, Elkader (Galena limestone).

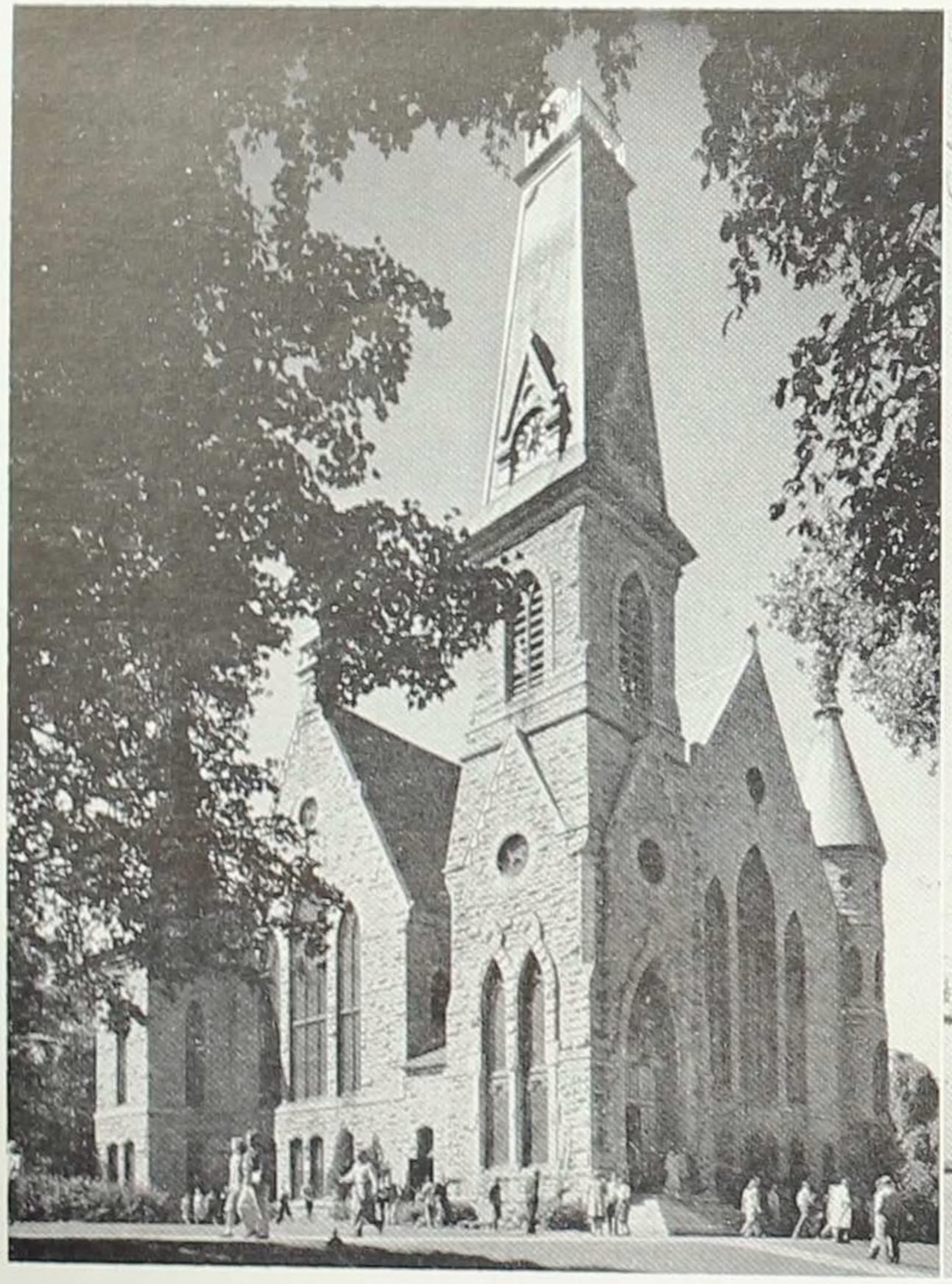


Humboldt school, Humboldt (St. Louis limestone).

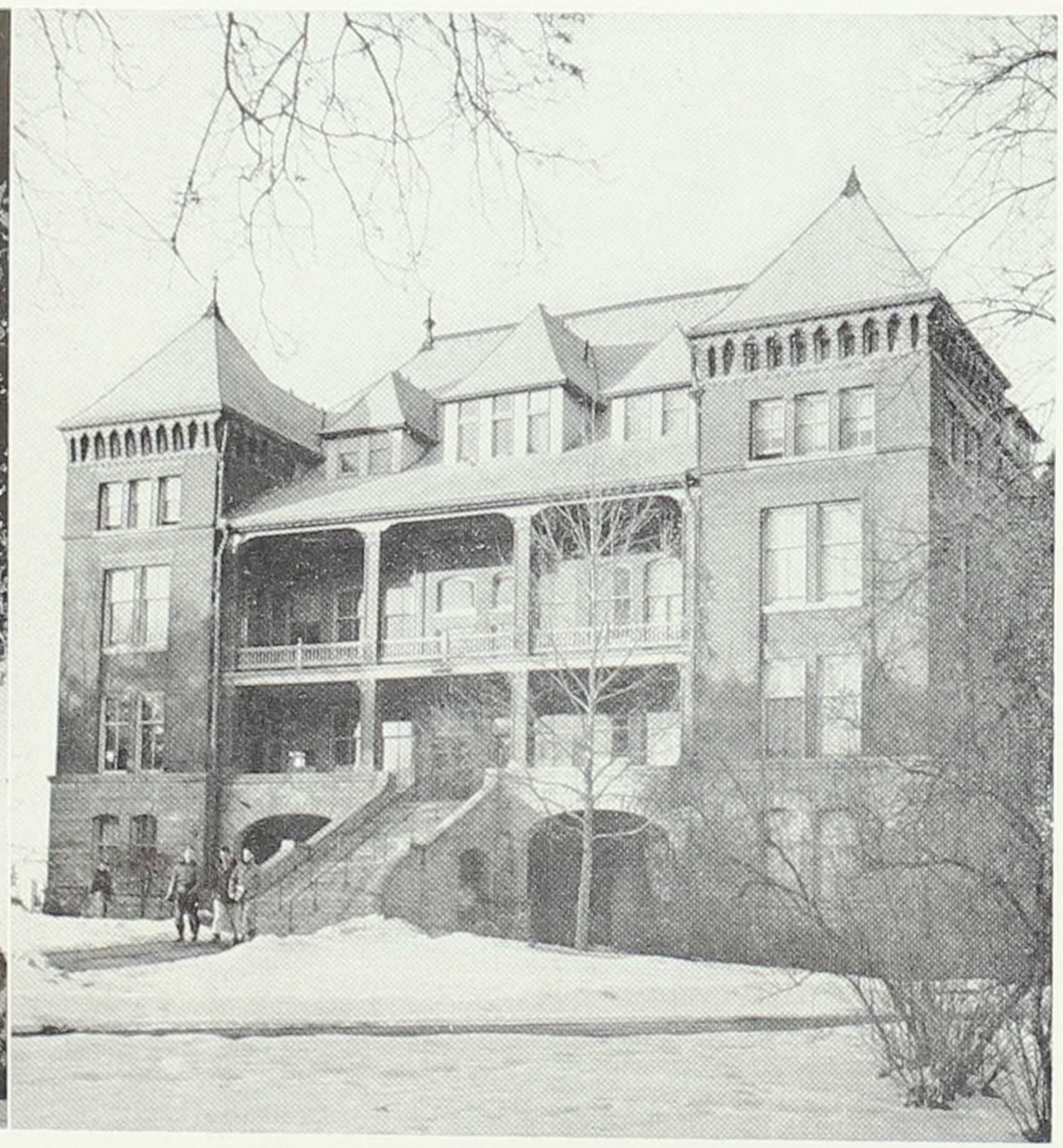
Old Capitol, Iowa City (State Quarry Beds).



Julien Dubuque monument, near Dubuque (Galena limestone).



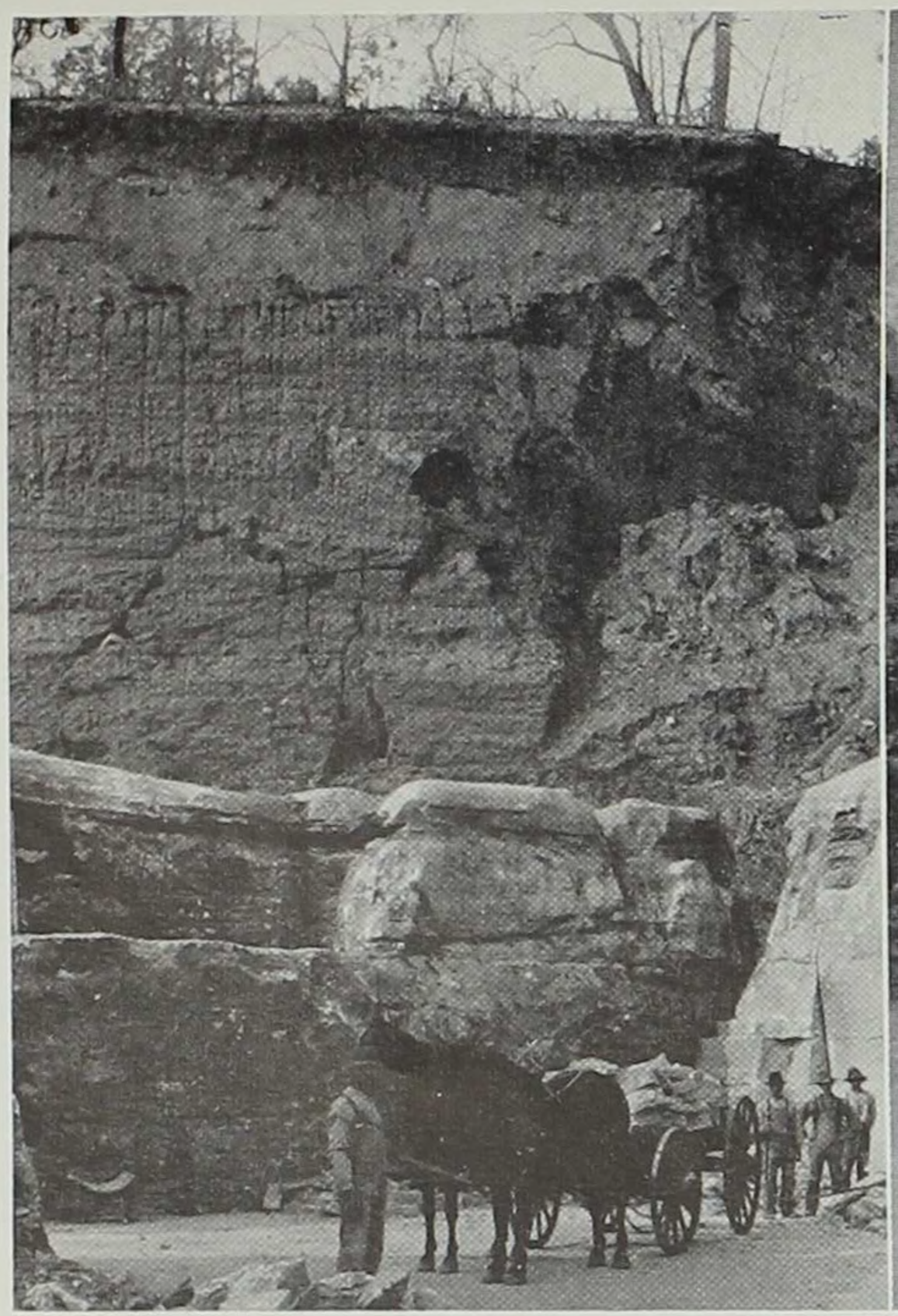
Cornell College chapel, Mt. Vernon (Niagaran limestone).



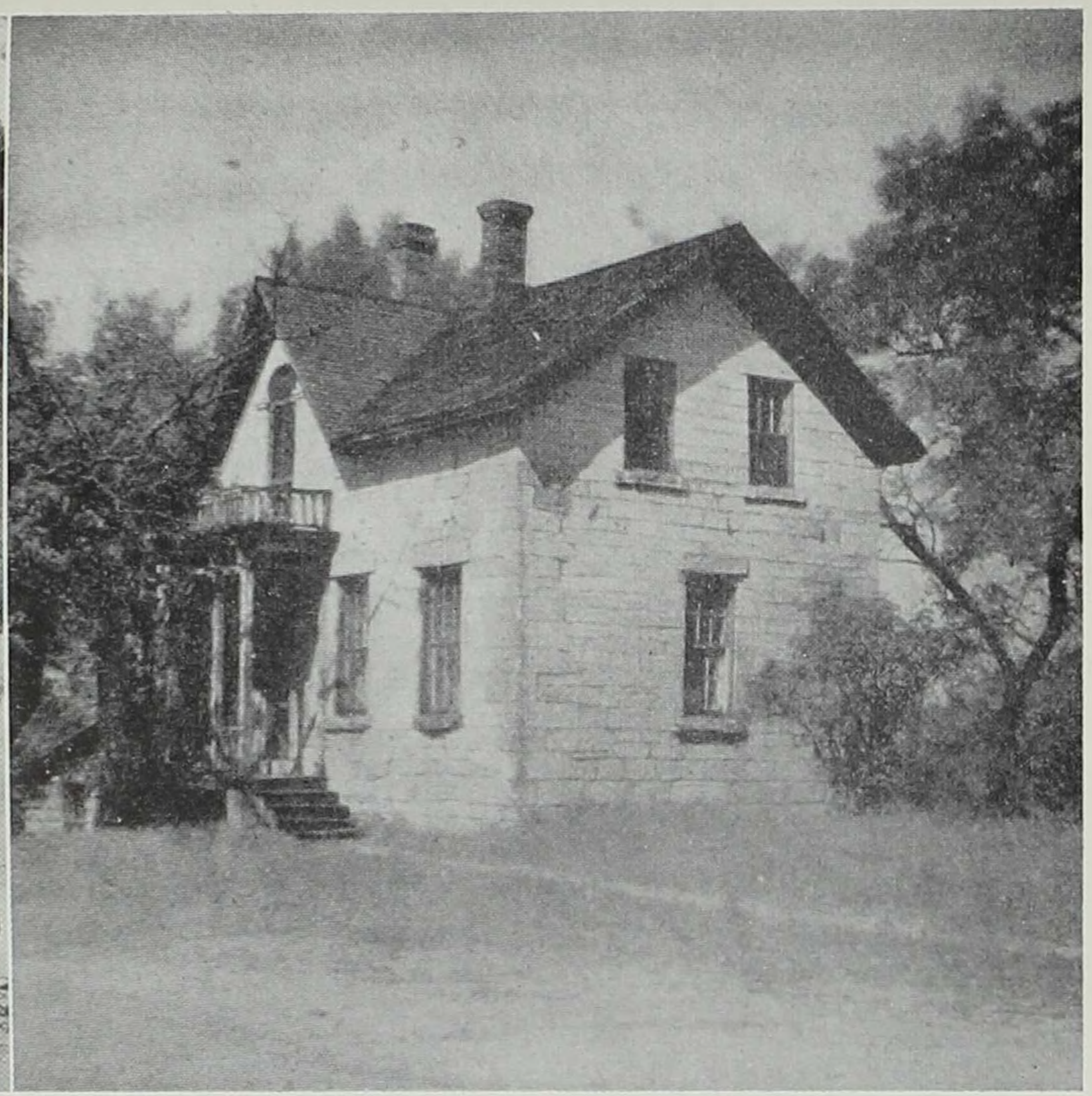
Botany Hall, Iowa State College, Ames (Niagaran limestone).

Cornell College chapel, Mt. Vernon (Niagaran limestone).

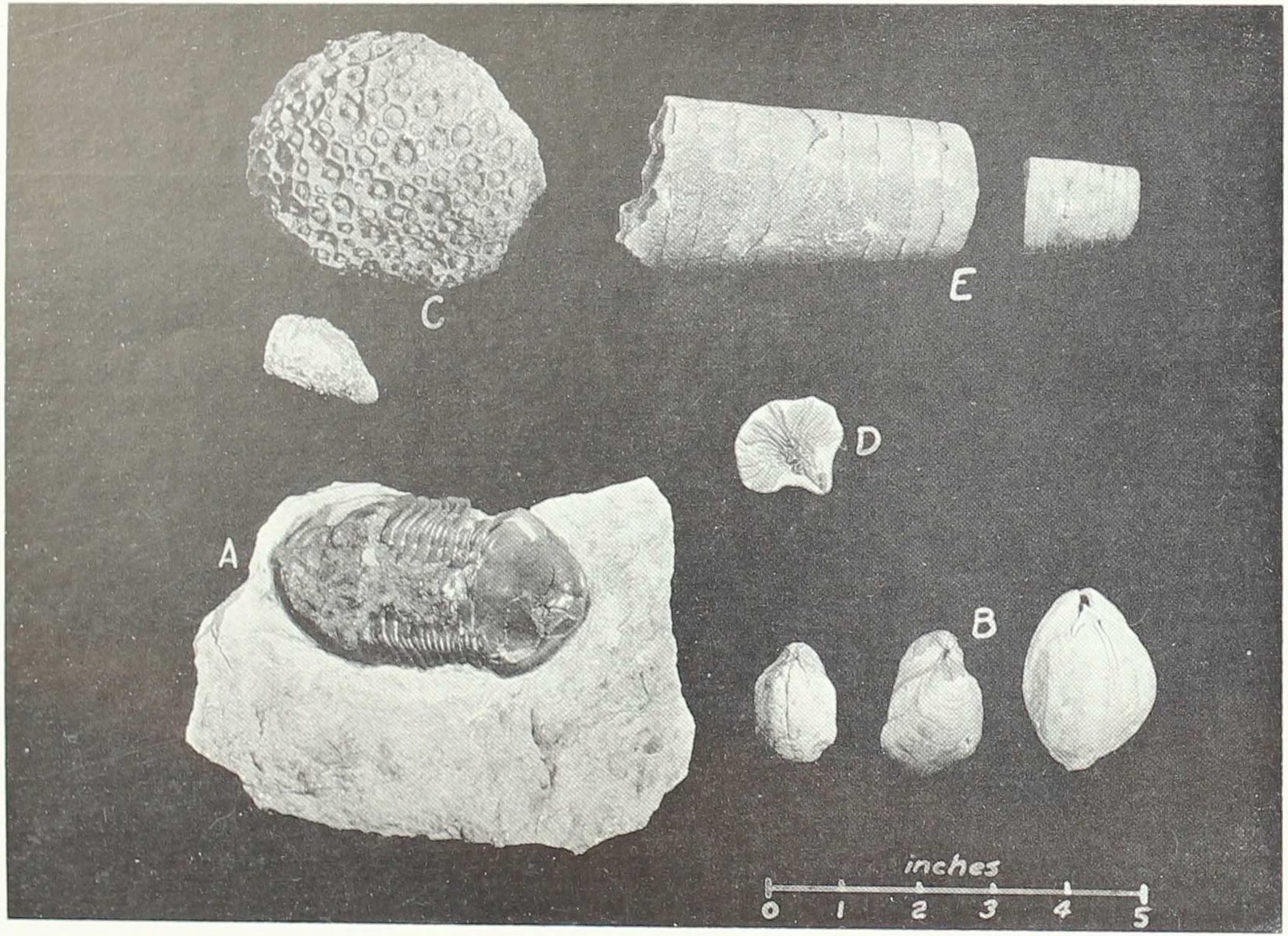
Botany Hall, Iowa State College, Ames (Niagaran limestone).



Gypsum bed, Fort Dodge (Fort Dodge).



Fort Dodge home, built of gypsum (Fort Dodge).



FOSSILS FROM IOWA QUARRIES

Fig. A Trilobite, from the Ordovician.
B Silurian brachiopods.
C Corals: a colony, and a "horn" coral, Mississippian.
D Crinoid calyx, from Le Grand, Iowa.
E Parts of a cephalopod.

fifty miles in width in the north, extending from Winnebago County southwest to Muscatine County. There is much limestone in the system, and the Wapsipinicon and Cedar Valley formations have been extensively quarried for crushed rock. The large cement company quarries at Mason City get their rock from the Shell Rock formation of this system.

Mississippian Formations

Next higher in the succession is the Mississippian system, outcropping again in a broad band, up to approximately twenty-five miles in width, extending from Humboldt County in the north to Lee and Henry counties in the southeast. This system, with the maximum thickness of approximately 700 feet, also has much limestone which has been actively quarried and which is being quarried today, particularly for aggregate and roadstone. The Hampton, Burlington, and St. Louis are important limestone formations of the system. At Le Grand, there are notable large quarries, first opened almost 100 years ago. At the beginning, they produced building stone, then for many years crushed rock for use as railroad ballast. More recently, the production has been for aggregate, roadstone, and agricultural limestone. There are quarries in the Mississippian along the Skunk River north of Ames. Some stone has been used here from the earliest days, but there were no real quarries. Then beginning about

E Parts of a cephalopod.
Mississippian.
B Silurian brachiopods.
C Corals; a colony, and a "horn" coral, Miss

1935, a small quarry was opened. In 1939, the construction of the Ankeny ordnance plant was started, creating a great demand for roadstone. Other quarries were opened, and have continued production of roadstone and agricultural limestone through the years.

Pennsylvanian Formations

The rocks of the Pennsylvanian cover an area much larger than that of any other system. It includes most of the state south of the line extending northeastward from Harrison County to Webster County, thence southeastward to Lee County. In Iowa, the Pennsylvanian has a maximum thickness of about 1800 feet. Much of this is shale, but there is also limestone, particularly in the upper part, as well as sandstone and coal. The sandstone has been quarried as a building stone in some places, as at Red Rock on the Des Moines River. The limestone, more abundant in the upper part of the system, has been quarried in several places in the southern and southwestern counties. These quarries are operating today in the production of crushed rock. The extensive cement rock quarries in the vicinity of Earlham and Winterset produce from the Bethany Falls member. Other prominent producing limestone horizons are the Winterset, Marmaton, Oread and Deer Creek.

Permian Formations

Gypsum is the only material quarried from the Permian, all in the restricted area around Fort

Dodge. It is only because of the development of improved methods of removing the over-burden that it is now quarried rather than mined.

Cretaceous Formations

Finally, there is the Cretaceous system in the northwestern and western counties. This contains a soft chalky limestone which has recently been quarried for the production of agricultural limestone. The system also contains beds of conglomerate, a cemented gravel, which through weathering has reverted to the condition of gravel. This has been used for surfacing roads, and as aggregate, but the material has been secured from pits rather than quarries.

If space permitted, much could be told about the beginnings and development of quarrying at particular places. In his Iowa geological report of 1870 surveyor Charles A. White stated: "The quarries that have become most noted and from which large supplies of good material for distant transportation may be obtained are those of Anamosa, Johnson county, Le Claire, Le Grand, Keokuk, and Farley. . . . There are, of course, hundreds of other quarries in the State that are locally almost invaluable."

Dubuque Quarries

There are many interesting stories of the first quarry, of changes, perhaps of long-continued operation, or of gradual cessation. The river towns in particular all have their quarries which

have operated at one time or another. Dubuque, for example, has a long record. Quarrying of the abundant limestone in the vicinity must have started shortly after 1840. The Eagle Point Lime Company was quarrying rock from the Galena formation at Dubuque in 1899, and there were probably quarries at the location from the days of early settlement. Other important quarries in the city at the opening of the century were on Dodge and South streets, Eighth Street, Fourteenth, and at the crossing of the North Cascade Road and the Illinois Central Railroad. The Dodge Street quarries were those of Tibey, Burns and Saul, and James Rowan. Quoting from Volume 10 of the *Iowa Geological Survey Annual Report* (1899): "Throughout the city, and indeed throughout the area of the Galena, there are numerous other openings which from time to time are worked for stone." More recently, the Dubuque Stone Products Company operated the large quarry at Eagle Point, but this also is now abandoned.

Jones County Quarries

The great importance of the quarrying industry in the Silurian area has already been noted. Here again, much more might be said of eastern Iowa. Let us take Jones County as an example. As the early settlers came in, the cliffs along the Wapsipinicon River west of Anamosa attracted attention. The stone is in beds, not too thick, with relatively thin overburden, and relatively easy to

quarry. Even before Iowa became a state in 1846, the U. S. Army had used stone from this locality in the construction of military roads. In 1852, stone was hauled from the vicinity of Stone City and used in the construction of the first buildings at Cornell College. Between 1859, when shipments by rail began, and November, 1895, over 150,000 cars went out over the railroads. At $20 per car, this had a value of more than $3,000,000. The stone was shipped to all six states bordering Iowa, and the important railroads in the northwest used it extensively in the construction of bridges. Many of the early buildings at the Rock Island arsenal were made of it.

The Stone City quarries, owned at the turn of the century by H. Dearborn and Sons, were opened by H. Dearborn in 1869. Others, by name, toward 1900, were the Anamosa quarry, the first to ship by rail; Champion quarry No. 2, opened by Crouse, Shaw, and Weaver in 1866; Johnellen quarry, opened by J. A. Green in 1887. Stone for the penitentiary buildings at Anamosa first came from Champion No. 2, later from the State quarry, also in the Stone City area.

Cedar County Quarries

Cedar County was another center of quarrying activity in the Silurian area. The Gladfelter quarry at Cedar Valley, opened in 1887, was among the earliest in southeastern Iowa producing rock for the manufacture of lime. Another was

that of the Sugar Creek Lime Company at Lime City, opened a few years later. Building stone also was produced from these quarries.

In 1883, J. C. Bealer, "who as a practical bridge architect saw the great value of the stone at this point for bridge piers and all heavy masonry," (*Iowa Geological Survey Annual Report*, Vol. 11, p. 378, 1900), had opened the Bealer quarry at Cedar Valley, on the right bank of the Cedar River. In 1906, his quarries were reported as "the most noteworthy in Iowa, and among the largest in the Mississippi Valley."

The village of Cedar Valley developed around these quarries. Other quarries in operation in Cedar County in 1892 were McLeod's on the west bank of the Wapsipinicon, below Massilion; Frink's on Mill Creek north of Clarence; Burrough's on Rock Creek west of Tipton; Wallick's on a tributary of Baldwin Creek; Hecht's on Mill Creek north of Clarence; Cary's southwest of Tipton on Rock Creek.

Quarries in the Devonian Area

Several of the larger and older cities of the state, among them Waterloo, Mason City, Cedar Falls, Cedar Rapids, and Iowa City, are located in the Devonian area, and it can be accepted that quarries sprang up in the vicinity of each, as they were settled. The large quarries of the cement companies at Mason City were somewhat later in development, the Northwestern States Portland

Cement Company going into operation in 1908, the first in Iowa for cement rock, and the Lehigh Portland Cement Company in 1911. Farther south, there were many quarries operating in the vicinity of Iowa City long before the 1890's. The State quarry, located on the Iowa River a few miles northeast of North Liberty, supplied most of the stone for the Old Capitol at Iowa City.

Des Moines County Quarries

Des Moines County may be taken as an example of one area wherein Mississippian limestones were actively exploited in an early day. In 1893, every township was reported to have quarries supplying stone for local use, the largest in the vicinity of Burlington. There was a group of quarries taking stone from what was then the end of Division Street, including the Larin quarry at the corner of Amelia and Claim, the Hoppman quarry at the corner of Maple and May, the City quarry near Maiden Lane and Seventh, and the Loftus quarry at the corner of Seventh and Maple streets. These all had their beginnings during the later years of the last century.

Madison County Quarries

The lower part of the Pennsylvanian system is one dominantly of shale, sandstone, and coal, with only small amounts of limestone. It is the upper part of the system that supplies the limestone quarries of the south-central and southern parts of the state. Many of these are relatively late-

comers, although limestone quarrying has been an active industry in the vicinity of Winterset for many years. One of the quarries supplying rock for one of the Des Moines cement plants is near Winterset, the other farther north near Earlham, also in Madison County. These quarries opened for the production of cement rock about 1910, and in the years since, tremendous quantities have been taken out. But the Winterset quarries also supplied stone for many buildings long before 1910.

Ancient Life of the Quarry Rock

The sedimentary rocks are a storehouse of evidence of past life, in the form of what are known as fossils. Some fossils are the actual remains of such life, as is the case with shells of marine invertebrates found in the rocks in many places. Other fossils are the replacements, by mineral matter deposited from subsurface water, of the hard parts of animals. This is probably the most common type of fossil. In other cases there is only the impression of the ancient animal, or some part of it. The presence of these fossils helps us to construct the story of the life and events of the past, although the record is far from complete.

So, in the sedimentary rocks of Iowa, most of them of marine origin, we may expect to find the fossils of animals living in the waters when the sediments were laid down. In some strata they are abundant, in others they are scarce or absent. And of course they are of many kinds. Most are

in limestone or shale, more frequently, perhaps, in limey shales.

These fossils are important as a means of establishing the geological age of a system, or one of its subdivisions. The science has developed to the place where the fossils characteristic of the different strata are known. Also, fossils help in correlation, by which is meant that they help in establishing the equivalence, the "sameness" of age, of strata in different parts of the world.

Nature does a grand job on some of the fossils, in freeing them from the surrounding matrix. This it does by weathering, particularly the case where the fossil is more resistant than the rock matrix. Then the fossil may be found lying on the surface near the rock outcrop. But many excellent fossils are turned out of the unweathered rock in quarrying operations. So it has been through the years, that the quarries have become the hunting ground of the paleontologists, the students of ancient life. Many fine fossils have been discovered in quarries.

Trilobites

Trilobites, an extinct crustacean very distantly related to crabs and other modern crustaceans, are guide fossils to some older formations, and fine fossil trilobites have come from some of the quarries of northeastern Iowa. The animal, as the name indicates, was three-lobed, the lobing being parallel to the length. Most were small, not more

than an inch or two in length, though forms having a length of eighteen inches are known from the Cambrian. Trilobites lived all through the Paleozoic, but died out at the end. According to O. J. Walter, in his paper, "Trilobites of Iowa and Some Related Paleozoic Forms," published in Volume 31 of the *Iowa Geological Survey Annual Report,* seventy-nine species of trilobites had been established in the state up to about 1920.

Brachiopods

Another small form of invertebrate life, the brachiopod, is the most common fossil of the Iowa limestones and shales, there being many genera and species. The animal had two shells, or valves, which it could open and close, somewhat in the manner of a clam. Each brachiopod shell also is bilaterally symmetrical. This symmetry gives the fossil shells of some the appearance of a butterfly with wings spread and flattened, whence the name butterfly shell. They were small, the fossil shells being no more than a few inches across. Some were smooth-shelled, others ornamented. Some horizons of the Silurian beds contain numerous casts of a rather large brachiopod.

Corals

Corals were abundant in Paleozoic seas, and their fossilized remains have been found in many Iowa quarries. In the Silurian formations, fossil reefs containing much coral have been uncovered. Along the Iowa River in Johnson County, the Ce-

dar Valley formation is noted for its petrified corals. Coralville is named from the abundance of fossil corals found in the vicinity. The horizon of the Cedar Valley formation in which the corals are abundant is known as the Coralville member.

Crinoids

Another form of life that has yielded interesting fossil forms is the crinoid. This animal, an echinoderm, or spiney-skinned creature — and thus related to the starfish — lived in a small calcareous enclosure made of many plates. This enclosure, or calyx, not more than an inch or two across, was supported on a calcareous stalk made up of flat cylindrical plates. Apparently this stalk served only as a means of attachment to the sea bottom.

Crinoids were abundant in the Paleozoic seas, particularly in the Mississippian. When the animal died, the calcareous skeleton usually disintegrated, and its parts became scattered about the sea bottom. Under exceptional conditions, the crinoid skeleton upon death of the animal might fall over into the sea mud and be buried and preserved with no, or only partial, disintegration. From such circumstances have come the wonderful fossil crinoids of the Le Grand quarry on the Iowa River near Le Grand. These fossils can be released from their matrix by patient and delicate work with needles and brushes. On a slab containing an abundance, they may be brought into fine relief. Mr. B. H. Beane, of Le Grand, has

been an enthusiastic student of crinoids, and specimens collected and prepared by him are now found in museums in this country and abroad. Many new species have turned up in the course of his study. Slabs prepared by him, containing crinoid fossils intertwined in great abundance, are objects of spectacular beauty.

Cephalopod

Another fossil that is frequently found in the limestone of Iowa quarries is the cephalopod. The word simply means "head-footed," from the thought that the animal used its head as a means of getting about. Early representatives of this invertebrate animal lived in a slender cone-shaped shell. As the animal grew the shell was extended, and a new partition developed in the shell as a sort of floor in the outer part of the cone where the animal lived. In the course of growth, to a length of several feet with some species, many partitions were formed. The straight fossil cephalopods commonly are thus slender cone-shaped shafts of rock, up to several feet in length. The partitions show as lines circumscribing the fossil.

This then is in part the story of fossils from the rocks of Iowa quarries. It is only a part, however. Our respects might also well be paid to other groups of animals, bryozoans, pelecypods, fish, and others, all from our Iowa rocks. The quarries provide fine hunting for the relics of ancient life.

CHARLES S. GWYNNE

Forecasters of Quarrying

The need for good building stone was recognized by the Iowa pioneers. In his *Notes on Wisconsin Territory; Particularly with Reference to the Black Hawk Purchase, or Iowa District,* Lieutenant Albert Miller Lea was impressed with the prospects for good limestone quarries in 1835. As he rode with his mounted Dragoons up the Des Moines River valley, Lea noted much sandstone "suitable for building" while limestone seemed even more plentiful. Curiously, with the optimism of youth, Lea failed to recognize the possible need or use of stone in modern road building. "The country being so very open and free from mountains, artificial roads are little required. A few trees taken out of the way, where the routes much travelled traverse the narrow woods, and a few bridges thrown over the deeper creeks, is all the work necessary to give good roads in any direction."

Four years later, in 1839, John Plumbe, Jr., declared the "geological features" of Iowa were highly interesting; the country abounding with "rock" while even "marble quarries" had been discovered. Plumbe noted that the Maquoketa River was "bounded with high limestone bluffs, afford-

ing inexhaustible quarries of the best building material." Henry County, he declared, was also abundantly supplied with the best quality of limestone and freestone for building purposes. He described the location of Iowa City a beautiful one, noting in particular "a fine quarry of marble, of which the Capitol is to be constructed upon a very magnificent scale." Despite such outcroppings Plumbe felt that "what are generally termed builders' and field stone" were seldom seen.

When David Dale Owen made his survey of the leadmining area in 1839 he devoted considerable space to the limestone and sandstone quarries which lay open to the pioneers between Davenport and the northern limits of the lead mining region. He described the "*cliff*" limestone as "mural escarpments, exhibiting every variety of form" which gave to the "otherwise monotonous character of the landscape of Iowa a varied and picturesque appearance." He agreed with Plumbe that the Maquoketa quarries were excellent but felt the Iowa City marble, while beautiful, was not likely to "afford extensive marble quarries."

In the year Iowa achieved statehood John B. Newhall published *A Glimpse of Iowa in 1846*. Struck by the frequent ranges of "bluffs" or "calcareous strata of lime rock" along the margins of Iowa's rivers, Newhall did not overlook the mineral resources of individual counties. He found Johnson County "abundantly supplied with

excellent building material; both lime rock and superior clay for brick." He declared the Iowa City marble a "geological wonder" and carried a specimen to Europe where it created "extreme interest" in the British Museum in London. Newhall recorded that quarries of the "best building material abound in the bluffs of almost every stream" in Van Buren County and expressed the opinion that Wapello and other counties were equally fortunate.

When James Hall made his survey of the eastern half of Iowa between 1855 and 1857 he published a detailed account of his work by authority of the state legislature. By this time many quarries had been opened in Iowa and Hall carefully recorded the geological story they revealed. Nor did he forget history! In describing the Le Claire limestone above Davenport, Hall noted that this quarry provided much of the stone going into the piers of the historic first Mississippi River bridge at Davenport. Opened in 1856, this bridge later brought Abraham Lincoln to its defense when the steamboat *Effie Afton* was wrecked on one of its piers. Throughout the pages of his survey Hall records limestone quarries from which stone was taken to construct early bridge piers and erect homes.

The diversity of quarrying as it exists today stands in sharp contrast to the few uses made of stone before the Civil War. Prior to the Civil

War the emphasis was placed on lead mining, and coal was rapidly coming into prominence. Today highway construction — cement, blacktop, and gravel — requires huge quantities of stone from the numerous quarries that dot the face of Iowa. A tremendous amount of limestone is needed for agricultural purposes while the use of stone for buildings and bridges (except as it forms a part of cement, sand, and gravel) has become negligible. In 1953 Iowa ranked 33rd among the states in the production of minerals — cement, stone, sand and gravel, and coal ranking in that order in importance for the Hawkeye State. The presence of quarries is a vital economic factor in the construction of roads and highways.

WILLIAM J. PETERSEN

A GEOLOGICAL TIME CHART

Era-Group	*Period-System*	*Epoch-Series*	*Age-Stage*	
Mesozoic	Cretaceous	Gulfian	Carlisle Greenhorn Graneros	
		Comanchean	Dakota	
	Permian	**Ft. Dodge**		
	Pennsylvanian	Virgil	Waubaunsee Shawnee Douglas	
		Missouri	Pedee Lansing Kansas City Pleasanton	
		Des Moines	Marmaton Cherokee	
	Mississippian	Meramec	Ste. Genevieve St. Louis Spergen	
		Osagian	Warsaw **Keokuk** **Burlington**	
		Kinderhook	**Gilmore City** **Hampton** **Prospect Hill** **Maple Hill**	
Paleozoic	Devonian	Upper	**Sheffield** **Lime Creek** **Shell Rock**	**St. Quarry Beds**
		Middle	**Cedar Valley**	
			Wapsipinicon	**Davenport** **Independence** **Otis**
	Silurian	Niagara	**Gower**	**Anamosa** **Le Claire**
			Hopkinton	
		Alexandria	Kankakee Edgewood	
	Ordovician	Cincinnati	**Maquoketa**	
		Mohawk	Galena **Decorah-** Platteville	
		Chazey	St. Peter	
		Beekmantown	Prairie du Chien	
	Cambrian	St. Croix	Jordan St. Lawrence Franconia Dresbach	
Pre-Cambrian			**Sioux Quartzite**	

Systems of Iowa Stone in Use

Pre-Cambrian
- Goodnow Hall, Grinnell College
- Sioux City — St. Thomas Church
- St. Joseph church

Ordovician
- Ft. Atkinson
- Bridge at Elkader
- Dubuque monument

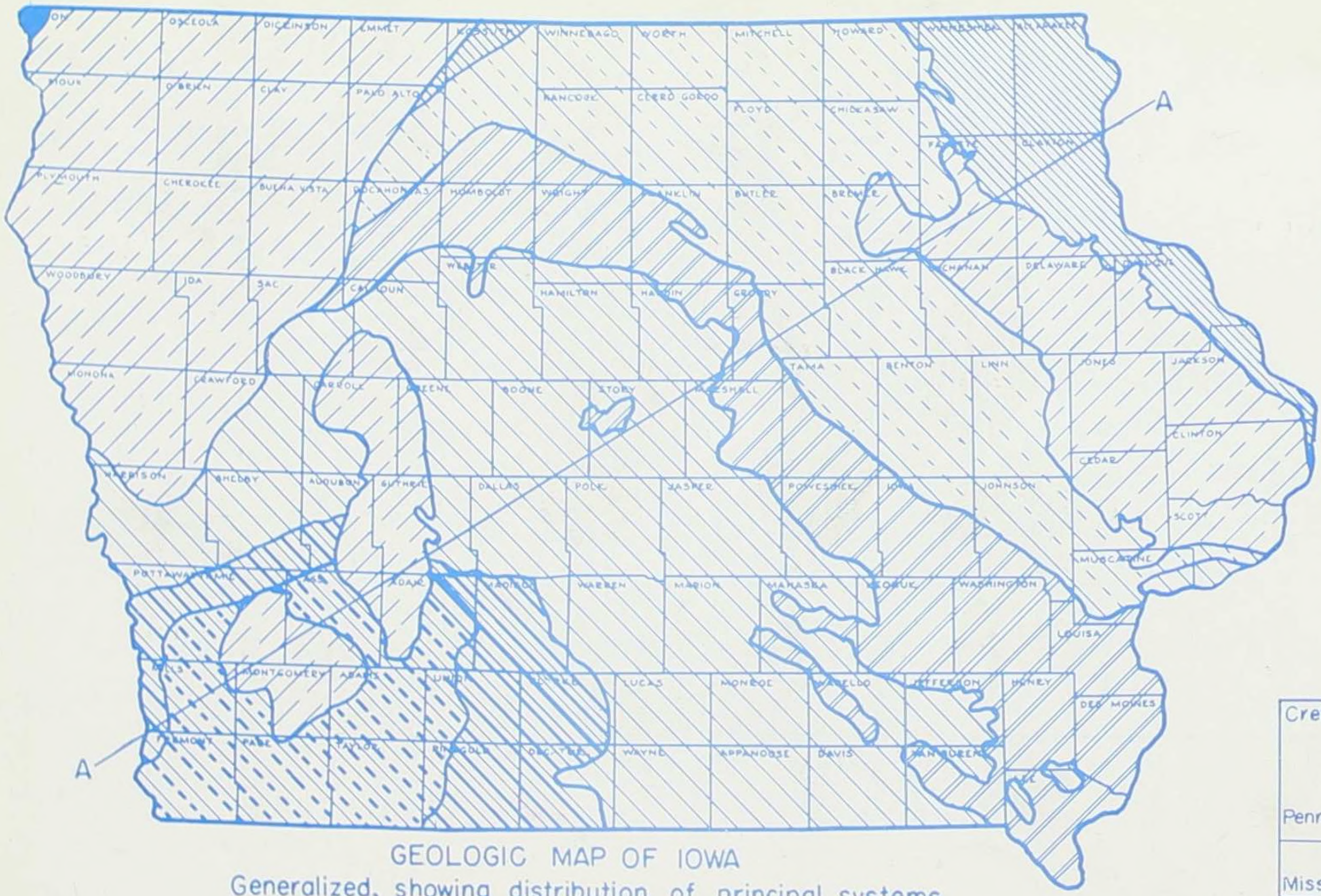
Silurian
- Chapel at Cornell College
- Botany Hall at Ia. St. College
- St. Martin's church, Cascade

Devonian
- Old Stone Capitol
- Trinity Lutheran church, Davenport
- Protestant Episcopal church, Davenport

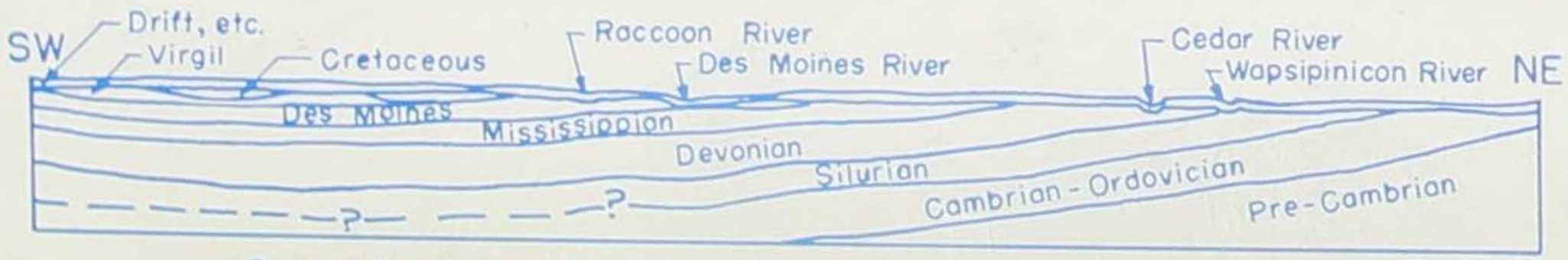
Mississippian
- School at Humboldt
- Locks and buildings at Keokuk

Pennsylvanian
- Many buildings in Osceola
- Madison County courthouse
- Residences along W. Grand Ave., Des Moines
- Amana church and store

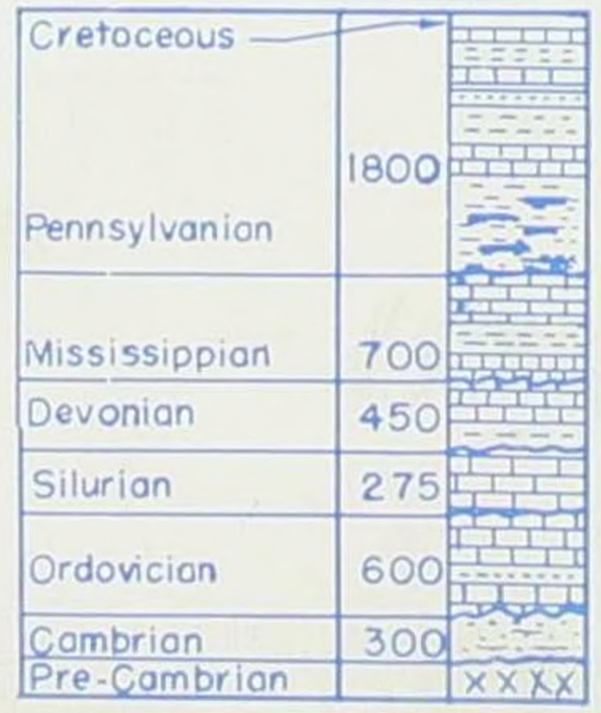
Permian
- Houses in Ft. Dodge
- Cardiff giant



GEOLOGIC MAP OF IOWA
Generalized, showing distribution of principal systems



Generalized structure section of Iowa, on the line A-A



General Geological
Section of Iowa