ROCK RESOURCES OF IOWA

George F. Kay

Introduction

Rocks in the wide, scientific use of the term include all classes of earthy or stony material, whether consolidated or not. Soft chalk, softer clay, or the loose bed of sand or gravel—if produced by natural physical agents—is to the geologist as truly rock as the hard granite bowlder found in places in our prairies. In accordance, however, with a somewhat prevalent notion, the rocks of Iowa may be divided into hard and soft, into indurated and non-indurated rocks, into the regularly-bedded deposits that are recognized as rocks by even the non-geological observer, and the loose, superficial materials that almost everywhere conceal the beds of the indurated series.

The hard or indurated rocks of Iowa consist chiefly of limestones, sandstones, quartzites, various forms of shale, coal, and gypsum. All of these rocks except coal are of marine origin. Over the hard or indurated rocks there is spread a covering of unconsolidated materials—mantle rock—ranging from a few inches to more than five hundred feet in thickness, and forming the soils and subsoils which are so important an element among the many causes of Iowa's prosperity. These unconsolidated materials include the drift, of glacial origin, loess, the result of wind action, geest, a residual product of weathering, and alluvium, which is a flood-plain deposit.

The indurated and the mantle rocks are the geological formations of the state. Detailed studies have been made by the staff of the Iowa Geological Survey and by other persons of the different geological formations, their extent and thickness, the character of the different kinds of rock included, something of the contained fossils, and the economic features of the formations. Careful examinations have been made of the various economic minerals and their distribu-

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This paper and the three which follow were presented at the Iowa Power Conference, held March 30 and 31, 1927, at the State University of Iowa under the auspices of the College of Engineering and the Extension Division. Reprinted by permission from Extension Bulletin no. 170, April 15, 1927.

tion, geology, properties, and uses. More than thirty volumes have been published by the Iowa Geological Survey alone on the many phases of the rocks and minerals of the state.

System	Series	Formation	Columnar Section	Thickness Feet	Character of Rocks
Pleistocene	Wisconsin				
	Iowan				
	Illinoian				
	Kansan				
	Nebraskan				
Cretaceous	Upper Cretaceous	Colorado		150	Shales, with soft chalky limestones
		Dakota		100	Sandstone
Permian		Fort Dodge		50	Sandy shale and sandstone
				30	Gypsum
Pennsylvanian	Missouri	Wabaunsee		108	Shale and limestone
		Shawnee		233	Limestone and shale
		Douglas		26	Limestone and shale
		Lansing		34	Limestone and shale
		Kansas City		131	Limestone and shale
	Des Moines	Pleasanton			Shale and sandstone
		Henrietta		750	Shale and sandstone
		Cherokee			Shale, sandstone, coal.
Mississippian	Meramec	Ste. Genevieve St. Louis		0-40	Limestone
		Spergen Warsaw		35-105	Limestone
	Osage	Keokuk Burlington		150-215	Limestone
	Kinderhook			150	Shale and sandstone
Devonian	Upper Devonian	State Quarry – Lime Creek		40-120	Limestone Shale
		Cedar Valley		100	Limestone, shaly limestone. Some dolomite in the northern counties.
		Wapsipinicon		60-75	Limestones, shales and shaly limestones.
Silurian	Niagaran	Gower		120	Dolomite
		Hopkinton		220	Dolomite Very fossiliferous in places.
	Alexandrian			0-40	Limestone and dolomite.
Ordovician	Cincinnatian	Maquoketa		200	Dark shales, shaly limestones, and locally, beds of dolomite.
	Mohawkian	Galena		340	Dolomite chiefly. In places unaltered limestone.
		Decorah		0-40	Shales with thin beds of limestone
		Platteville		90	Marly limestones and shales.
	Canadian	St. Peter		80-160	Sandstone
		Prairie du Chien: Shakopee		20-80	Dolomite
		Prairie du Chien: New Richmond		20	Quartzitic sandstone
		Prairie du Chien: Oneota		150	Dolomite
Cambrian	Croixan	Jordan		100	Coarse sandstone
		St Lawrence		50	Dolomite, sandy
		Dresbach			Sandstone, with bands of glauconite
Algonkian	Huronian	Sioux Quartzite			Quartzite

Figure 1

In this paper discussion will be limited largely to the consideration of the rocks of the state which are of economic value, and hence are related closely to our industrial development. These rocks be-

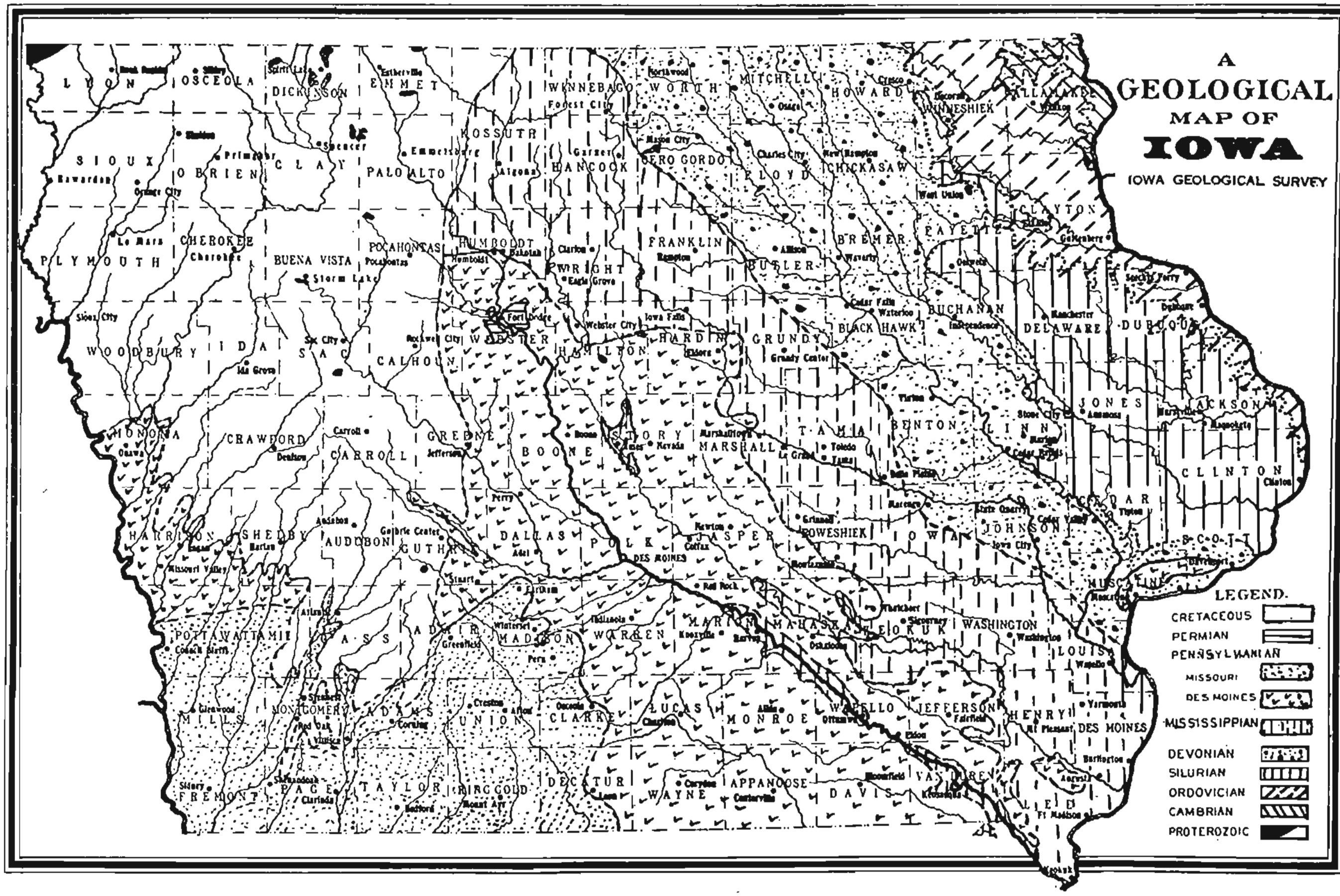
A
GEOLOGICAL
MAP OF
IOWA
IOWA GEOLOGICAL SURVEY
LEGEND.
CRETACEOUS
PERMIAN
PENNSYLVANIAN
MISSOURI
DES MOINES
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
PROTEROZOIC

Figure 2

long in age to several of the well established geological systems. From oldest to youngest, the systems represented by rocks in Iowa are Algonkian, Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, Permian, Upper Cretaceous, and Pleistocene. The subdivisions of each of these systems in Iowa are given in Figure 1; also the thickness and character of the rocks of each of the formations. It will be noted that many of the formations bear geographic names. These names are derived from localities where the beds are well exposed or typically developed. Thus, the Des Moines series is named from the river along which the beds of this age are found as surface rocks; the St. Louis, from the city where the formation was first studied; and other geographic names have similar reasons for their application.

The areal distribution in Iowa of each of the systems of rocks is shown on the geological map of Iowa, Figure 2.

Rocks of Economic Importance

The rocks of economic importance have a wide range in use, in origin, in age, and in distribution. The Sioux quartzite, although not quarried in Iowa, is used in adjacent states as a building stone, for paving blocks, and other purposes. The Croixan is the best water-bearing horizon in Iowa, owing to its wide outcrop in Wisconsin and Minnesota, and the St. Peter forms the next most reliable aquifer. The lead and zinc of Dubuque county are found in the Galena limestone. The different limestones of the state yield abundant supplies of crushed and dressed stone, notably the Ordovician and Silurian. The cement plants at Mason City get their limestone and shale from the Devonian. The plant at Gilmore uses limestone from the local beds of Mississippian age, which also supply the Pyramid plant at Valley Junction, while the Hawkeye plant, near Des Moines, gets shale from the Des Moines series and limestone from the Missouri. On account of its stores of coal and shale the Des Moines series comprises probably the most important rock strata of Iowa. The rocks of St. Louis age at Centerville contain a bed of gypsum which is being used for making wall plaster, and the extensive bed of gypsum in the Permian system at Fort Dodge supplies several large mills which manufacture various kinds of building materials. The great shale formations of the state, such as the Maquoketa, the Kinderhook, the Des Moines, and the Colorado, also the glacial drift sheets and the loess, supply numerous clay works with raw materials for brick, tile, pottery, and other wares. Sand and gravel beds in the drift or in stream valleys, and to a less extent beds of sandstone, supply the demands for these materials for building, road construction, and other uses.

The extent to which the rock resources of Iowa are being developed may be indicated best by referring to the annual production of various minerals. Although it would be of great interest to trace the history of development of each of our mineral resources the discussion in this paper will be limited to a consideration of the output of the last few years. Figures of yearly production will be given for the year 1920 and each succeeding year including 1925; figures for 1926 are not yet available.

Chief Mineral Products

The chief mineral products being produced commercially in Iowa are coal, cement, gypsum, clay products, sand and gravel, and stone and lime. The total annual mineral production in recent years is shown in Figure 3.

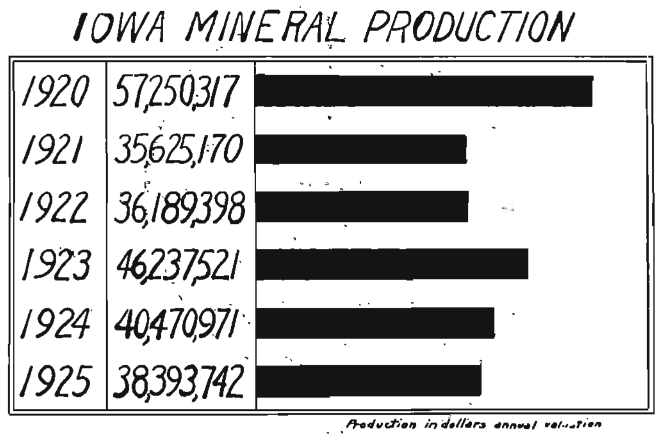

Figure 3

It will be seen that in this six-year period the greatest production was in 1920, the smallest in 1921. Without attempting to discuss the many factors which contributed to the marked differences in yearly production it may be stated that 1920 was the inflation year; in this year the production was $20,000,000 higher than in the previous year; prices were at their peak and the demand for products was above normal. In 1921 and 1922 the production dropped back more than $20,000,000 each year. Then in 1923 there was an increase of more than $10,000,000 above the production of the preceding year. It is noteworthy that in this year the increase was not limited to one product but was shared by all the major branches of the mineral industry. The decline of 1925 below 1924 was due almost entirely to the reduction in tonnage and value of the coal produced in the latter year as compared with that of the year before. The following table shows the value of the chief products for each of the years from 1920 to 1925.

	Coal	Cement	Gypsum	Clay Products	Sand and Gravel	Stone and Lime
1920	$30,793,847	$ 8,742,854	$4,422,965	$10,489,232	$1,993,441	$840,544
1921	17,256,800	7,439,983	2,922,700	5,711,583	1,726,958	563,427
1922	16,119,000	7,709,313	4,146,182	5,739,449	1,752,233	719,203
1923	20,517,000	10,351,971	5,368,532	7,039,924	2,181,881	775,134
1924	18,097,000	8,811,587	5,657,339	5,692,147	1,473,065	739,632
1925	14,807,000	8,674,563	6,734,271	5,726,239	1,546,900	904,669

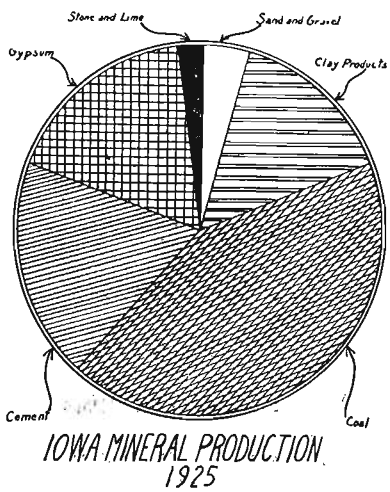

Figure 4

In 1925 the order of values of the chief products from the highest to the lowest was coal, cement, gypsum, clay products, sand and gravel, and stone and lime. The relative values of these materials are shown graphically in Figure 4.

Coal

The value of coal each year greatly exceeds the value of any other mineral product in Iowa. The values for 1920 and each succeeding year including 1925 are shown graphically in Figure 5; and the tonnage production and value in Figure 6. In 1920 the value reached $30,793,847, which is the highest figure in the history of coal mining in the state. In that year the total output was 7,813,916

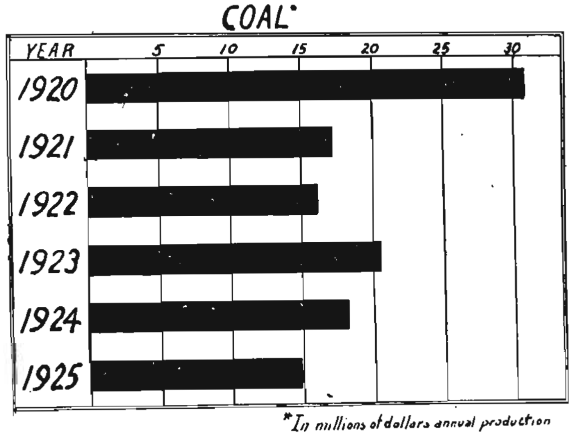

Figure 5

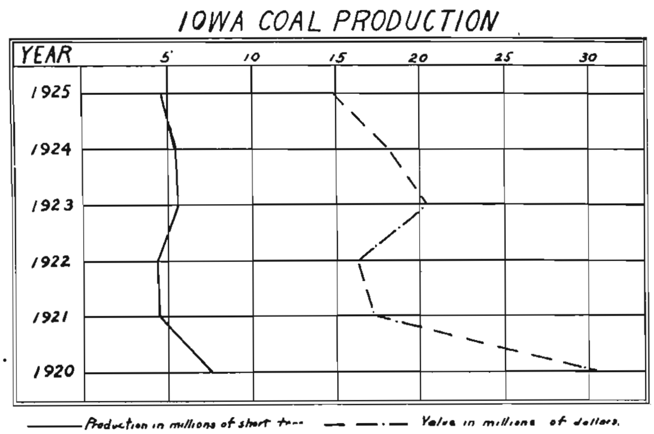

Figure 6

tons with a value of $3.94 a ton at the mine. The number of employes was 11,905 men. The average number of days worked in the coal mining counties was 250. In 1921 the value of the output was $17,256,800; in 1922, $16,119,000; in 1923, $20,517,000; in 1924, $18,097,000, and in 1925, $14,807,000. The value for 1925 was the lowest of any year since 1916.

The chief coal is mined from the Des Moines series in the Des Moines valley, but some coal is mined in Adams, Page, and Taylor counties from the Nodaway coal seam, which averages only about 18 inches in thickness. In 1925, Marion county ranked first in value of coal produced; Monroe county ranked second, Polk county third, Appanoose county fourth, Lucas county fifth, Boone county sixth, and Dallas county seventh. Figure 7 shows the coal producing counties in Iowa in 1925; the numbers indicate the rankings of the most important counties. It has been estimated that at the present rate of production there is sufficient coal in Iowa to last for more than twenty-five hundred years.

Figure 7

Cement

Only a comparatively few years ago Iowa entered the field as a producer of Portland cement, yet to-day she ranks high among states in this regard. In 1920, the value of the output was $8,742,854; in 1921, $7,439,983; in 1922, $7,709,313; in 1923, $10,351,971; in 1924, $8,811,587; and in 1925, $8,674,563. These values are shown graphically in Figure 8. The banner year was 1923, when 5,732,470 barrels were produced, and 5,570,675 barrels were shipped. The shipments were made by the following five plants: the Gilmore Portland Cement Company, Gilmore City; Hawkeye Portland Cement Company, Des Moines; Lehigh Portland Cement Company, Mason City; Northwestern States Portland Cement Company, Mason City, and the Pyramid Portland Cement Company, Valley Junction. The

Pyramid and Hawkeye plants use the wet process; the others use the dry process. All the plants use limestone and shale and burn the clinker with coal. In this year there were twenty-seven producing states in the United States, and Iowa occupied eighth place in both production and shipment. The Portland cement factories of Iowa manufactured 4,648,145 barrels of cement in 1925, and during the same year they shipped 4,856,849 barrels, which at an average price of $1.79 per barrel were worth $8,674,563. In this year Iowa

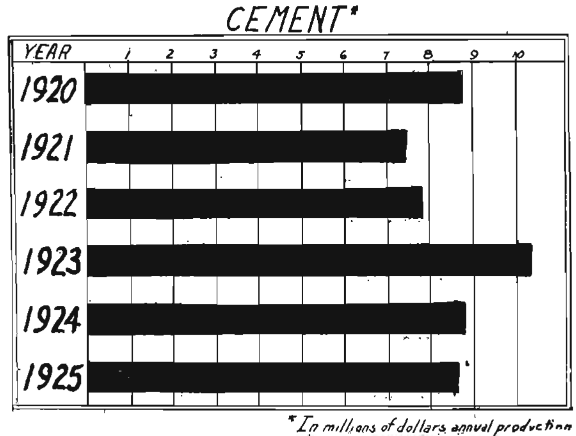

Figure 8

was the only state in the Union which suffered a decline in production, and was one of the two states where shipments declined in amount and value, the other being Illinois. The raw products, limestone and shale, from which Portland cement is being made in Iowa are widely distributed in the state, and at several places the rocks are of unusually good quality and occur in such quantity that they are available for extensive future development.

Gypsum

For many years Iowa has been one of the important producers of gypsum and its products—wall plaster, fireproofing, tile, blocks, boards, etc., plaster of Paris, and other materials. For many years New York has ranked first of all the states in the Union in value of gypsum, and Iowa with few exceptions has been second. Volume XXVIII of the reports of the Iowa Geological Survey deals with the subject of gypsum in a most comprehensive manner. The geologic, chemical, economic, and technologic aspects of gypsum are described.

The value of the gypsum in 1920 was $4,422,965; in 1921, $2,922,700; in 1922, $4,146,182; in 1923, $5,368,532; in 1924, $5,657,339; and in 1925, $6,734,271. These values are represented graphically in Figure 9. The value in 1921 was less than in 1920, but since 1921 the value has increased consistently until in 1925 the value was the highest in the history of the gypsum industry in Iowa. The gypsum products industry in Iowa is one of the few branches of the mineral business which shows constant gains from year to year, even during the adverse conditions that have prevailed during most of

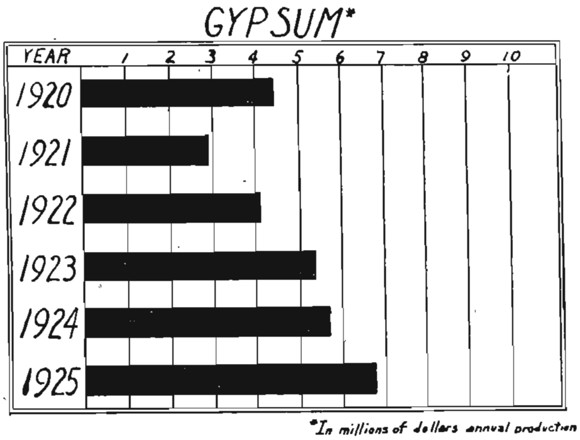

Figure 9

the past few years. The tonnage of crude gypsum raised in 1925 was 800,167. Of this total 140,451 tons was sold crude to Portland cement mills as retarder, for agricultural gypsum—"land plaster"—and for various other purposes. Most of the gypsum mined is calcined to make plaster of various sorts, wall board, partition and roof tile, and other materials. Five plants are operating at Fort Dodge and one plant at Centerville.

Clay Products

The value of clay products in 1920 was $10,489,232, the highest figure in the history of the industry; in 1921 the value dropped to $5,011,583; in 1923 it rose to $7,039,924; in 1924 it again dropped to $5,692,147, and in 1925 it rose somewhat, the value being $5,726,239. The values during these years are shown graphically in

Figure 10. The kinds of clay products marketed are hollow building tile of various kinds, sewer pipe, drain tile, common brick, face brick, flue lining, paving brick, and pottery. In Iowa there were sixty-seven establishments in 1925. The chief producing counties in recent years have been Cerro Gordo, Webster, and Polk. Our state ranks twenty-third in the United States in value of common brick sold, fifteenth in value of face brick, fifth in value of hollow tile, second in value of drain tile, and eighth in value of sewer pipe. Slowing down in building operations and in other civic improve-

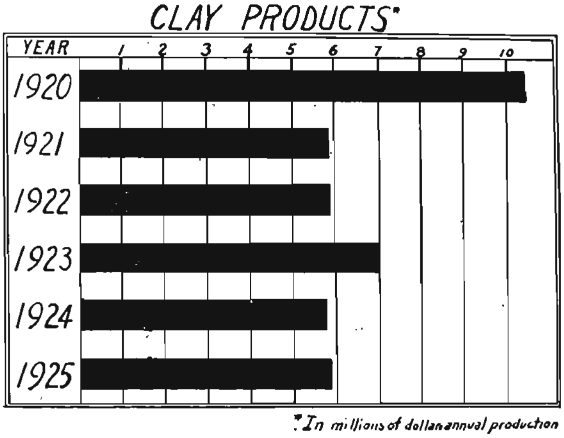

Figure 10

ments wherein clay products are used, as well as in land improvement represented by drainage and similar work, have a marked effect upon the clay working industries. Although Iowa has abundant clay for all ordinary uses the state does not possess, so far as is now known, any strictly first-class refractory clays in commercial quantities.

Sand and Gravel

The value of the sand and gravel produced in Iowa in 1920 was $1,993,441; in 1921, $1,726,958; in 1922, $1,752,233; in 1923, $2,181,881; in 1924, $1,473,065, and in 1925, $1,546,900. The values during these years are shown graphically in Figure 11. The sand was used mainly as building sand, paving and road making sand; some was used for molding, cutting and grinding, fire or furnace purposes, engines, filters, and various other purposes. The gravel was used in the building trade, for railroad ballast and for paving and road making.

More than forty counties are producing sand and gravel; the chief producers are Polk, Muscatine, Cerro Gordo, Cherokee, Sac, Linn, Hardin, Boone, Black Hawk, and Wapello. It may be noted that several of these counties—namely, Cerro Gordo, Cherokee, Polk, Sac, Hardin, and Boone—in the central part of the state are

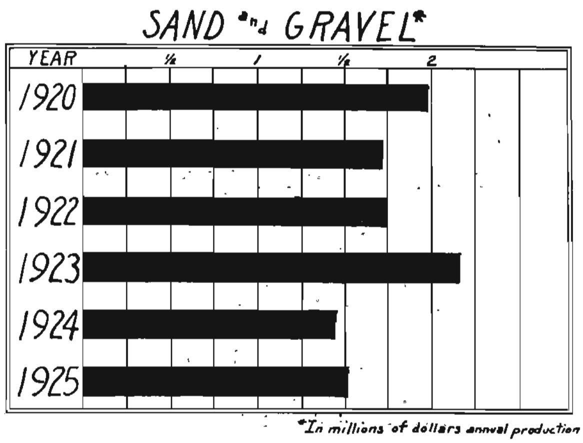

Figure 11

in the area covered by what is known as the Wisconsin glacial drift. This drift sheet contains great amounts of sand and gravel, both incorporated in the body of the drift and as masses of nearly clean material. These latter are all ready for the shovel of the excavator, as in Cherokee, Cerro Gordo, and Sac counties, and the former yields its store to the streams, from which it may readily be dredged, as is the case in Polk county. The other important counties are located on large streams—the Mississippi, the Cedar, and the Des Moines—which have gathered their stores from the glacial drift across which they flow.

The sands and gravels of Iowa are by nature better fitted for the coarser uses rather than for finer ones such as glass making, molding, polishing, and filter sands. However, some of these latter purposes are served by carefully selecting and preparing some of the finer and better grades of sand.

Limestone and Lime

The value of limestones and lime produced in Iowa in 1920 was $840,544; in 1921, $563,427; in 1922, $719,203; in 1923, $775,134; in 1924, $739,632; and in 1925, $904,669. These values are represented graphically in Figure 12. The value in 1925 was the largest reached by the industry since 1912. The limestone is used in con-

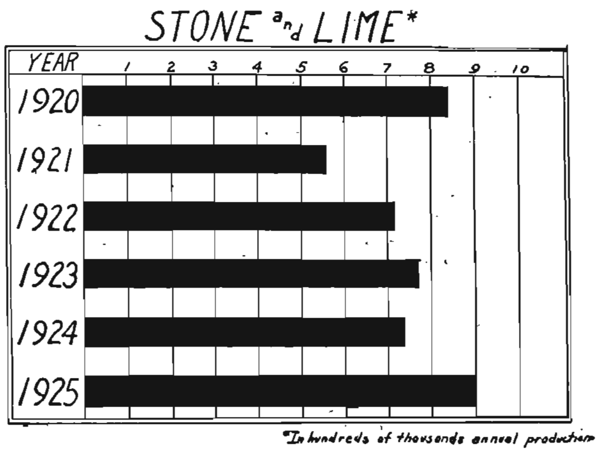

Figure 12

crete and road work, in agriculture, for railroad ballast, flux, in sugar factories and for building. The chief producing counties are Scott, Dubuque, and Black Hawk.

Lime is burned at Dubuque and at Hurstville near Maquoketa.

Oil and Gas

Oil in commercial quantities has never been found in Iowa. Gas has been found and no doubt will continue to be found in various parts of the state in small quantities in sands and gravels of Pleistocene age. One is not justified in making the statement that oil and gas will never be found in commercial quantities in the indurated rocks of Iowa, but it is proper to assert as has been asserted frequently in reports of the Iowa Geological Survey and elsewhere that all the evidence that has been gained from a study of the geology of the state, especially in connection with the many deep wells that have been drilled in efforts to get supplies of water, points consistently to the conclusion that in nearly all parts of Iowa it would be a waste of money and effort to drill deep wells with the sole expectation of obtaining commercial quantities of either oil or gas. In volume XXIX of the reports of the Iowa Geological Survey there is a thorough discussion of the possibilities of finding oil and gas in Iowa. The geologic formations are discussed in detail, and the probabilities of oil being found in such well known horizons as the Platteville (Trenton), Silurian, Devonian, and the Cherokee shales are considered. The prospect is stated to be distinctly dis-

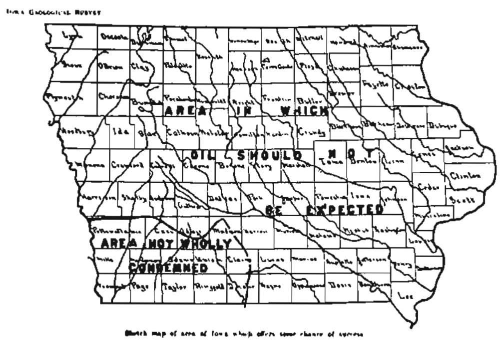

Figure 13

couraging. The only part of the state for which any hope is held out is the southwestern, including most of the three southern tiers of counties as far east as Winterset, Osceola, and Leon. There is no use in drilling, either here or elsewhere, below the upper part of the St. Peter sandstone. The chance of failure, even in southwestern Iowa, is very high.

Natural Fertilizers

A few years ago it was reported that potash was present in Iowa lakes, but investigation showed that there was no foundation for such rumors. Gypsum has been found useful as a soil amendment, and Iowa has abundant supplies. Peat, which is found in the many bogs which lie on the Wisconsin glacial drift of north central Iowa, can be used for chemical fertilizers and is inoculated with nitrifying bacteria. No extensive deposits of phosphates have been found in Iowa, but some limestone beds contain traces of this material, although not enough to make them very valuable on that account. Iowa has large deposits of limestone which is suitable for agricultural purposes. The best and most extensive beds are near those localities where the need for limestone is greatest. A recent report on the fertilizers of Iowa, prepared by Professor John E. Smith, was published in volume XXXI of the reports of the Iowa Geological Survey. Professor Smith states that nearly ninety per cent of Iowa soil could be made more productive by the addition of limestone.

Iowa with her rich soil is one of the foremost agricultural states of the Union. Perhaps our pride in our soil resources causes us to underestimate the importance of our other natural resources. The rocks of the state are a great asset. Their value will be realized more and more as we assume to a greater extent than we have in the past our obligation to use in connection with the development of our industries and in other ways our own natural resources rather than ship into the state from other states similar materials of no better quality than are to be found within our own borders.

IOWA COAL AREAS AND CHARACTERISTICS OF IOWA COAL

JAMES H. LEES

I feel that the subject assigned to me for discussion is of very serious importance to the interests represented here, for no matter how we may designate the present stage of civilization—whether the age of steel or electricity or radio or even jazz—it still remains true that fuel is the basic resource of industry, and of the great primary sources of power and heat—coal, water-power, oil, natural gas—coal is now and probably in our generation will remain well in the lead. If this is true it is well that every citizen should have an intelligent interest in this resource—its occurrence, its extent, its character and the best methods for its recovery and use.

A generalized time-scale to show those periods which are of special interest in this study may well be given here and is as follows:

Cenozoic	Present
	Pleistocene—Glacial period
	Pliocene
	Miocene—Some coal in California
	Oligocene
	Eocene—Coal and lignite
Mesozoic	Cretaceous—Coal
	Jurassic
	Triassic—Some coal in Virginia and North Carolina

Professor E. C. Jeffrey of Harvard University in summarizing a recent paper on Conifers and the Coal Question says: "It is clear from the structural study of Tertiary coals and their contained woods that these coals can not have been formed *in situ* as is generally assumed, since the woods are those of land and even desert trees." "Tertiary coals in general - - - are to be regarded as the result of water transportation and aqueous sedimentation." Science, N. S., vol. LXV, p. 357, April 8, 1927.