WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
E. F. Bean, Acting Director

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A BRIEF OUTLINE

OF THE

# GEOLOGY, PHYSICAL GEOGRAPHY, GEOGRAPHY, AND INDUSTRIES

OF

# WISCONSIN

by
W. O. HOTCHKISS and E. F. BEAN

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# WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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# THE WORK OF THE STATE GEOLOGICAL AND NATURAL HISTORY SURVEY

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The work of this Survey is separated into the following divisions:

A. Geology, in charge of Acting State Geologist E. F. Bean
B. Natural History, in charge of President E. A. Birge
C. Soils, in charge of Professor A. R. Whitson

## GEOLOGY

This division is a clearing house for the collection of geological information and its dissemination to the people of the state. This information is disseminated by means of published reports, by correspondence, and by conference with callers at the Survey office, Room 316, Science Hall, Madison.

Some of the important types of field work in recent years have been a detailed study of the iron bearing and copper bearing formations in the northern part of the state, road material surveys which have resulted in a saving of about $2,000,000 in the cost of highway construction, the making of topographic maps in cooperation with the United States Geological Survey, and a study of the underground water supplies available for cities, villages, industries, and homes.

## NATURAL HISTORY

This division is making a study of the plant and animal life of the state. In recent years much time has been spent upon a detailed study of our lakes. The lakes of Wisconsin are a very valuable asset, and this work has great economic as well as scientific value.

## SOILS

This division has completed a general soil survey of the northern half of the state and is now engaged in more detailed surveys in the southern part of the state, where many county maps have been completed. Inquiries regarding the soils of Wisconsin should be directed to A. R. Whitson, Soils Building, Madison.

# THE DAYS OF OLD

W. O. HOTCHKISS, *State Geologist*

IF WE were to start to dig anywhere in Wisconsin, except in a rock ledge, we would find first a layer of soil. Below this layer of a foot or so of soil in some parts of the state we would find hard rock. In other parts we would find below the soil a layer of unconsolidated material of sand, clay, gravel and bowlders. In a very few places we could dig for nearly 600 feet in this loose material, but usually we would not go 200 feet before we came to solid rock. Everywhere below the surface of the land, at depths of a few feet or a few hundred, we would find solid rock if we were to dig down.

W. O. HOTCHKISS

In the mantle of soil, loose earth, sand, clay, gravel, and bowlders that covers the solid rocks, the geologist sees only material derived from the breaking up of earlier solid rocks. In the solid sandstones, limestones and shales that lie below this mantle he sees material that once was loose, the sands, marls and clays of other times, that has again been hardened by nature into solid rock.

The rocks have been called "the great stone book of nature" in which we may read if we will the story of the days of old on this earth of ours—the great stone book whose pages were written, and are being written, by the hand of the Creator himself.

The study of this great stone book is a very broad science, and yet the reading of much of it is relatively so simple that the average man needs only to have his attention called to the important features to understand them clearly. It is only about a hundred and fifty years ago that Hutton, a Scotch farmer, first taught us the primary lesson in reading this book.

In his rambles along the rugged sea coast near his farm he saw sandstone cliffs being slowly beaten by the waves and torn into sand grains to make the sandy ripple-marked beach. He found in the sandstone cliffs the same sort of ripple marks that he saw in the loose beach sand at his feet, and the truth came to him that the cliffs must once have been loose sand rippled by the waves of a former sea. It was not hard to picture the ripple-marked beaches he walked upon as being slowly cemented to sandstone, raised above the sea, and again torn down by the waves to make beaches on some future sea shore, geologic ages hence. Looking both into the past and the future this cycle of events could be imagined to go on indefinitely. As Hutton expressed it—"we find no vestige of a beginning,—no prospect of an end."

He found the rocks on opposite sides of the valleys to be made of the same succession of beds, like two pieces from the same layer cake. And they both showed the same evidence of being sea deposits. Thus the layers must once have been continuous across the valleys; the valleys must have been carved in the rocks after they were elevated above the sea. He found each valley had a stream, a large one in a large valley, and in the smallest perhaps a rivulet that only flowed after a rain. But each stream he found carried mud and sand, from the soil and rocks. Given sufficient time he saw that the wind and the rain would eventually remove the hills and produce a plain. In the course of the deliberate, age-long movements of the surface of the earth, this plain might slowly sink below the sea and be covered by new deposits of sand and mud, or it might be slowly uplifted and the streams again started on their work of carving new valleys and hills and eventually reducing it to a new and lower plain.

Thus Hutton taught us the great principle of modern geology—that the processes which we see going on about us all the time, the process of wearing away by wind and streams, known as erosion, and the process of deposition in lakes and seas, have been at work throughout all the hundreds of millions of years of geologic history, "with no vestige of a beginning and no prospect of an end." For that far away beginning and the probable end we must turn from the "great stone book of nature" and ask the astronomer to consult the starry page of the heavens.

If the "everlasting hills" of Wisconsin have mostly been carved from rocks that once were great sea bottom plains they are evidently the most recent of geologic productions, and yet to carve their present forms the slow processes of nature must obviously have taken many, many millions of years.

When we study the rocks of Wisconsin we find that parts of the state as well as adjoining parts of the Mississippi Valley have been covered many times by great shallow seas which deposited the sands and muds that we now see hardened to sandstones and quartzites, shales and slates, limestones and marbles. After each period of submergence and deposition Wisconsin was elevated above sea level and became dry land. Streams developed and began to carry away the land to the sea, and carve new valleys and hills and plains. Again the sea returned, due to sinking of the land, and new sandstones, limestones or shales, were deposited, only again to be elevated slowly above the sea and start anew the process of erosion.

These cycles, as we can read in the "great stone book of nature," were repeated at least a dozen times in Wisconsin. Frequently the sea and its deposits would cover but a part of the state, so that in the great layer cake of sandstone, shale, and limestone that covers the eastern, southern and western parts of the state, we would not find all the beds present in any one place if we were to dig down through them. Some of those found in the west we would not find in the east, and some of those in the east are not found in the west.

If we were to start a deep shaft in the northeastern part of Milwaukee county we would go first through a few inches or feet of soil. Next we would find a layer of glacial deposited material, clay, gravel, bowlders and sand. Then if all the formations were present we would penetrate the different beds in order from top down, as shown in the "geologic column"—figure 1.

Geology does not measure time in years and only recently have other sciences come to its aid to give us approximate ideas of how long ago the early pages of that "great stone

## Geologic Column

| Era | System | Formation | Character, Use, Thickness | Cities on or near Formation Outcrop |
|---|---|---|---|---|
| CENOZOIC | Quaternary | Glacial Drift | Sand, clay, gravel, bowlders, marl and peat. 0-600 ft. | |
| PALEOZOIC | Devonian | Milwaukee | Shale and dolomite 0-170 ft. | MILWAUKEE |
| | Silurian | Waubakee | Shaly dolomite 0-50 ft | NO MILWAUKEE |
| | | Niagara Group | Dolomite, lite gray, sometimes cherty beds, thick to thin. Lime, crushed stone, Bldg. stone and flux 300-719 ft. | RACINE WAUKESHA CHILTON STURGEON BAY |
| | | Neda | Oolitic iron ore in local patches 0-55 ft. | MAYVILLE |
| | | Richmond | Gray to blue limy shales thin bedded. 50 to 540 ft. | GREEN BAY |
| | Ordovician | Galena | Gray dolomite sometimes cherty Hard beds good for bldg. stone & crushed rock 100-250 ft. | PLATTEVILLE |
| | | Decorah, Platteville (Black River) | Dolomitic shale and dolomite with some pure limestone in Grant Co Hard beds good for crushed rock and building stone. 100-120 ft | DARLINGTON |
| | | St. Peter | Sandstone, fine to med grained white to buff 0-330 ft | VIROQUA |
| | Canadian | Shakopee (Lower Magnesian) | Dolomite gray thick bedded cherty Agricultural lime, crushed rock. 0-250 ft. | CASHTON |
| | Ozarkian | Oneota (Lower Magnesian) | | |
| | | Madison | Limy sandstone, fine grained 0-30 ft. | |
| | | Mendota | Dolomite, local near Madison 0-20 ft. | MENDOTA |
| | Cambrian | Jordan | Sandstone, med. to coarse grained, white 0-75 ft. | LODI |
| | | Trempealeau | Sandstone fine grained thin bedded, with purplish limy shale and a thin dolomite layer Road surfacing. 50-110 ft. | TREMPEALEAU ALMA |
| | | Mazomanie | Sandstone, limy, yellow and green. Not present in western part of State. 100-165 ft. | MADISON |
| | | Franconia | Sandstone, yellow and green with limy shale beds. Road surfacing. Building stone not present in eastern part of State. 120-170 ft. | |
| | | Dresbach | Sandstone, heavy bedded, white to yellow. 40-250 ft. | LA CROSSE CAMP DOUGLAS |
| | | Eau Claire | Fine grained yellow sandstone and shale. Road surfacing and building stone. 90-350 ft. | MONDOVI COLFAX |
| | | Mt. Simon | Coarse yellow to gray sandstone. 0-700 ft. | EAU CLAIRE BLACK RIVER FALLS |
| PRE CAMBRIAN | Keweenawan | | Ancient dark colored lava flows, conglom. and sandstone. Copper ore and crushed stone. 40000-55000 ft. | ST. CROIX FALLS ASHLAND SUPERIOR |
| | Huronian | | Quartzite, slate, marble, iron formation. Iron ore and ganister. 8000-12500 ft. | HURLEY ABLEMAN |
| | Archean | | Granites, greenstones, schists, used for monument and crushed stone. | CHIPPEWA FALLS WAUSAU RHINELANDER |

Fig. 1.

book" were written. According to the work of the students of physics the Devonian rocks—youngest in Wisconsin and found only in small areas on the Lake Michigan shore north of Milwaukee—are about 370 million years old. The limestone which occupies the area east of Waukesha, Fond du Lac and Green Bay is about 430 million years old. The sandstone which occupies the central part of the state is about 600 million years old, Keweenawan and Huronian rocks are about 1,200 million and Archean rocks, those at Wisconsin Rapids, Wausau and the central northern state, the most ancient rocks in the world, date from a period 1,600 million years ago. An error of a few million years is of course of no importance when such enormous periods of time are considered.

With such figures before us the duration of 10 to 40 *thousand* years since the last glacial period seems but an instant.

If we were to start on a trip from Milwaukee to Wisconsin Rapids and observe the various kinds of rocks we would find that we passed over the same series in succession. At the bottom of our deep shaft—if we dug down nearly 2,000 feet—we would find Pre-Cambrian granites, gneisses or schists, very ancient crystalline rocks of entirely different character from the bedded rocks we had been digging through. On our overland trip when we got to Wisconsin Rapids we would find the same kind of ancient granites and other crystalline rocks. The real thickness would be represented by the depth of our shaft and our journey would have shown us the same beds because they had been gently tilted upward toward the northwest and erosion had beveled off the edges. In going overland to Wisconsin Rapids we would thus be going downward with reference to the geologic column.

After we got through the soil and other loose material with our deep shaft we would find the Milwaukee shaly dolomite—the kind of rock they formerly used to make natural cement at Milwaukee in the days before the much superior portland cement superseded it. The second formation would be the Waubakee dolomite—a thin rock bed not known to be over 50 feet thick. In our overland journey we would find that the area covered by these formations extended only four or five miles toward Wisconsin Rapids. The third kind of beds we would find in our deep shaft would be a group of very pure dolomite beds known as the Niagara group. In our overland journey we would find this group making the great cliffs quarried for lime and crushed rock at Mayville. This group makes the *Niagara escarpment*—a line of west facing cliffs extending from a short distance north of Waukesha up along the east shore of Winnebago clear to the tip of Door County. A similar cliff of this same group of dolomite beds makes the rock over which the water drops at Niagara Falls—from which the group gets its name.

Below the Niagara group in our deep shaft we may encounter one of the beds of iron ore, such as are found in a few places at the bottom of the Niagara (the largest of these, a mile or so long is mined under the cliffs near Mayville) but we are more likely to go directly into the Richmond shale. Our overland journey would show us this shale as a hard, somewhat limy clay shale beneath the ore at Mayville. It is used to make tile and brick near Fond du Lac, and along the east side of Lake Winnebago where large pits afford a good opportunity to see it. This was formerly called Cincinnati shale as it was wrongly supposed to be the same in age as that found along the Ohio River near that city.

Continuing our deep shaft through this shale we would come to two dolomite formations, the Galena and Black River. In our overland journey we would find few outcrops as these formations near Fond du Lac are mostly hidden by glacial drift. But by talking with the well drillers we would learn that these formations occur as far west as Ripon. In the southwest part of the state these dolomites are well exposed along the valley sides, and also in the mine workings, for these are the beds in which the lead and zinc ores are found in Grant, Iowa and Lafayette counties.

Going back to our deep shaft in the northeast corner of Milwaukee County and starting to dig deeper we find the next formation below is the St. Peter sandstone. This is a very soft, porous formation full of water, and if our shaft were real instead of imaginary, unless we were able to seal off the water, we would find it impossible to pump it out fast enough to permit us to go deeper. This sandstone serves as a great reservoir for water in the eastern and southern parts of the state and many public and private water systems get their water from this formation.

This formation is so soft that it is readily worn away at the surface, consequently it is usually found only in a narrow belt near the edge of the harder, more resistant, dolomite that overlies it. In our overland journey to Wisconsin Rapids, under the limestone quarry at Ripon, we would find some of this sandstone which is dug out and sold for plaster sand.

The next lower formation we find in our shaft is the Lower Magnesian limestone, a fairly hard rock that has been used quite extensively for crushed rock for road building and other construction near Madison and La Crosse and generally north of the Wisconsin River and along the Mississippi. This formation makes the remarkable castellated cliffs that add so much to the beauty of the Mississippi gorge between the mouth of the Wisconsin and the St. Croix.

Below the Lower Magnesian limestone in our shaft we would come to the great Cambrian sandstone series. This is mostly soft porous sandstone with some shaly and limy beds. It is filled with water which is of enormous value to the people of the state. Many large and small cities, including the state capital, get an abundant and cheap supply of pure water from this formation. Deep wells by the hundreds have been drilled into it for this purpose. The value of this cheap, pure water supply to citizens of Wisconsin can be appreciated only when we learn of the expense and difficulty of filtering and treating muddy river water as must be done over much of the rest of the country.

In our overland journey from our deep shaft to Wisconsin Rapids we would find the Cambrian sandstone extending from Berlin to our destination. If we went by way of Friendship we would see it making the great mounds that rise above the sandy plain—Friendship Mound, Roche a Cris, and many others, with their steep cliff sides and castellated tops—and we would find it making the river bank where we crossed the river at Nekoosa. We could extend our journey farther and see this great sandstone series in the Camp Douglas mounds, the Dells at Kilbourn, and in the cliffs and roadcuts all over the area between La Crosse and Eau Claire.

In this large area the shaly and limy beds of this sandstone series are of great use for road surfacing and the many excellent roads found here are possible because these beds furnish an abundant cheap material well suited to the moderate traffic burden.

Some of the sandstone beds make very fine building stone which locally finds extensive use. Stone from Dunn County was selected to complete the cathedral of St. John in New York because of its beautiful soft cream color and its excellent quality.

North of a line drawn from Shell Lake through Chippewa Falls, Abbotsford, Wisconsin Rapids, Waupaca and Shawano to Wausaukee, the rocks we would find are different from those we have been describing. Except along the Lake Superior shore and inland a few miles they are nearly all crystalline rocks, such as granites, gneisses, schists, quartzites and ancient dark colored lava flows.

In these old rocks are found the famous granite quarries of Montello, Red Granite, Wausau and Marinette county from which come some of the finest and hardest granites of the world. In our shaft we would find the same kind of rocks below the Cambrian sandstone series at Milwaukee. Everywhere in Wisconsin we find this same condition. If we were to dig further until the heat of the earth stopped us we would find the same kind of ancient rocks.

These Pre-Cambrian rocks include some ancient sediments—sandstones, shales and similar rocks—but they have been folded and altered so they no longer look like the younger rocks we have been describing,—their beds are on edge or steeply inclined, and the rocks are changed by the tremendous pressure which they have suffered. In these altered and folded rocks and in the great lava flows we find abundant evidence that hundreds of millions of years ago Wisconsin, northern Michigan and Minnesota was a mountainous country with volcanoes that belched forth enormous quantities of lava hardly equalled at any time elsewhere in the world.

In these folded sediments are found the great iron mines,

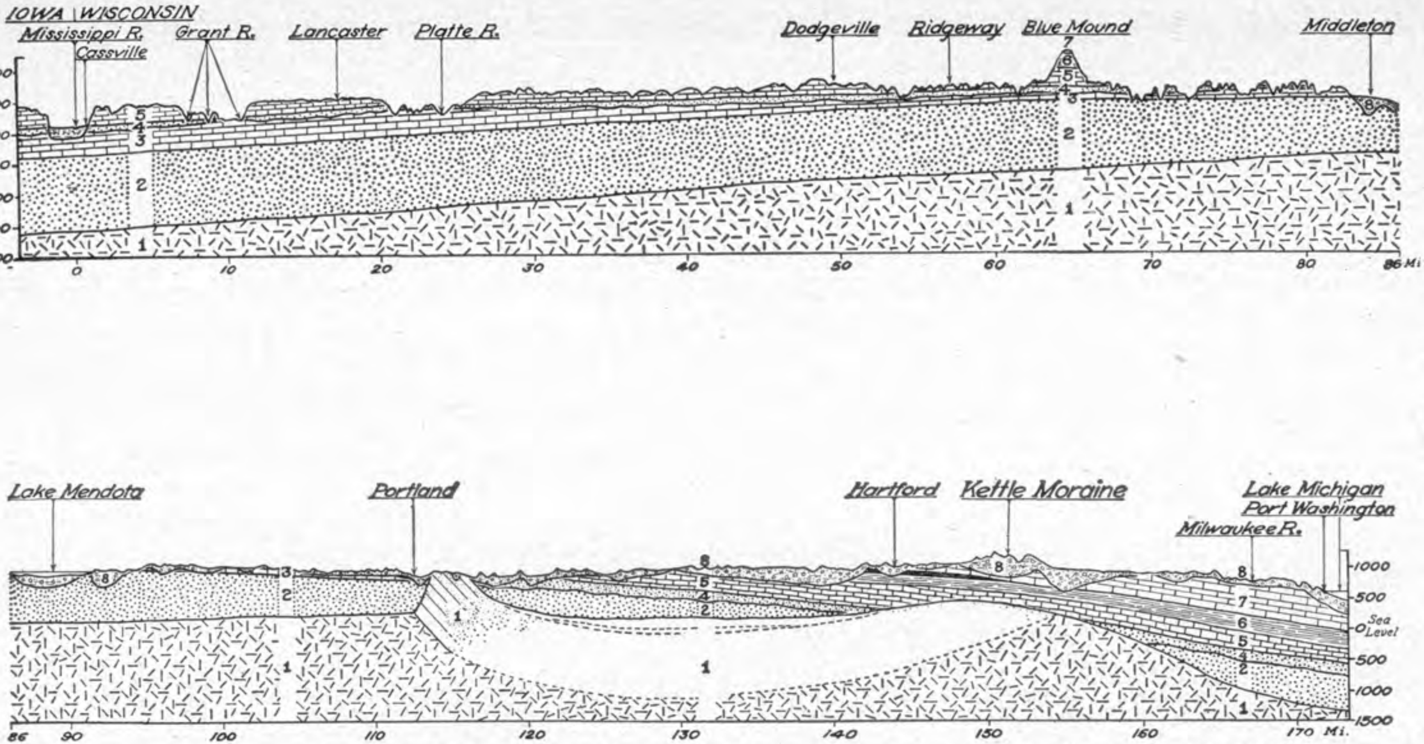


Fig. 2.—Cross section showing beds of rock, from Grant County on the Mississippi, to Ozaukee County on Lake Michigan.

and in the folded lava flows are the great copper deposits of the Lake Superior region.

These ancient mountains were worn down almost to a plain by long ages of erosion before the sea came over it to deposit the Cambrian sandstones. Some of the hard folded sediments projected as high hills above this old plain and made islands around which the Cambrian seas deposited their sands. The Baraboo Hills, the quartzite at Portland near Waterloo, and Rib Hill near Wausau, the highest point in the state, were islands of this type. The geologic cross section across the state shown on the preceding page gives an idea of the Waterloo quartzite island, and its great eastward extension shown by deep wells. This section also shows that the great layer cake of sandstone, shale, and limestone has been greatly bowed up in the middle and slopes down to the east and west.

The general distribution of the limestone, sandstone, and crystalline rocks of the state is shown in figure 3. This map also shows the edge of the great ice sheet which advanced from the northeast—from Canada—and covered all the state but the southwest quarter.*

When the glaciers melted away they left great quantities of material called "glacial drift" that they had carried along with them in their advance. They picked up the soil and sand and clay as they plowed along, and ground up the rocks that laid in their path to make pebbles and bowlders and fine "rock flour." Some of this material was dumped in a mixed up mass, and some of it was assorted into beds of clay, sand or gravel by the streams that issued from the melting ice just as we find them today coming from the glaciers of Alaska or Switzerland.

Along the outer edge of the ice, where it paused in its advance or melting back, it dumped great piles of mixed material in the form of hummocks and kettles which are called terminal moraines. These moraines dammed the old valleys and made beautiful lakes such as those at Madison and in many other parts of the state.

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* The reader can secure without charge the larger, colored geologic map of the state which shows the distribution of the various rock formations in much greater detail if he will write the State Geological Survey at Madison. In 1911 a very large colored geologic wall map of the state was distributed to each school in the state. Copies of this are still available if desired by any school.

One great lobe of the glacier advanced down the Lake Michigan basin and another down the valley of Green Bay and Lake Winnebago. On the high land between, where the two lobes met, they left a great area of rugged hummocks and deep kettles, some of which are filled with water and


Fig. 3.—Map showing the limestone, sandstone, and crystalline rock areas of the state. Crystalline rocks are the ancient granites and other hard rocks.

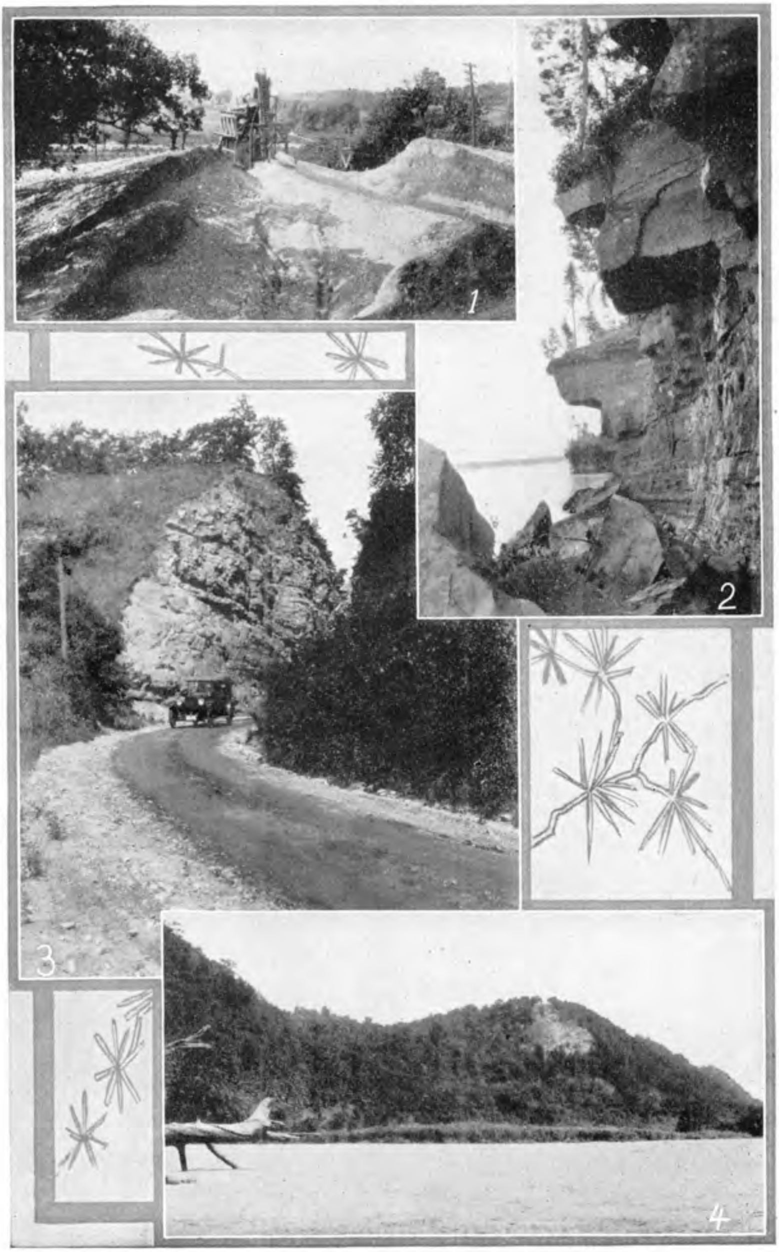
make the Oconomowoc lakes and many others. This moraine extends from Walworth County into Kewaunee County and is known as the great Kettle Moraine.

The Green Bay lobe paused at Neenah and left a moraine dam across the old Fox Valley south of which now lies Lake Winnebago.

The glacial drift is made up of the material the glacier found in its path. In the eastern part of the state this was chiefly limestone and the deposits left by the glaciers make the fertile soils of that region, and the abundant limestone gravels. In the northern and western part of the state the rocks are hard, granites and similar rocks, and the soils produced are sometimes rich clay loams and sometimes sandy. The gravels here are necessarily made of pebbles of the harder crystalline rocks.

In that part of the state which the glaciers did not cover—the southwest quarter—we find no glacial drift, so this part is commonly called the "Driftless Area." The valleys and hills we find here give us a very good idea of how the whole state looked before the glaciers came to fill up the valleys and level off the hills. It has been computed that the level fertile lands of the glaciated area are worth several hundred million dollars more than they would have been if the glaciers had not covered them. The glacial soil is more level and a greater percentage of this area is fit for cultivation. We may thus look at the glaciers as having carried out one of the greatest real estate improvements ever undertaken in Wisconsin. The grading and draining operations carried on by men are infinitesimal by comparison.

Not only has real estate been improved but the glaciers left us an almost priceless abundance of construction materials in the excellent gravel and sand deposits. If we had to ship our gravel from the Atlantic seaboard and our sand from the Rocky Mountains we would build no concrete buildings or bridges or roads. Neither would we enjoy the thousands of miles of cheap gravel roads we now have. Wealth of natural geologic resource such as this is seldom expressible in dollars. It can only be measured by the service and comfort that people can enjoy by reason of its abundance. If it is lacking or present only in small quantities people must simply do without the service. Other states south and west of us rightly envy us our great abundance of road-building material. They have to ship theirs long distances at great cost, and so cannot have as many or as good roads as we can in Wisconsin. Much of this we owe to the fact that the glaciers came into our state and left for us abundant wealth in these deposits.

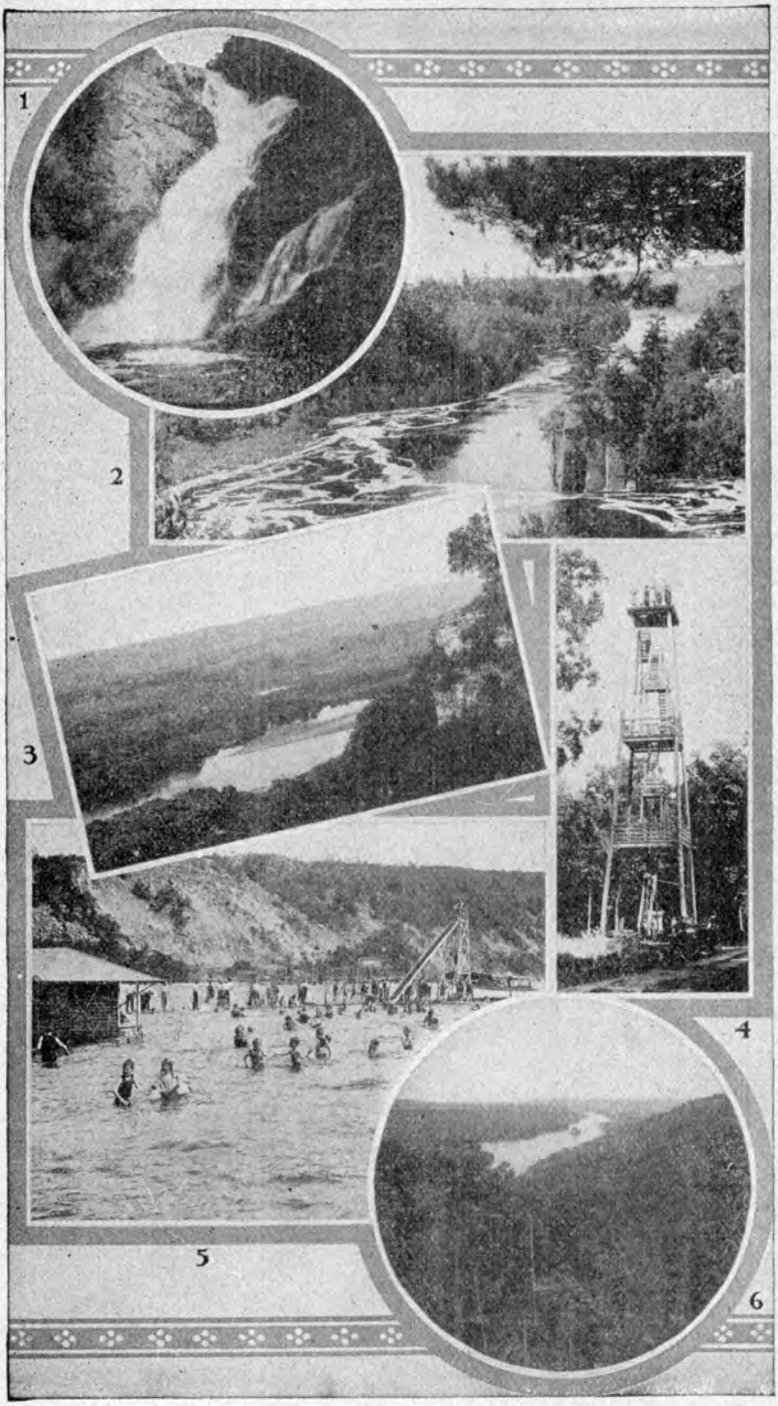


1. Glacial Gravel Pit producing Material for Concrete Road.
2. Rugged Wave Cut Cliffs along Lake Superior in Apostle Islands.
3. Second deepest Highway Cut in U. S. near Mindoro, La Crosse Co.
4. Sandstone Bluffs along Wisconsin River near Boscobel.

## Conclusion

In this brief article the attempt has been made to give a general idea of the geology of the state, and a very little of what it means to the people who live here. In conclusion I wish to emphasize that the same forces and processes that made Wisconsin in the past are at work today just as they always have been, "with no vestige of a beginning and no prospect of an end." Every rain, every flood, and every dust-bearing breeze is doing its part to wear Wisconsin away and carry it into the rivers and down to the sea. The same slow movement that has alternately lowered the state below sea level and raised it up again is now going on. We see old beaches along Lake Michigan which show us that region is slowly rising—only an inch or two in a century, perhaps, but nevertheless enough so that we can see the effect.

The study of the geology of the state teaches us that this old world of ours, even though its changes be slow, is nevertheless a constantly changing living thing, responding continuously to the demands of its Creator.




WISCONSIN PARKS

(1) Patterson State Park, High Falls 165 feet. (2) Dalles of St. Croix River Inter-State Park, (3) Looking up Wisconsin. Sequel Point Nelson Dewey, (4) Look Out Tower Peninsula, (5) Beach Devil's Lake, (6) Looking up the Mississippi River from Perrot Park.

# DESCRIPTION OF THE SURFACE FEATURES OF WISCONSIN

By E. F. BEAN, *Assistant State Geologist*

## TOPOGRAPHY FROM THE AUTOISTS' VIEWPOINT

THE autoist may see in Wisconsin three types of topography, plains, plateaus and mountains. The autoist from Beloit driving through Madison, Portage, Kilbourn, Mauston, Black River Falls, Merrillan, Eau Claire, Menomonie, Prairie Farm, Amery and St. Croix Falls has to the west and south a plateau, to the east and north a level to gently undulating plain. The plateau which we shall call the Western Upland is a broad upland deeply cut by numerous streams.

E. F. BEAN

Whether the autoist makes excursions into the plain, or into the Western Uplands, he may see forms slowly wrought through millions of years by the work of streams, the wind and other forces of nature. He may see lakes, and ice formed hills, that were formed in the geological yesterday. The following trips describe in brief fashion a few of the many interesting excursions available to the citizens of Wisconsin.

### Devils Lake and the Dells

Starting from Portage we shall go to Kilbourn and Devils Lake and return to Portage by way of Baraboo, a drive of about 60 miles. At the Dells we shall find the largest river in Wisconsin flowing in a deep gorge and at Devils Lake a beautiful lake in the midst of mountain scenery.

From Portage to Kilbourn much of our route is through a gently undulating plain. The soil is sandy, for our route is in the southern edge of the central plain (fig. 3), which is a great crescentic area underlain by sandstone and extending from Marinette County southwest to Portage, thence northwest to Washburn County. A casual examination of the road cuts shows, however, that all of the soil has not come from the neighboring hills. Instead there is a wide variety of rock types, some of which came from several hundred miles to the northeast. The geologist tells us that at one time a great ice sheet similar to those now found in Greenland once covered all of Wisconsin except about 13,360 square miles in the southwestern part. This great glacier modified the soil, topography, and drainage, and along

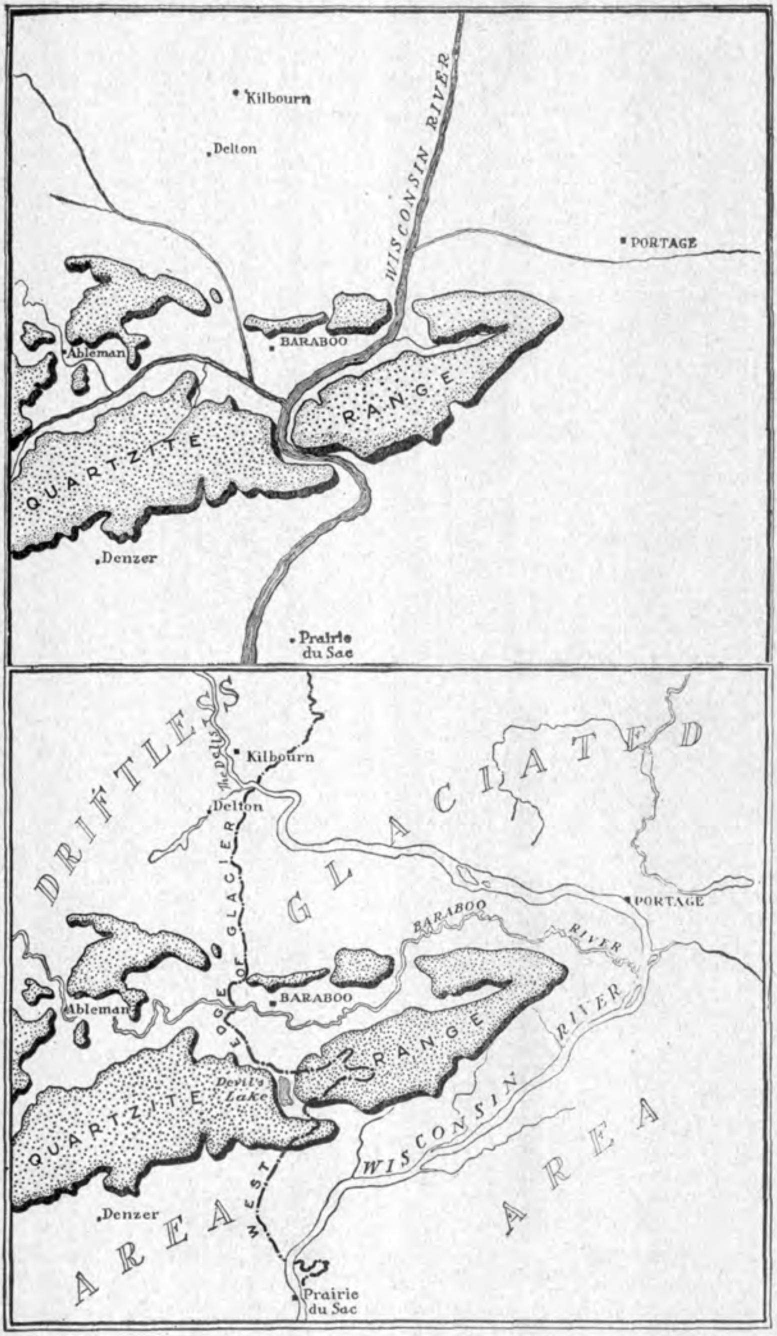



**Fig. 4.—Above—Course of the Wisconsin River through the Baraboo hills before the glacier dammed its course. Below—Present course of the Wisconsin River caused by glacier built dams.**

with great quantities of other material brought in the foreign bowlders we have observed. During the glacial period there were times when snowfall and the resulting accumulation of ice exceeded melting and the ice front advanced. At times there was a balance between melting and accumulation and the ice front remained stationary. During other periods melting exceeded ice accumulation and the ice front retreated. The glacial period may have lasted as long as a million years. It was ended in the geological yesterday, perhaps only 35,000 to 50,000 years ago. There were several advances, the latest being called the Wisconsin stage of glaciation. It is possible that we are now living in an interglacial period, and that an ice sheet may again cover the state.

About five miles east of Kilbourn we enter an area of rougher topography characterized by irregular ridges, hummocky hills, and undrained depressions called kettles. These kettles are due to the melting of buried ice blocks or to depressions inclosed by drift ridges. This rougher area about three miles in width is the terminal moraine of the Wisconsin ice sheet. This moraine can be followed northward to Langlade County, thence west to Hudson. It trends southeastward from Kilbourn to the vicinity of Lake Geneva.

Going west from the terminal moraine we cross an outwash plain built by streams flowing away from the melting ice. Since glacial times this plain has been gullied by streams. Before taking the boat to visit the Dells, we should picture conditions at the time of maximum advance when the ice sheet stood about two miles east of Kilbourn. In pre-glacial times the Wisconsin River flowed almost directly southward (fig. 4) from Stevens Point to the Lower Narrows west of Portage. From this course the Wisconsin was diverted by the glacier. As flow to the south was blocked by the ice front, the Baraboo Range, and the western upland, a lake was formed which drained through the Black River (fig. 5). This lake, called Glacial Lake Wisconsin, which covered an area of 1,825 square miles was three-fourths the size of Great Salt Lake and over eight times the size of Lake Winnebago. The level of this lake was about 940 feet above sea level, so that the site of Kilbourn was covered by water. The history of this lake is written in the clays, silts, and sands deposited in its depths, and in the ice rafted bowlders left stranded on its shore.

The melting back of the ice front permitted the lake to find a new outlet through the terminal moraine to the southeast. As this outlet was lowered by erosion, the lake was drained and the Wisconsin River began the process of cutting a narrow channel in the broad low ridge of sandstone which lay athwart its path at Kilbourn. This narrow gorge thus cut gave rise to the Dells, "the most famous and beautiful feature of the Wisconsin Valley."

The gorge is seven and one-fifth miles in length, the portion below the dam being one-third the total length and known as the Lower Dells. The gorge above the dam, usually called the Dells, is 60 to 120 feet deep and but 52 feet wide in its most constricted part.

The scenic features of the Dells are similar in character to those of that far-famed beauty spot of New York—Watkins Glen. All these features were carved in the sandstone by wind and water. The relative weakness or resistance of the layers of sandstone together with vertical cracks called joint planes has determined the forms produced.

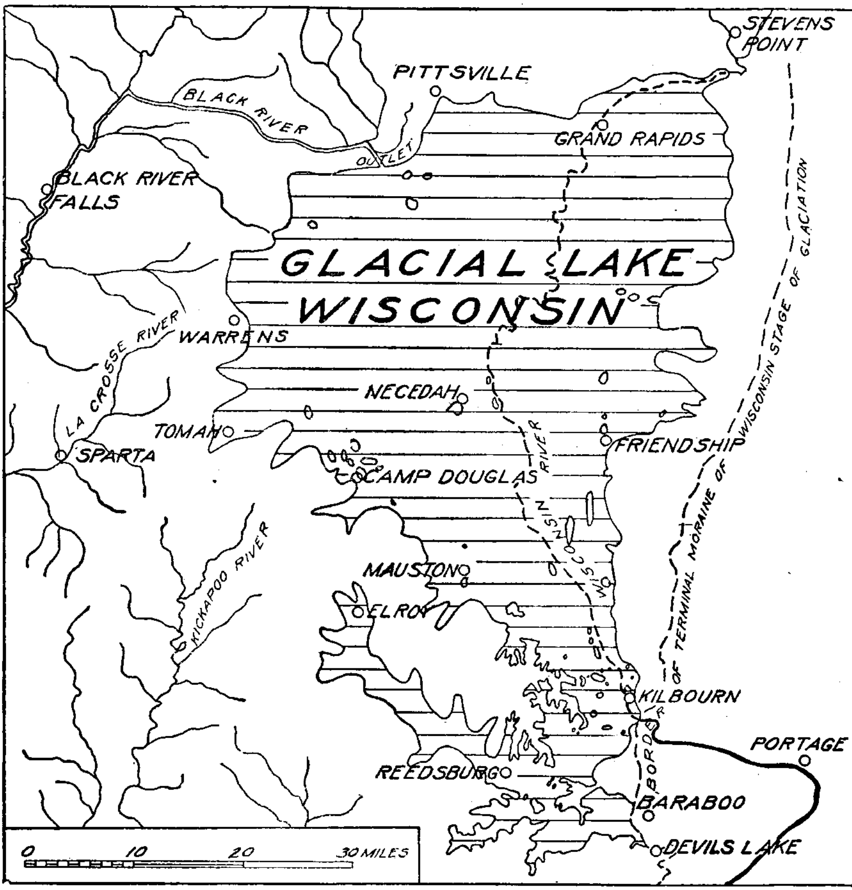



**Fig. 5.**—Glacial Lake Wisconsin formed by glacial damming of the **Wisconsin** River.

***Artist's Glen, Coldwater Canyon, Rood's Glen,*** and ***Witches Gulch*** are narrow, tortuous ravines cut by tributary streams. Here and there circular chambers called potholes have been cut by pebbles swirled by eddies at the base of waterfalls. The *Devil's Jug* in Coldwater Canyon is especially large and perfect. In places the ravine is so narrow that there is scarcely room for a person of ordinary width to go through—hence ***Fat Man's Misery.*** At times when but little water is flowing it seems inconceivable that these passages have been cut by running water. Immediately after a heavy shower, however, all doubts are removed. A tremendous volume of foaming muddy water rushes through the straight stretches, boils through narrows, cascades over falls, and swirls in the potholes below. The whole effect is so weird, so impressive, that the visitor never forgets the experience. The walls are covered with lichens, moss, ferns, small trees, and shrubs. The light is subdued since vertical walls and overhanging foliage combine to shut out the sunlight.

Only a few features of the main gorge need be described. Most of us prefer to give our imagination full sway and to apply names of our own selection to the fantastic forms observed. The *Jaws* is a constriction of the channel by more resistant rock. At the *Navy Yard* we see the rounded sterns of boats jutting out from their anchorage. *The Narrows* just below Artist's Glen is but 52 feet wide. This was spanned in 1848 by the first bridge across the Wisconsin in this part of the state. The Narrows is due to the fact that the river is flowing in a channel which is newer than the rest of the gorge. The river formerly turned west just below the mouth of Coldwater Canyon and returned to the present channel about three-fourths of a mile down stream. *Stand Rock* is an isolated column of sandstone about 45 feet high and 6 or 8 feet in diameter, capped by a more resistant layer about 20 feet in diameter. Frost, rain, heat, cold and the wedging action of roots, have played their parts, but the chief cause is the sand blast which has worn away the softer parts of the sandstone and left this column isolated from the adjacent cliff. Such forms are common in sandstone throughout the Driftless Area. The Camp Douglas Mounds are a large scale illustration of the same principle of wind and sand erosion of soft rocks.

Returning to Kilbourn we cross the river and go south to Baraboo. At Delton we cross the post-glacial gorge of Dell Creek. Here a side trip can be taken to see *Mirror Lake Gorge*—a small sandstone gorge like the Dells—and *Mirror Lake,* which some think even more beautiful than the Dells. After leaving Dell Creek valley our route is on an outwash plain sloping gently westward from the Wisconsin Terminal Moraine, a range of hills one-fourth to three-fourths of a mile to the east.

To the south of us is the Baraboo Quartzite Range, which consists of two ridges extending east and west for about 25 miles. The South Range, commonly known as the Baraboo Bluffs, is 1 to 5 miles wide and rises 300 to 800 feet above its surroundings. The narrower, discontinuous North Range is 100 to 560 feet in height. The ridges are joined at the ends, thus forming a canoe shaped basin through which the Baraboo River flows.

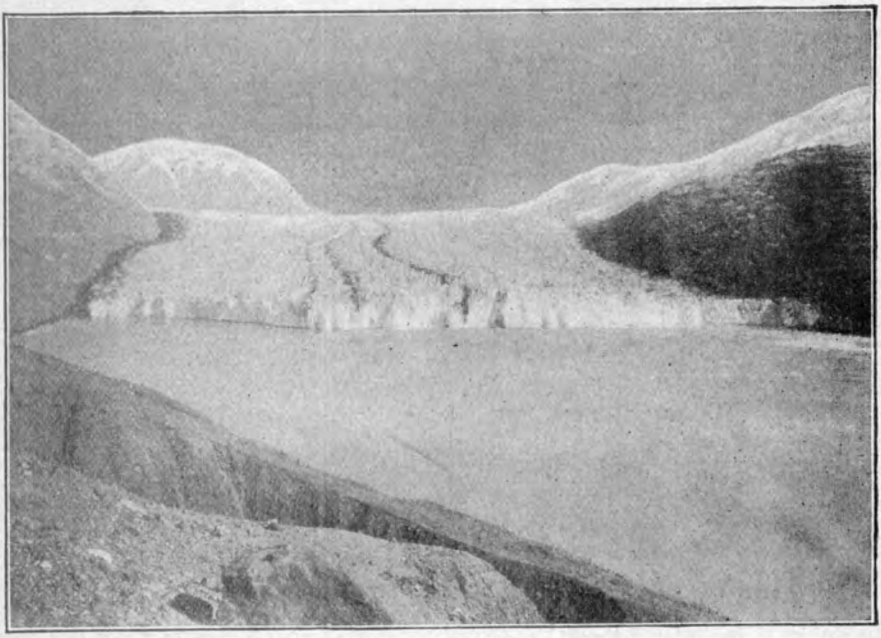
Before glacial time the Wisconsin River (fig. 4) flowed southward through the North Range at Lower Narrows on a valley bottom 200 feet below the present Baraboo River, then west and south through the Devils Lake gap, around the end of the Devil's Nose, and southward toward Prairie du Sac. The gorge through the South Range was much deeper and more impressive than the present gorge below Niagara Falls. The volume of water was somewhat less but the gorge was over three times as deep since the bottom of the gorge was about 500 feet below the present lake level. Huge blocks of quartzite in the talus slopes extended down to the river. There was no lake, no level place where the cottages and hotel stand. During the glacial period this gorge was blocked by a tongue of ice east of Kirks. Another tongue north of the range advanced into the Baraboo Valley (fig. 4) blocking the north end of the gorge with a lobe of ice similar to the one in the south end. These ice lobes ended in sheer ice cliffs probably one or two hundred feet in height. Between them was a glacial lake dotted with icebergs and standing at a level about 180 feet higher than the present lake. To the west of the ice in the Baraboo Valley and far to the northward was Glacial Lake Wisconsin (fig. 5).

As the rock and soil laden ice melted it left near the glacier front great deposits of sand, gravel, clay and bowlders—a typical terminal moraine. The streams flowing away from the ice built an outwash plain of sand and gravel and carried the finer material out into the glacial lakes.

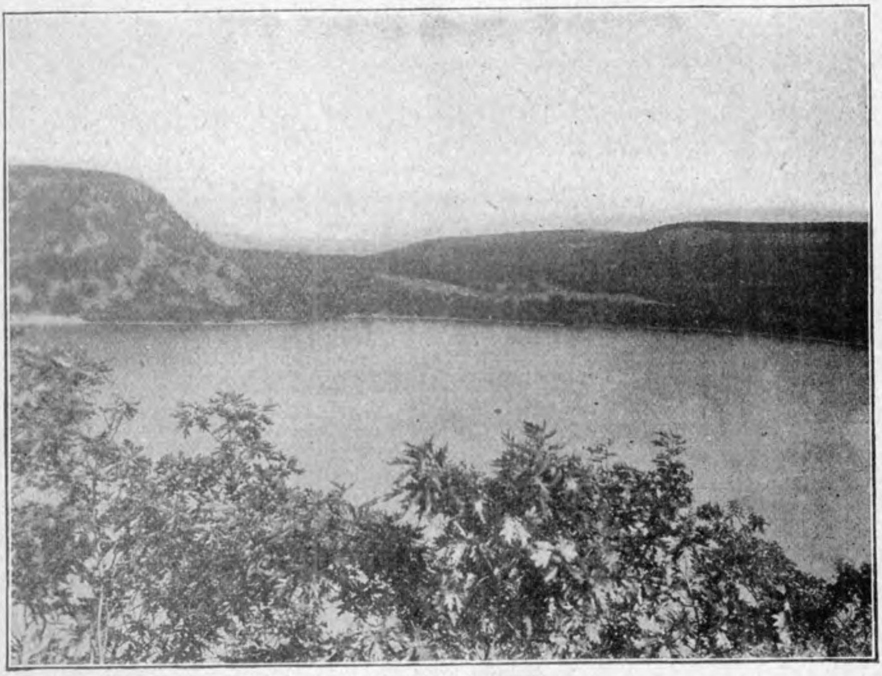
We are now ready to resume our journey to Devils Lake. Leaving the outwash plain we cross the terminal moraine to the ground moraine in Baraboo. Going south toward Devils Lake we are again in terminal moraine topography until we reach the flat outwash plain at the north end of the lake.

The Devil's Lake of today lies in a depression with river cut talus covered walls of quartzite on the east and west sides and morainic dams at the north and south ends. Owing to the extensive filling the present lake has a maximum depth of but 43 feet. The lake has no visible outlet but drains slowly by percolation through the morainic dam at the south end.

Following the trail we leave the north end of the lake and climb to the top of the East Bluff. Some 500 feet below us lies the lake, "a gem of true mountain scenery, such as cannot be seen elsewhere east of the Rockies." In the immediate foreground are fantastic forms like the Devil's Doorway wrought in the purplish quartzite by the falling away of angular blocks which once surrounded it. Below is the talus slope giving mute testimony to the time that has elapsed since Nature began tumbling down the giant blocks of quartzite from the cliffs to build these gigantic slides. Across the lake are the mingled colors of quartzite and pine. To the south and north we trace the moraine with its roughly undulating hardwood hills. With some search near the top of the East Bluff we may find stream-eroded potholes in the quartzite, indicating that the ancestral Wisconsin once flowed at this level. In imagination we can see the pre-glacial Wisconsin about 1,000 feet below us, can look to the southeast where it rounds the Devil's Nose and begins its long journey to the Mississippi. Or we can see glacial Devils Lake standing at a level 180 feet higher than today with magnificent glaciers at both ends.



As Devils Lake appeared in glacial times.



Devils Lake today.

A day is far too short a time in which to see all the striking features of this region. Parfrey's and Durward's glens, east of Devils Lake, carry us back to very early geological history when ravines were cut in the quartzite. At a later date Cambrian conglomerate and sandstone filled the ravines. Still later in time, streams cut most interesting gorges in the sandstone and conglomerate. Other interesting natural features are the Upper Narrows at Ableman; Pine Hollow, Pewits' Nest, the post-glacial gorge of Skillet Creek southwest of Baraboo; the Natural Bridge in the sandstone two miles north and a little west of Denzer; Fox Glen near the east end of the North Range, and numerous other gorges.

Returning to Baraboo we drive east to the Lower Narrows, where the Baraboo River escapes northward through a great gorge, cut in pre-glacial days by the southward-flowing Wisconsin River. The walls of this gorge rise over 500 feet above the Baraboo River. Going north through the gorge we turn east across the river, skirt the North Range for about five miles, recross the Baraboo, and drive over the broad flood plain of the Baraboo and Wisconsin, and across the Wisconsin River bridge to Portage, the end of our trip.

### Wisconsin River and the Military Ridge

Going northwesterly from Madison on T. H. 12 we travel through a glaciated area (p. 10) in which we see no castellated mounds such as characterize the Camp Douglas country. We do see numerous lakes and swampy areas so common in regions covered by the last ice sheet. Just east of Sauk City we cross the terminal moraine (page 17) which marks the eastern border of the Driftless Area.

Crossing the Wisconsin River at Sauk City we follow T. H. 60 westward to Prairie du Chien on the north side of the Wisconsin River. In some places the road runs along the river bank at the very base of high bluffs capped by limestone. In other places the road swings several miles away from the bluffs and traverses the level river plain. We are following a very ancient valley, a trench from 2 to 5 miles in width and from four to five hundred feet below the level of the upland on either side.

This trench was gradually cut down by age-long erosion of the ancestral Wisconsin River. Well records indicate that the rock bottom of this trench lies at least two hundred feet below the present valley bottom. Streams flowing away from the great ice front carried a tremendous load of sand and gravel which gradually filled the lower part of the trench. Later on the river carried away part of the fill and left a series of flat benches.

On the return trip we follow T. H. 19. Crossing the Wisconsin River at Bridgeport, we climb 500 feet, out of the Wisconsin trench, to the Military Ridge near Patch Grove. Proceeding eastward, we are impressed with the fact that we are on top of our local world. To the north is a short steep slope to the Wisconsin River. To the south is a long gentle slope drained by tributaries of the Rock and Mississippi.

The road follows the divide so closely that no streams of importance are crossed in sixty miles.

East of Barneveld we pass Blue Mounds. West Blue Mound which has a height of 1,716 feet above sea level and about 400 feet above the surrounding upland is the highest point in southern Wisconsin. Blue Mounds are isolated outliers of the Niagara limestone escarpment (p. 6) which is 69 miles to the east in Wisconsin, and from 45 to 55 to the south and west in Illinois and Iowa. Similar mounds are the Platte mounds near Platteville, and Sinsinawa mound near Dubuque. The existence of these outlying mounds shows that the Niagara limestone was formerly far more extensive. Like the sandstone mounds near Camp Douglas, Blue Mounds are small remnants left in the gradual wearing away of a rock formation.

As we near Verona we cross a line of hummocky hills, which look quite different from the hills seen to the west. By the roadside there are bowlders of granite, trap and other rocks entirely different from the limestone and sandstone rocks in the ledge nearby. These are foreigners brought in by the ice sheet. We have left the Driftless Area and are back in the drift-covered lake country.

### Camp Douglas

In the country between Kilbourn and Humbird the citizens of Wisconsin may see scenery typical of the Great Plains in Montana or the Dakotas. The railroad map shows that the railroads run in nearly straight lines. This indicates that this is an unusually flat plain. To the southwest is the irregular bluff line which marks the edge or escarpment of the Western Upland. Rising abruptly from the plain are steep sided, isolated rocky castle-like hills and crags. At one time the Western Upland extended far to the east, but it has been driven back by the long continued attacks of weather, wind and streams. The isolated mounds, which in the West would be called buttes if small and mesas if large, are outliers left during the retreat. The plain was made in part by the wearing down of soft horizontal sandstones and shales, in part by the deposition of sand and clay by wind and waters.

The preservation of the mounds is due to a capping of somewhat harder sandstone. Wind work and weathering tend to wear away the softer sides, until the weight of the overhanging capping causes it to fall. The mounds gradually decrease in size until the capping is all removed. Then the mound becomes a conical hill, gradually becoming lower and finally blends with the plain.

The wind- and water-carved features of these mounds are far too fragile to stand the grinding of glacial ice. They owe their existence to the fact that this region lies in the Driftless Area (p. 12).

From one of the mounds near Camp Douglas we can see mounds illustrating all stages in the process of destruction. Near the escarpment, as at Camp Douglas, mounds are very numerous, farther away

**there are only isolated mounds.** (Fig. 6.) The mounds near us rise to heights of 100 to 220 feet above the plain. As far as the eye can reach to the north and east, the plain stretches away—monotonously level broken only by castellated mounds. Part of this plain was once covered by the waters of Glacial Lake Wisconsin (p. 17).

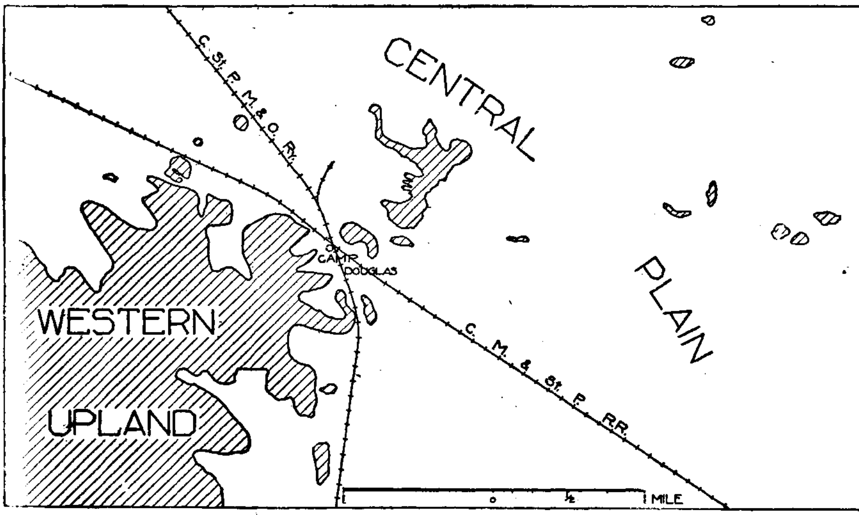



Fig. 6.—Relation of sandstone mounds to the upland.

Roche 'a Cris and Friendship near Friendship; Bruce Mound near Merrillan, the Humbird Mounds, Saddle Mound near Pray, Castle Mound near Black River Falls, these and numerous others are remnants of the great formation which once covered this area. For countless ages, the wind and water have been at work subdividing broad mesas into buttes and wearing the buttes down to a flat plain.

### Milwaukee—Oconomowoc—Mayville—Holy Hill

About 18 miles west of Milwaukee on T. H. 19 we enter the Oconomowoc Lake region, justly famed as a summer resort. Some 30,000 years ago, two lobes (Fig. 7) of the great ice sheet met along a line trending northeast from Richmond (south of Whitewater) through the Oconomowoc Lake country to Kewaunee county. As the ice melted away, there was formed between these lobes the Kettle Moraine of eastern Wisconsin. The kettles ranging in size from small depressions a few rods in diameter to great hollows from 100 to 200 feet in depth are due to the melting of buried ice blocks. In some of these kettles lie the Oconomowoc Lakes surrounded by country of great variety—parallel steep sided gravel ridges, conical hills and flat outwash plains. Pewaukee Lake, an exception to the rule, lies in a preglacial valley blocked on the west and east by drift.

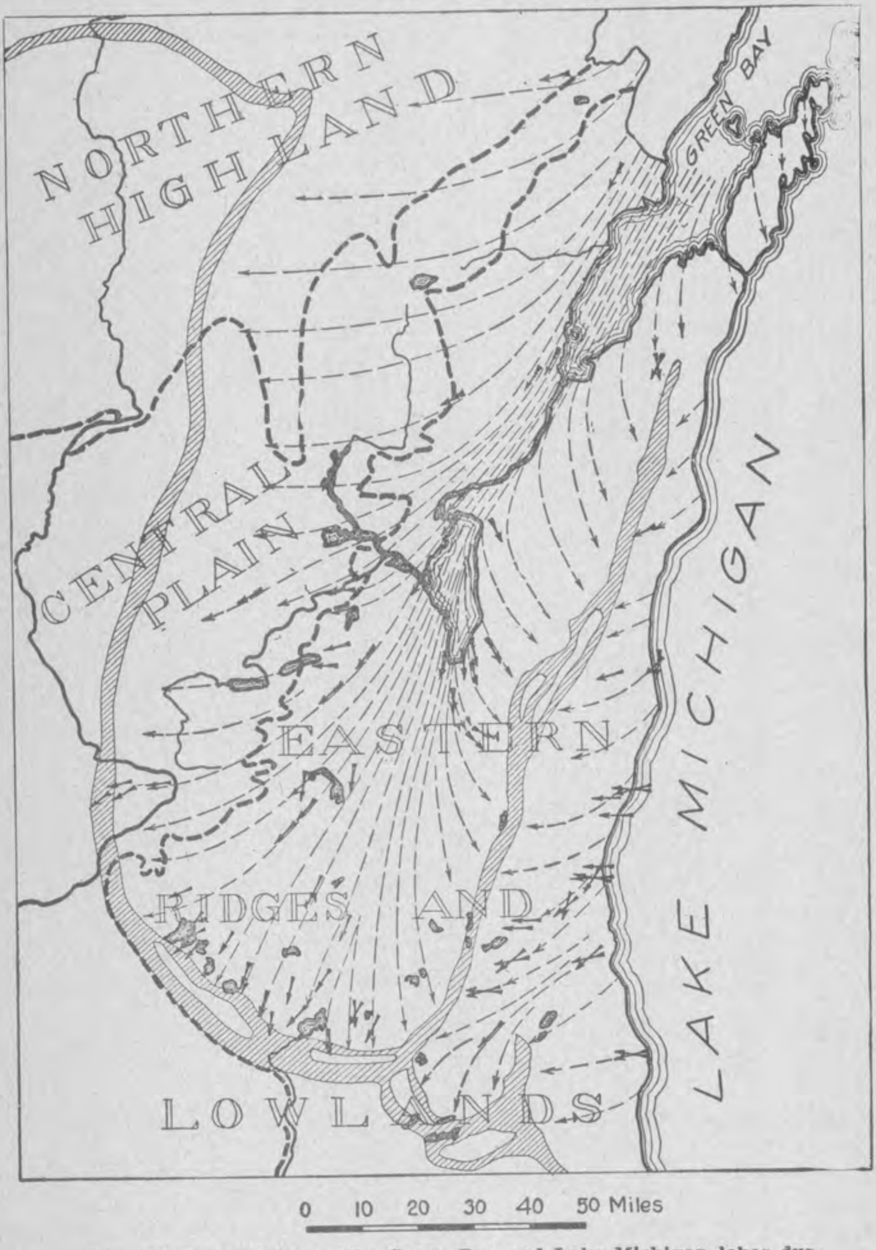



Fig. 7.—The position of the Green Bay and Lake Michigan lobes during the last glacial period.

The gravel pits near Okauchee are representative of a great industry made possible by the work of glacial ice which picked up and crushed rock and transported it to places where streams from the melting ice built up great deposits of sand and gravel. To the glacier we are indebted for the cheap supplies of widely distributed sand and gravel so extensively used for gravel and concrete road construction.

Going north from Oconomowoc on T. H. 67 we soon leave the moraine country behind. In the vicinity of Ashippun we enter a gently undulating plain known as ground moraine. Here we see numerous long oval hills called *drumlins.* These hills are characteristic of the ground moraine east and northeast of Madison, which is one of three well known drumlin areas in this country, the others being in eastern Massachusetts and northwestern New York.

Near Neosho are long narrow winding gravel ridges called *eskers.* These gravel ridges were deposited by streams flowing beneath the ice.

The iron mine at Iron Ridge is located at the foot of the Niagara escarpment (p. 6). At Mayville we turn east to Theresa, thence south on 15 and 83. South of Hartford shortly after reentering the Kettle Moraine country, we turn to the east on County Trunk P toward Holy Hill, the highest point in the Kettle Moraine. On its summit we are 1,361 feet above sea level, nearly 400 feet above Hartford and about 360 feet above the valley to the east. From this vantage point we have a comprehensive view of the Kettle Moraine, that great complex of ridges, knobs, kettles and plains left by melting ice.

### Fountain City, Alma—Independence—Arcadia

It is impossible to outline a short trip which will give a comprehensive view of the Western Upland which has very fittingly been called the Wisconsin Berkshires. In the trip outlined we see only a small part of the Western Upland, and a short section of the Mississippi River gorge, which has a length in Wisconsin greater than the distance from London to Liverpool. The gorge furnishes the most rugged topography and picturesque scenery to be seen in the state, in fact one authority has characterized this the rival of the Rhine gorge in beauty and its superior in size. The crags, battlements and towers carved from sandstone and limestone by wind and water are not inferior to the ruined castles along the Rhine. The vineyards on the terraced slope, the houses clinging to the side of the bluff, the forest-clad northern slopes, the grassy southerly exposures each recall pictures from the Rhine.

Lake Pepin nearly 22 miles long and from 1 to 2½ miles wide, caused by the damming back of the Mississippi by the delta of the Chippewa; Lake St. Croix, a similar long, narrow portion of the St. Croix blocked by the Mississippi; Trempealeau Mountain; these and numerous other points of interest must be left for future trips.

Going north from Fountain City to Alma the highway for the most part is on a sand and gravel bench 20 to 30 feet above the river. Well records show that this gravel and sand is 75 to 80 feet in thickness near the bluff at Fountain City and 103 feet near Alma. Near here we can find gravel deposited by the river in glacial times to a height of 80 feet above the river. The geologist tells us that before the time of the great glaciers the gorge was from 100 to 200 feet deeper than at present. The Chippewa, Black, St. Croix, Wisconsin and other streams flowing away from the ice sheet carried such an enormous load of sand and gravel from the glaciers that their valleys, and that of the Mississippi, were partially filled. Later when all the streams were carrying a smaller load, they cut down their channels and by swinging back and forth in the gorge, removed a great deal of the sand and gravel, and formed relatively level benches or terraces.

In some places our route is near the base of the bluffs and the road is cut in loose material which has fallen and slid down the bluff; in others where the river is close to the bluff the road is a notch cut in sandstone or shale ledge; in other places the road swings a mile or so away from the bluff. The bluff rises about 500 feet above the river, usually with a nearly vertical upper cliff formed by limestone and a steep bowlder-strewn slope below, due to less resistant sandstone and shale. As we cross the bowlder-strewn stream valleys we realize that at times these mountain torrents have terrific force, and are able to move bowlders weighing several tons.

North of Alma we turn up the Buffalo River valley on T. H. 37. The glacial filling in the Mississippi gorge blocked the Buffalo, causing it to fill its valley with sand and silt. As the channel of the Mississippi was partially cleared out the Buffalo was able to remove part of its valley fill, leaving fragments of the old flood plain as benches along the valley. Leaving the Buffalo River we drive up Elk Creek valley on County Trunk B. Near the east line of Buffalo County we cross the divide between Elk Creek and Little Elk Creek, a tributary of the Trempealeau. To the south is the forest-covered steep slope of the Magnesian limestone. To the north only the higher hills and ridges are capped by limestone. As we descend some 450 feet to Independence, we shall see the greenish shaly Franconia sandstone (p. 4), then the more massive cliff-forming Dresbach sandstone. Between Independence and Arcadia, there are several cuts and pits in the underlying Eau Claire shale. This region is characteristic of the Driftless Cambrian sandstone country between Kilbourn and Eau Claire.

Going west from Arcadia on T. H. 53, we pass through higher and higher rock formations until we reach the summit of a long ridge capped by Lower Magnesian limestone. As we follow this ridge to Fountain City we see on all sides the work of running water. The Lower Magnesian limestone was once a continuous formation extending far to the east. Streams have cut this up into a maze of ridges and valleys, with some ridges still retaining a capping of limestone. This region is similar to that part of the Western Upland between the La Crosse and Chippewa Rivers.

### St. Croix Dells

The route of this excursion is as follows: T. H. 48 Rice Lake to Luck, T. H. 35 Luck to St. Croix Falls, T. H. 35 and 14 to Cameron, T. H. 11 to Rice Lake.

Rice Lake lies in a very level plain. Well records show that this is an outwash plain built by streams from a great ice sheet. Beneath the sand and gravel deposited by the ice-fed streams, there is sandstone. Before glacial times the country from here west nearly to Luck and southeast to Merrillan resembled the Camp Douglas country of today (p. 23).

To the east and northeast of Rice Lake are the Barron Hills, a rolling upland rising near Meteor to a height of over 600 feet above the plain at Rice Lake.

Westward from near Cumberland lakes are numerous. This area was covered by the Wisconsin ice sheet (p. 17). When the ice melted away there was left in some places level outwash plains dotted with steep-banked lakes lying in kettles formed by melting ice blocks, all similar in general features to the plain south of Luck. In other places the ice left very irregular ranges of hills with deep kettles, like the terminal moraine east of St. Croix Falls. While the general topography is much alike in any part of glaciated Wisconsin, the infinite variety of forms assumed make each new district interesting.

The St. Croix Dells is a steep-sided narrow gorge cut 200 feet deep in the Keweenawan lava flows. Like the Wisconsin Dells the gorge has been cut by the river since the continental ice sheet melted away. The vertical walls, the isolated crags, and even the direction of the river are due to the vertical joints in the lava flows.

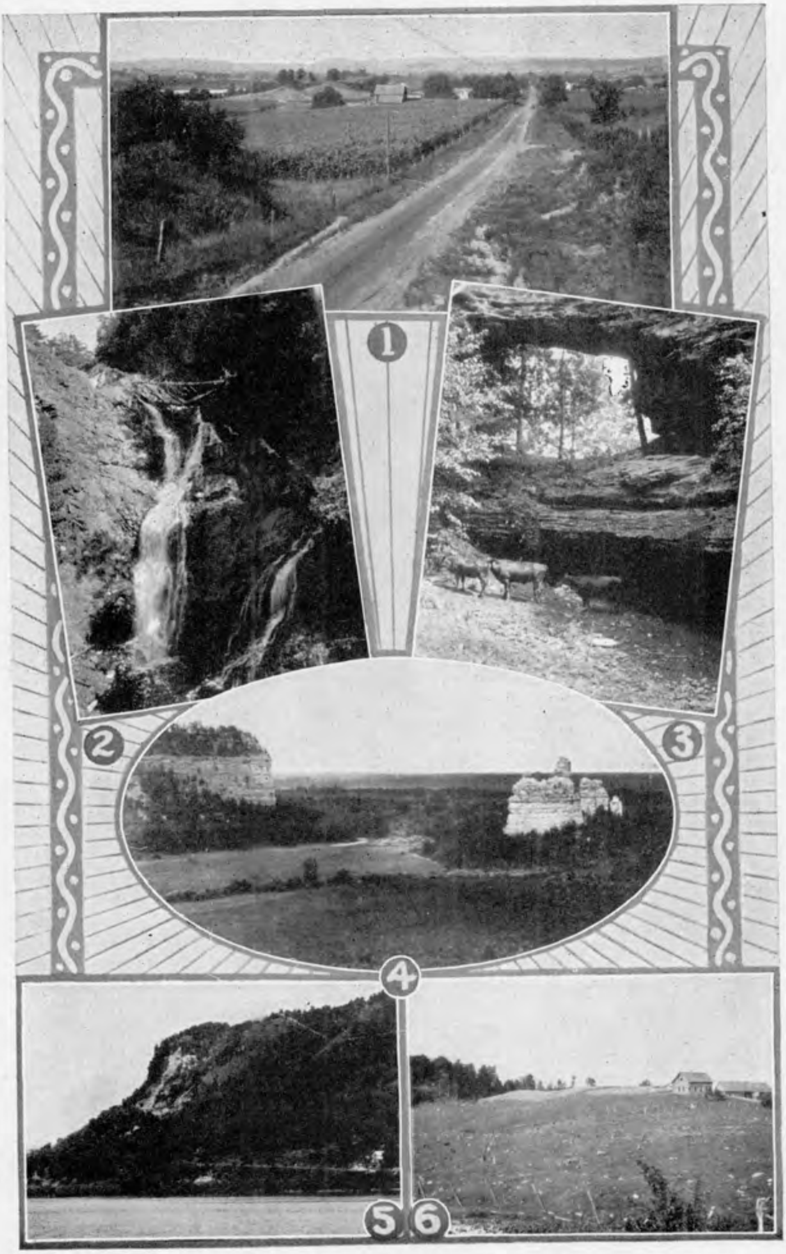
One of the most remarkable features is the pot-holes, roughly circular bowls cut in the trap by rolling stones kept in motion by the swirling water of eddies. These range in size from shallow holes but a few inches in diameter to gigantic wells 5 to 25 feet in diameter and as deep as 80 feet. The walls are worn smooth, but are somewhat uneven due to unequal hardness of the rock. The existence of these pot-holes at all elevations from the river level up to 100 feet above the river is sufficient evidence to convince the visitor that this gorge was cut by running water.

It is fortunate that a tract of 580 acres in Wisconsin and 150 acres in Minnesota has been purchased and set aside as the Interstate Park, thus giving the public access to this interesting and beautiful gorge.

### Manitou Falls—Brule River

Starting from Superior our route is:—south on Trunk Highway 35 to Manitou Falls, the highest waterfall in the state; thence easterly on county trunk B to Winneboujou; north in the Brule Valley to T. H. 13, which we shall follow to Superior.

The city of Superior is built on a red clay plain bordering Lake Superior in a belt from a few miles to 20 miles in width, extending eastward beyond Ashland. This plain was formed by the deposition of



1. Broad Valley in Western Upland between Sparta and La Crosse.
2. Manitou Falls, Black River, near Superior.
3. Natural Bridge near Denzer, Sauk County.
4. Sandstone Castle Mounds near Camp Douglas.
5. Limestone capped Sandstone Bluffs near Alma.
6. Boulder strewn Terminal Moraine at Glidden.

mud in glacial lakes that were held in between the front of the great continental ice sheet and the highlands to the south, west and north. The lake clay and beach deposits show that at one time the surface of this lake stood about 450 feet above the present level of Lake Superior. The outlet was southward past Solon Springs to the St. Croix River. Since glacial times the clay plain has been cut into by streams, so that many parts are very hilly. The streams now flow in ravines from a few feet to over a hundred feet in depth.

Southward from Superior there is a gradual rise of about seven feet per mile in the first nine miles. From there on to the road corner near Manitou Falls the grade rapidly becomes steeper. At Manitou Falls the Black River drops over the steep northern slope of the Douglas Range in a fall of 160 feet in a horizontal distance of not more than 150 feet. At the falls the gorge walls are of trap. Below the falls, the river flows for about a mile in a narrow canyon with sandstone walls rising from 100 to 170 feet above the river. Below the sandstone gorge the valley is somewhat wider, and is bordered by clay banks from 60 to 100 feet in height. The water-fall and gorge indicate that after the continental ice sheet withdrew the Black River cascaded down a slope much like the one now occupied by the highway. This stream soon cut a channel through the loose sand, gravel and clay. There was a waterfall near the north end of the present sandstone canyon. This waterfall gradually worked back into the sandstone and finally into the trap, producing the gorge and falls of today.

The Upper Falls is a little over a mile in a straight line, about a mile and a half by the river, from Manitou Falls. At Upper Falls there is a perpendicular fall of 31 feet over trap ledge.

Driving east from Manitou Falls we have a splendid view. Near us is the steep north slope of the Douglas Trap Range; in the distance the Duluth bluffs; between these and below us is the clay plain. Our route eastward is over a broad upland south of the Douglas Trap Range. The ground is so level that extensive swamps exist.

At Winneboujou we enter Brule River valley, which was at one time occupied by a long narrow bay of a glacial lake. This lake drained southward through a channel connecting the headwaters of the Brule and St. Croix (Fig. 8). We follow the river northward, cross the Douglas Trap range about four miles north of Brule village and descend to the red clay plain. As we travel across this plain toward Superior and cross the numerous valleys, we appreciate how streams may so change a plain that it becomes a series of ridges and valleys.

### The Bayfield Peninsula

The visitor who wishes to see shore features had best travel by boat. In this way he can see the cliffs, bars and beaches. The cliffs of red sandstone range from a few feet to 60 feet in height. Waves have carved innumerable caves, arches and pillars in the sandstone producing remarkably interesting architectural effects. Along much of the shore the waves are cutting cliffs in sand, clay, gravel and bowlders.

The material worn from the cliffs is carried along shore to form beaches and bars.

The auto trip permits some views of shore forms, but is concerned largely with the general features of the Bayfield peninsula. Going northward from Ashland, we skirt the shore of Chequamegon Bay. To the west the land rises rapidly to heights of 150 to 650 feet above the bay within the first mile.

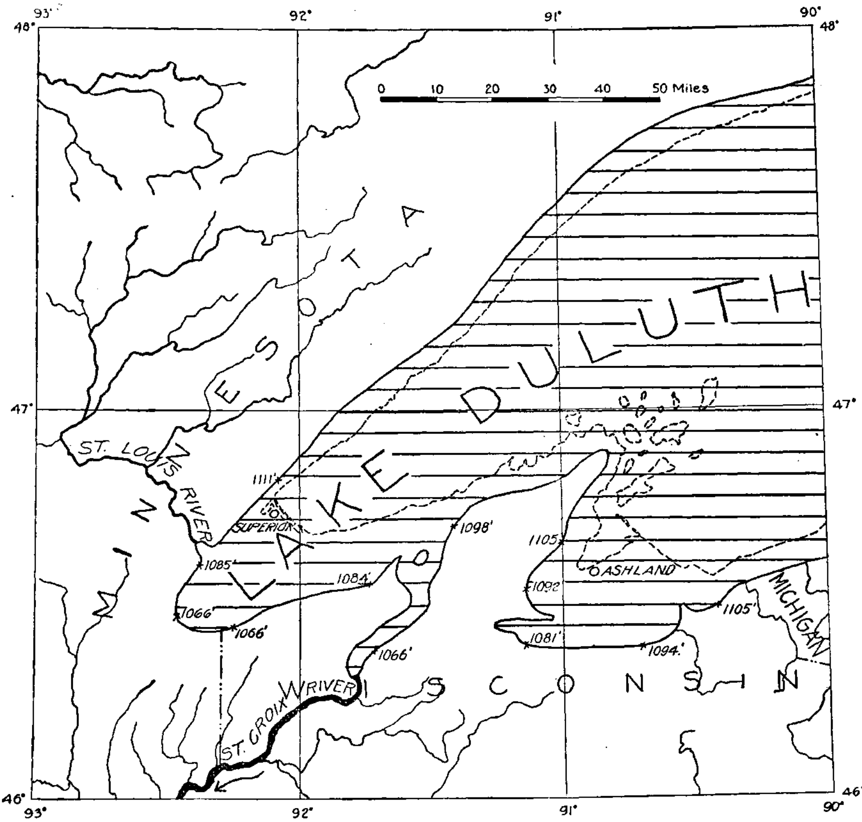



Fig. 8.—General outlines of glacial Lake Duluth.

At Red Cliff the route swings westerly across the peninsula to Cornucopia. Away from the lake no sandstone ledge is seen. The ridges and knobs are of drift deposited by the great ice sheet. The geologist tells us that in glacial times two lobes of ice were formed, one moving southwesterly, the other moving southward on the eastern side of Bayfield peninsula. As the ice melted away the "kettle moraine" was formed between the two lobes. This is a region having an exceedingly irregular surface with knobs, ridges, and kettles from 50 to 150 feet deep. Here the surface rises to a height of about 700 feet above the lake, and the drift is probably 600 feet in depth. This area is a part of the "barrens." The soil is so sandy that water sinks rapidly into the ground. There are no streams, but there are numerous kettle lakes. Our route lies to the north of the kettle moraine, but we shall cross it later east of Iron River.

From Cornucopia to Port Wing our route roughly parallels the lake, crossing numerous stream valleys deeply cut in glacial drift, with falls over sandstone ledge near the lake.

South from Port Wing we are in the great clay plain (p. 28). At Iron River we turn east on Trunk Highway 10 and enter the "barrens." Here we cross no bridges or culverts. The road winds through a maze of ridges, knobs and kettles. The sandy character of the soil is indicated by the vegetation, jack pine and scrub oak, and by the sparse population.

Near Ino we see the heavy clay soil characteristic of the glacial lake plain around Ashland.

### Wausau to Tomahawk

Just as the stump-covered field enables us to picture the forest that has long since disappeared, so by study of the old worn-down stumps of mountains, the geologist is able to picture the mountains that once covered all of Wisconsin (p. 8). During countless ages these mountains were gradually worn down to a plain. In a few places a harder ridge or peak, called monadnock from Mt. Monadnock in New Hampshire, still rises considerably higher than the general level of the plain. Rib Hill, the highest point in the State, is such a monadnock, rising to a height of 1,940 feet above the sea and nearly 800 feet above the Wisconsin River. Mosinee Hills and Hardwood Hill, Flambeau Ridge and Barron Hills near Ladysmith, McCaslin and Thunder Mountains northwest of Marinette, the Baraboo Range, and the Penokee Range near Mellen and Hurley are all monadnocks. Rib Hill is between 550 and 650 feet higher than the surrounding plain, and serves as a landmark for miles in every direction.

Following T. H. 92 north from Merrill we see a very interesting section of the Wisconsin River. At Grandfather Rapids the river drops ninety feet in a distance of 1½ miles. Here as at other shorter rapids the river is flowing on a granite bed between granite walls. Rapids of this sort are common in all of Wisconsin covered by the ice sheet. Streams were forced to leave their old courses as the ice advanced. When the ice melted away the rivers in many cases flowed in new courses where rapids and waterfalls were caused by barriers of rocks and glacial drift. The state has no coal but is fortunate in having "white coal", a natural resource that can not be used up.

At Tomahawk every autoist should visit the park where ridges, knobs and kettles retain the original stand of pine.

### Door Peninsula

Starting from Green Bay the route is northeasterly through Sturgeon Bay, Egg Harbor, Fish Creek, and Ephraim to Sister Bay, thence south through Baileys Harbor, Jacksonport and Sturgeon Bay to Algoma, and from there to Green Bay.

Green Bay like Superior, Ashland and Fond du Lac is located on a plain of red clay deposited in the waters of a glacial lake. With the exception of a narrow belt of shale along Green Bay in the southwestern part of the peninsula, the surface rock is the Niagara Limestone. This formation dips gently eastward and the western edge of these limestone beds forms an escarpment (p. 6). North of Sturgeon Bay this escarpment has been steepened to some extent by glacial ice erosion and later wave cutting, forming steep bluffs rising to heights of 100 to 240 feet above Green Bay. South of Sturgeon Bay the bluffs are not so high. At Red Banks northeast of Green Bay there is a 100-foot bluff in glacial drift and red lake clay. Some historians believe that Nicolet, the first white man to visit Wisconsin, landed here in 1634.

From the escarpment there is a gradual eastward slope to the eastern side of the peninsula. South of Sturgeon Bay the country is undulating to gently rolling; to the north is rougher and limestone outcrops are more numerous. The whole peninsula was covered by the continental ice sheet, but in many places the glacial drift is very thin.

The peninsula is broken by Sturgeon Bay. This gap probably represents a pre-glacial stream channel deepened by glacial erosion. Its eastern end is connected with Lake Michigan by a canal 1⅓ miles in length.

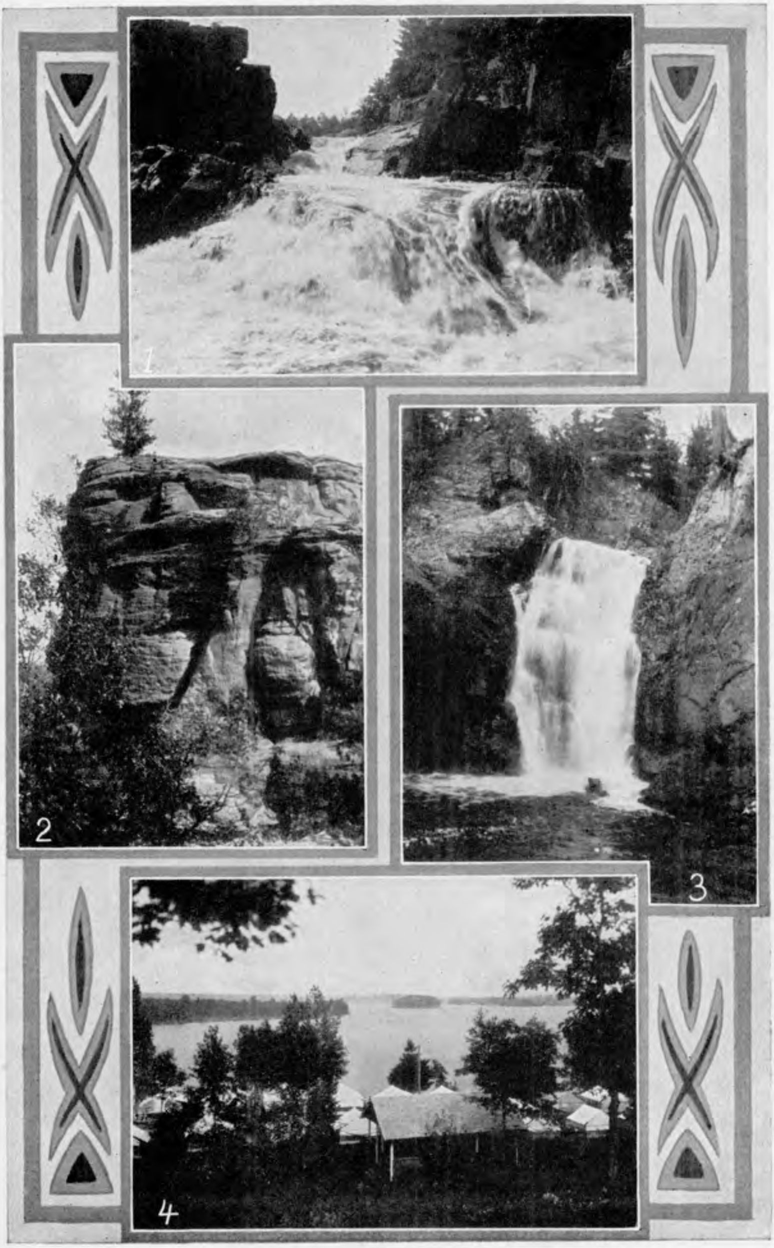
At Egg Harbor there is a bar of coarse gravel across the valley south of the town. This bar stands at an elevation of 51 feet above Green Bay and is a relic of the time when the waters of a glacial lake stood at this level. There are numerous bars of this sort around the shores of Door peninsula, but this is probably one of the most striking examples.

At Fish Creek we leave the trunk highway and drive to Ephraim through the Peninsula State Park. On the west coast bluffs of Niagara limestone rise 150 feet above the Bay. Eagle Bluff is 200 feet high. Abandoned glacial beaches may be seen near Fish Creek and Ephraim. Across Eagle Harbor from Ephraim a cave thirty feet above the present water level gives evidence of wave action in a glacial lake many thousands of years ago.

At the south end of the village of Baileys Harbor a glacial beach, 59 feet above the lake, passes northward into a line of overhanging rock cliffs. These ancient caves and projecting shelves of limestone are monuments to the work of waves in a glacial lake.

Kangaroo Lake, between Baileys Harbor and Jacksonport, has an interesting history. This was formerly a bay, across the mouth of which waves and currents have built a bar. Clark Lake and Europe Lake are of similar origin.

West of Casco we cross the kettle moraine of eastern Wisconsin, a drift deposit of great irregularity formed between the Green Bay and Michigan ice lobes (p. 24).



1. Pike River Falls at Amberg. Seen from Highway No. 57.
2. Wind Carved Face of a Sandstone Castle at Camp Douglas.
3. Tylers Fork where it falls over Ancient Lavas near Mellen.
4. Looking over Camp Winnepee at Catfish Lake near Eagle River.

## DRAINAGE OF WISCONSIN

### Rivers

The state is divided by a main watershed which determines that some of the streams shall flow into the Atlantic Ocean by way of Lake Superior or Lake Michigan, and that the remaining streams—the larger number—shall flow into the Gulf of Mexico by way of the Mississippi River.

The largest river, the Mississippi, forms the western border of the state from Prescott southward. Its chief tributaries are the St. Croix, Chippewa, Black and Wisconsin which unite with it in Wisconsin, and the Rock and several smaller streams which flow through Illinois to the Mississippi.

In the Lake Michigan system are the Menominee, Peshtigo, Oconto, Wolf-Fox, Sheboygan and Milwaukee rivers, together with numerous small streams.

The principal streams flowing into Lake Superior are the St. Louis, Nemadji, Bois, Brule, Bad and Montreal.

### Lakes

Wisconsin fronts on the waters of Lakes Superior and Michigan for over 500 miles. Within the state and outside the Western Upland, there are about three thousand lakes nearly all of which are within the area covered by the last ice sheet. Of these the largest is Lake Winnebago. If there had been no continental ice sheet, Wisconsin would be without lakes today. The lake basins were formed in three different ways. (1) Dams were thrown across pre-glacial valleys. (2) The melting of masses of ice buried by drift formed steep-sided depressions called kettles. (3) Some depressions are due to irregular deposition of drift. In the first class are the Madison lakes, Lake Geneva, Delavan Lake, Green Lake, Lake Winnebago and numerous other lakes formed by dams of glacial drift across valleys. Lakes St. Croix and Pepin are valley lakes dammed by deltas. All of the lakes in the Oconomowoc-Waukesha group except Pewaukee are kettle lakes. Big Cedar Lake in Washington county lies between ridges of glacial drift. The preservation of the basin was due to the burial and later melting of an ice mass. The origin of the lake basin is therefore a combination of the second and third types.

In all parts of the state except the Western Upland, there are numerous large and small marshes. These, in many cases, represent former lakes which have been obliterated by the cutting down of outlets, by the filling accomplished by waves and streams and by the growth of vegetation.

The lakes are of very great value to the state in that they furnish recreation to our own citizens as well as to thousands of visitors; they yield abundant fish and are a source of ice for a large number of people; they serve as reservoirs which prevent floods and furnish a more constant supply of water for power. The marl deposits in our lakes and swamps are just beginning to be appreciated as a source of agricultural lime. The marshes are valuable not only as homes of wild fowl, and as water reservoirs, but also as a source of hay, grass for matting, sphagnum moss, and cranberries. Many of these marshes have been drained, thus forming fertile farm land. In the future the vast peat deposits may be utilized as fuel.

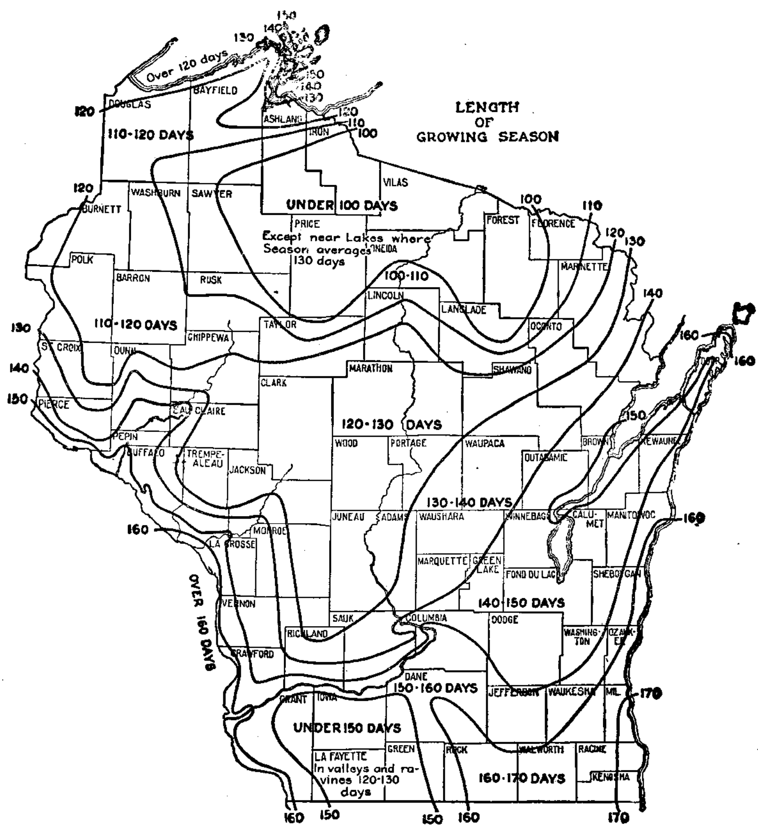



Fig. 9.—Length of growing season.

## CLIMATE

### Temperature

The southern part of the state is in the latitude of northern Spain, southern France and central Italy; the northern part is in the latitude of central France and Switzerland. The position of the state, 900 to 1,000 miles from the Atlantic Ocean and the Gulf of Mexico, results in its having very cold winters and rather hot summers. Wisconsin lies in the belt of prevailing westerly winds and has a variable climate characterized by the passage of a succession of cyclonic storms. The summer temperature of southern Wisconsin is similar to that of southern France, southern Germany or the Danube Valley; northern Wisconsin is about as warm as London or Berlin. The winter temperature is comparable to that of northern Sweden and central Russia. The extreme recorded range of temperature is from 54° below zero to

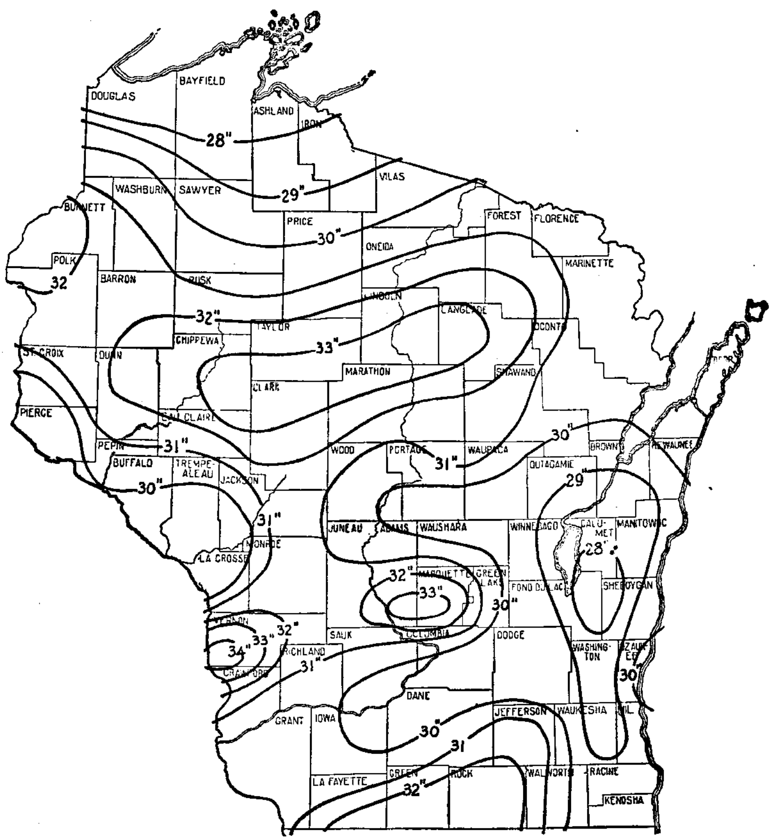



Fig. 10.—Mean annual precipitation.

111° above. Lake Superior and Michigan have a modifying influence upon temperature near their shores, the great absorbing capacity of the water retarding the approach of both winter and summer and equalizing the yearly temperature extremes. In relation to agriculture, the length of the growing season (Fig. 9) is probably the most important temperature condition. The average length of time from the last killing frost in the spring to the first killing frost in the fall ranges from 170 days in the southeastern part of the state to 75 days

**near the Michigan boundary.** The growing season **at Madison and** Beloit is as long as at Trenton, New Jersey, or the valley of Virginia; 75 days is shorter than the growing season at Rampart, Alaska, on the Yukon River near the Arctic Circle.

### Rainfall

The distribution of rainfall in Wisconsin is remarkably uniform. The mean annual precipitation is about 31 inches, ranging from 28 to

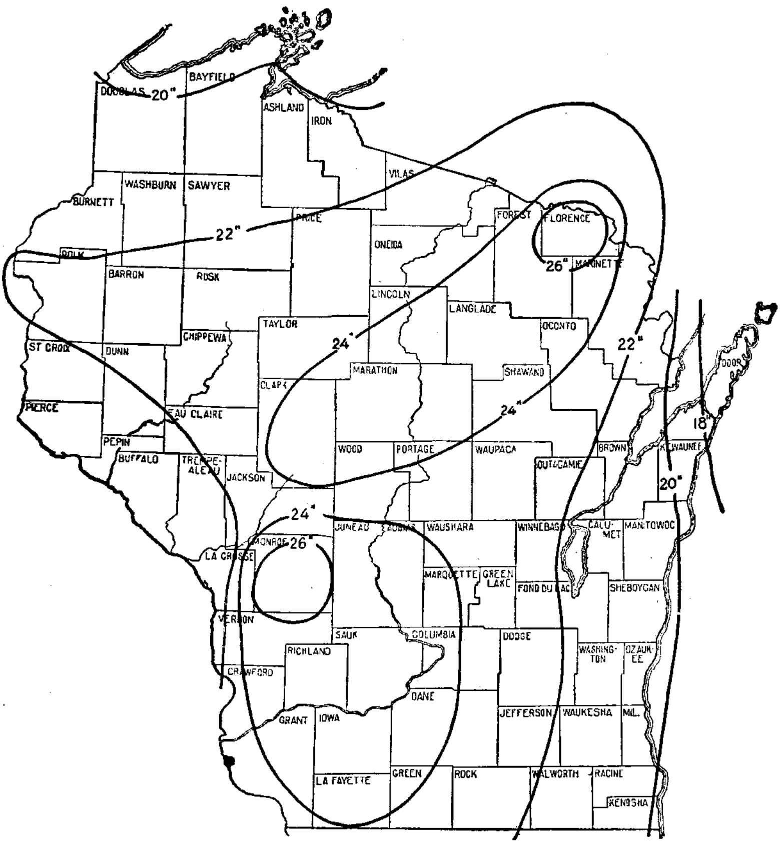



Fig. 11.—Mean warm season precipitation.

34 inches in various parts of the state (Fig. 10). This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany and Sweden, and is somewhat less than along the coast of Norway. Wisconsin is unusually fortunate in that most of the rainfall occurs just preceding and during the period of plant growth (Fig. 11). About half comes during May, June, July and August; nearly 70% from April to September, inclusive. **The small winter**

precipitation, mostly in the form of snow, causes virtually no leaching of fertility from the soil, or soil erosion. The average annual snowfall is 45 inches. Along Lake Michigan and in the northern part of the state the snowfall averages 53 inches; the central part of the state 36 inches; the southern part 40 inches.

### Sunshine

The sun shines in Wisconsin about half of the time possible. Owing to its northern latitude the summer days average 15 hours in length, thus the state receives more sunlight during the summer than do the states farther south.

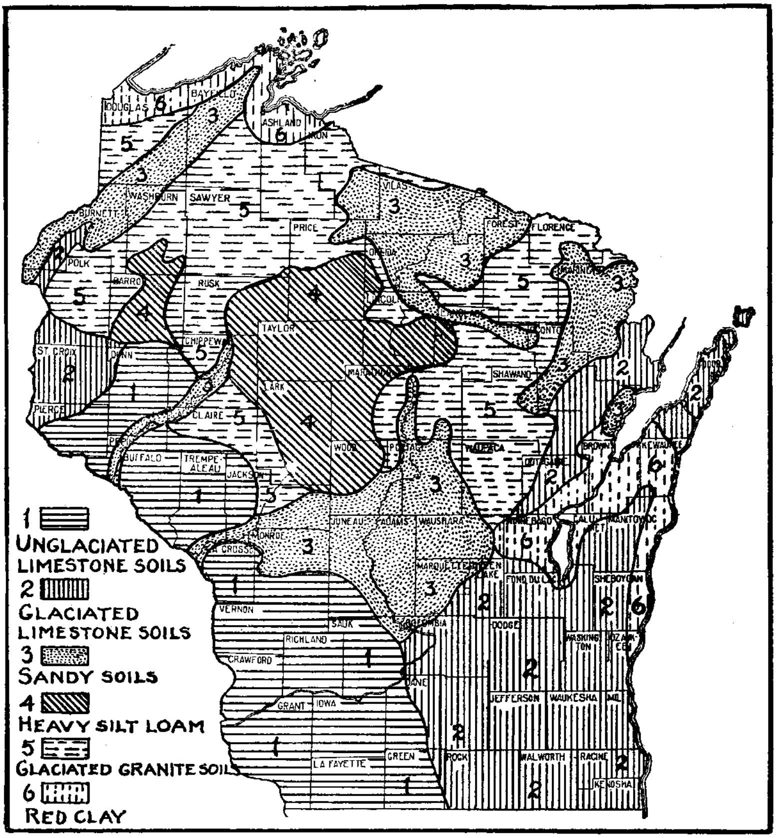



Fig. 12.—Soils of Wisconsin.

### Soil

The soils of Wisconsin are her greatest asset. The variations in soil and topography made possible an agriculture which does not have all its eggs in one basket.

Six general types of soil may be described (Fig. 12). Type 1 is the clay soil of the Driftless Western Upland, formed in part by the weathering of limestone, in part by wind-drifted silt, called loess. Type 2 is a mixture of the original soil with crushed rock largely limestone, and soil brought in by the glacier. Type 3 is sandy soil. In places this soil is due to the weathering of sandstone in place as in the Camp Douglas country. In other places the sand was deposited by glacial streams or by melting ice.

Type 4 is a silt loam with a heavy subsoil. This is glacial in origin.

Type 5, the glaciated granite soils vary greatly in character, some are heavy sandy loam, others are silt loam with well drained subsoil.

Type 6, is a heavy red clay deposited in glacial lakes (p. 29).

# GEOGRAPHY AND INDUSTRIES OF WISCONSIN

W. O. HOTCHKISS

"NONE of us liveth to himself" is a statement that is even more true of the citizens of Wisconsin today than it was when Paul wrote it to the Romans nearly two thousand years ago. Each one of us is dependent upon other people almost wholly for his prosperity and welfare, and other people prosper in proportion as each of us contributes his full share of effort to the common good.

A hundred years ago and less the average farm was conducted primarily to produce the things the farmer and his family needed to eat and wear. Little but what were considered luxuries was purchased, and relatively little was produced for sale. Nowadays the average farm is conducted as a *business*—with the idea of raising things to sell—and all the clothing and much of the food that the farmer and his family need is purchased from a merchant. Then the farmer actually produced his living. Few factories were needed, and little transportation of goods was necessary. Now the farmer runs a business and depends chiefly upon others for his actual *living*. As civilization advances we reach out farther and farther and learn to depend on more distant people. Our modern transportation methods—so cheap and fast compared to the wagons and sailboats of only 100 years ago—have served to increase greatly the number of people and the breadth of the area that contribute to the individual welfare of each of us.

So it is very evident that "none of us liveth to himself". We are so dependent on others that it is well worth while for us as citizens to know the quality of our state and its people, to know the various activities by which our fellow citizens make their livelihood and what they have in the way of property. It is also well for us to know of other states and countries and how their conditions compare with ours. The more each of us knows of such things the better are we prepared to fulfill our duties as citizens, and to recognize and further those public policies which are fairest to everybody and which best promote our common welfare in Wisconsin.

The study of the activities by which people make their livelihood is called economic geography and this is the subject before us for our consideration.

A given area of fertile soil will support a certain limited population if that population chooses to live by hunting. If the people have a sufficient degree of civilization and industry to manage herds and flocks this area will support a considerably greater population.

When they reach the stage where they cultivate the land and raise food crops, a still larger number can live on the products of this area. A vastly greater increase in the number can take place when the development of scientific knowledge makes possible the inventions of our time, those inventions that harness, for the benefit of all of us, our mineral resources and the forces of nature.

When men have developed that confidence in their fellow men, and the intellectual capacity, which permits them to pool their savings and their credit and join together in those large business enterprises that make possible the cheap production and distribution of the vast number of commodities that contribute so greatly to our present happiness they have reached the stage of development we find today in Wisconsin.

Still greater things are to be accomplished in the future if we develop greater capacity to cooperate with each other for our common welfare. The measure of our accomplishment will be the degree of capacity to cooperate intelligently, and that will depend on our knowledge of what we have and what we are, how much we know of what the other fellow has and what he is;, and as well, on the willingness of each one of us to "play the game" fairly and unselfishly, and contribute the best efforts of his labor, or of his service, or of his mind, to the welfare of all of us—to that great cooperative enterprise we sometimes call the *commonwealth.* In this connection it is well for us to recall the truth of Emerson's statement,—"one single idea may have greater weight than the labor of all the men, animals, and engines for a century."

Figures are not easy for most of us to grasp in these days when the census deals with millions and billions, so, in considering what the people of Wisconsin do for a livelihood, it is well to think of our 2,632,067 people, which the census reported in 1920, as made up of 1,000 communities with 2,632 people in each. Most of us can get a clear mental picture of a community of this size. Each community would have 1,115 people living on farms and 1,516 in the cities and villages. Those on the farms produce the food and raw material for clothing for all of the 2,632. Those in the city make the lumber and brick and other building material, and build the houses and factories; they make the steel and iron and other metals that we use; they grind the flour and make the agricultural machinery, the clothing, the tools and engines, the automobiles, the electric machinery, the rugs, print the newspapers, books and magazines; they operate the railroads and interurban lines that transport the goods that the 2,632 people of the community have to sell to other communities, and which they buy and bring in from the outside for their consumption and use. In the city group are also included the merchants who buy what the 2,632 have to sell, and what they need from other communities; and who sell to the 2,632 what they need and desire. The professional service group—doctors, nurses, lawyers, judges, clergymen and others who render service of that nature—are for the most part city dwellers.

No average community of 2,632 does all these things for itself. If it were obliged to do this we would do without many of the comforts and even of the things we count as necessities in these days. No Wisconsin farming community can produce the cotton or silk or warm climate fruits that we use so abundantly. Few of them produce the wheat or the wool that they need. Each of these 1,000 communities of 2,632 people is dependent for part of the fundamental necessities of food and clothing and shelter on the surplus produced by other communities not only in this state, and in other states, but in other countries as well. And each community produces a surplus of some commodities to supply the needs of others. So our average community does not exist. It is just a scheme to give us a mental picture of the occupations of the people of the state of Wisconsin. We get this community by dividing the state by 1,000 and from it we can get the state if we multiply the figures for this community by the same number.

If we pick this average community of 2,632 people out of the census figures for 1920 we will find that 1,637 are women, children and old people whose sole productive duties are concerned with working about the homes. Of these 1,637 there are 405 children in the common schools, 60 are in high school, 49 are in vocational schools either part or full time, 5 are in state or county normal schools training to be teachers, and about 10 are in the colleges and universities of this and other states, making a total of 529 who are securing an education.

The others—995 in number—are classed as "gainfulworkers," men, women and children over 10 years who work at jobs that bring them pay or profit. Of these 995 we find that 813 are males, and 182 are females. Of all men and boys over 10 years of age, 75.8% are gainfully occupied, and of women and girls over 10 years, 18.3% are likewise engaged.

Out of the 1,115 who live outside the city 308 are "gainful workers." These include those classed by the census as engaged in "*agriculture, forestry, and animal husbandry.*" The small proportion of those in other occupations is not separated and is here considered to belong in the city.

Of the 1,516 who live in the city 687 are classed as gainful workers. Thus we find that 49.5% of those who live in cities work for pay or profit, and 24.7% of those who live outside of cities are classed as "gainful workers" by the census. This smaller percentage of "gainful workers" among farm dwellers is due to two things. First, the census classifies the 271,900 people living in villages of less than 2,500 as rural, and second, that most country boys and girls work for the family and are not paid, while there is not work in the family occupation for the city young people and so more of them work at jobs for which they get pay. Consequently they get in the census as gainfully employed while their country cousins who work just as hard do not get counted in that class.

It is interesting to see how these 687 city workers in our community of 2,632 are employed. Nearly half of them—339—are engaged in *"manufacturing and mechanical industries."* These include those who operate the factories, garages, repair shops, blacksmith shops, building operations, clothing factories, and similar services that we need. These 339 make the plows and tractors, the lumber, the windmills, the washing machines, the automobiles, the boots and shoes, the clothing, the flour and other manufactured foods, the dressed meats, the furniture, build the houses and all the rest of the things our community needs, except what we bring in from outside.

The next largest group—91—are classified by the census as the *"trade"* group. These include the retailers and wholesalers, with their salesmen, clerks and deliverymen, the bankers, brokers, and real estate dealers and the laborers employed in all these occupations.

The third largest group—68—are in *"domestic and personal service."* These include the hotel and restaurant people, servants, janitors, barbers, laundrymen and laborers in these places of business.

The next two groups of the 687 gainful workers in the city of our community of 2,632 are the same in size—61 each. One group is engaged in *"transportation"* and includes railroad operatives, chauffeurs, draymen, motormen, longshoremen, telegraph and telephone operatives, and mail carriers. The other group is *"clerical"* and includes bookkeepers, clerks, stenographers and other office laborers.

The sixth largest group is engaged in *"professional service."* These people are our clergymen; our lawyers and judges; doctors, dentists, and nurses; engineers, school-teachers and professors; musicians, artists, and actors. They number 52 in our community of 2,632 people.

The seventh group includes those in *"public service."* These are our policemen, firemen and guards at our institutions and jails, public laborers, and our county, city, state and federal officers and inspectors. In our 2,632 people they do not quite make up a total of eleven.

The smallest group according to the census is engaged in *"mineral extraction."* This group of four operates the mines and quarries for our community.

The following table gives the 1920 census figures for occupations. From this the number of workers of the various groups named for each of the 1,000 communities have been taken by leaving off the last three figures—in other words, dividing by 1,000.

| | |
|---|---|
| **Population of Wisconsin** | 2,632,067 |
| Rural—Living outside incorporated villages and cities | 1,115,599 |
| Urban—Living in incorporated villages and cities | 1,516,468 |
| **Gainful Workers** | 995,401 |
| Farming, forestry, and animal husbandry | 308,038 |
| Manufacture and mechanical industries | 339,573 |
| Trade | 91,062 |
| Domestic and personal service | 68,332 |
| Transportation | 60,686 |
| Clerical | 60,910 |
| Professional service | 52,233 |
| Public service | 10,616 |
| Mineral extraction | 3,951 |

Now let us see what wealth the people of Wisconsin have. According to the "true value" figures of the Tax Commission for 1921 the total real and personal property assessed amounts to $4,587,636,860 of which $2,127,943,569 is in incorporated villages and cities, and $2,459,693,291 is outside—farm and timber property chiefly (with a very few industrial and power plants—that make no large percentage of the total.)

The tables following give, according to Tax Commission figures for 1921, the average of assessed property owned per capita by the rural and urban people of the state, and also the property taxes per capita. To give an idea of how these are divided the six highest and lowest counties in each group are given.

1921 PER CAPITA "TRUE VALUE" OF REAL AND PERSONAL PROPERTY ASSESSED

| RURAL | | URBAN | |
|---|---|---|---|
| **Six Largest** | | **Six Largest** | |
| County | True Value | County | True Value |
| Green | $4,008 | Marquette | $2,033 |
| Iowa | 3,999 | Dane | 1,998 |
| Lafayette | 3,949 | Milwaukee | 1,619 |
| Walworth | 3,705 | Polk | 1,601 |
| Dodge | 3,600 | Racine | 1,558 |
| Grant | 3,343 | Walworth | 1,555 |
| **Six Smallest** | | **Six Smallest** | |
| Shawano | 1,376 | Forest | 722 |
| Ashland | 1,322 | Sawyer | 718 |
| Price | 1,312 | Bayfield | 709 |
| Portage | 1,303 | Trempealeau | 678 |
| Oconto | 1,287 | Adams | 586 |
| Marinette | 1,082 | Vilas | 470 |

Average for all counties—Rural, $2,205; Urban, $1,403.
Average for state, $1,743.

The total public indebtedness of all units of government—state, counties, cities, villages and towns—in Wisconsin and for some other states in 1912 and 1922 is given for each person in the state, and in total in the table below. This sum is the total of bonds outstanding less the sinking funds in the treasury to pay them. These figures are from the United States census.

| | 1912 Per capita debt | 1922 Per capita debt | 1922 Total debt |
|---|---|---|---|
| New York | $116.59 | $158.15 | $2,426,305,000 |
| Minnesota | 32.26 | 109.99 | 282,932,000 |
| Michigan | 20.43 | 94.09 | 386,860,000 |
| Iowa | 15.94 | 62.23 | 158,311,000 |
| Illinois | 23.62 | 54.66 | 367,804,000 |
| Indiana | 24.21 | 51.21 | 166,754,000 |
| Wisconsin | **16.56** | **38.81** | 105,520,000 |

Only seven states in 1922 had a lower per capita public debt than Wisconsin. They were Alabama, Georgia, Kentucky, Missouri, New Hampshire, South Carolina and Vermont. Wisconsin's total per capita public debt is only 57% of the average of its neighboring states. This state far more than its neighbors, has been paying its public bills as it went along and has much less debt than they have to be paid off by future taxation.

1921 PER CAPITA TAXES PAID ON REAL ESTATE AND PERSONAL PROPERTY

| RURAL | | URBAN | |
|---|---|---|---|
| Six Largest | | Six Largest | |
| County | Amount | County | Amount |
| Florence | $69.92 | Wood | $49.81 |
| Oneida | 60.91 | Oneida | 48.33 |
| Forest | 59.93 | Polk | 47.68 |
| Iron | 57.45 | Dane | 46.13 |
| Vilas | 55.47 | Burnett | 45.95 |
| Sawyer | 54.70 | Vernon | 45.16 |
| Six Smallest | | Six Smallest | |
| Shawano | $26.33 | Dodge | $26.19 |
| Waushara | 25.82 | Richland | 25.96 |
| Milwaukee | 25.55 | Adams | 24.99 |
| Adams | 25.48 | Portage | 24.92 |
| Door | 24.75 | Washburn | 24.85 |
| Portage | 17.54 | Vilas | 21.75 |

Average for all counties: Rural, $34.83; Urban, $38.48.
Average for the state, $36.93.

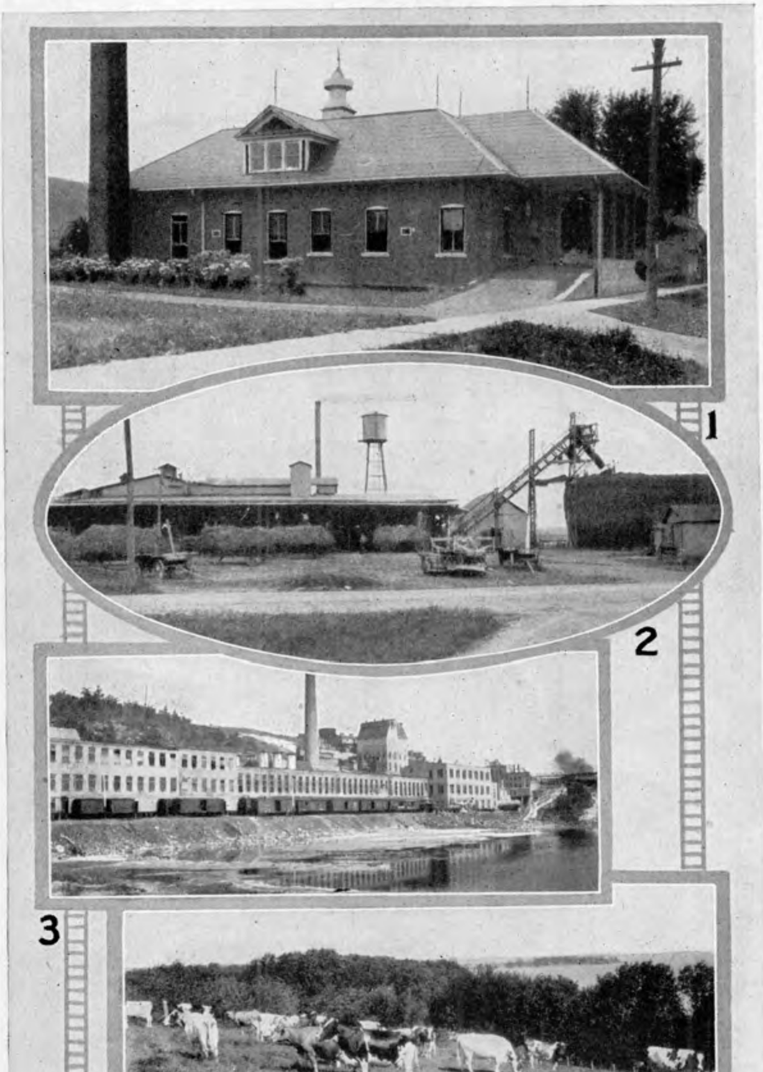
If these tables were complete they would show in nine counties that rural property averages over $3,000 per capita, and in 35 counties it is over $2,000. In no county does it amount to less than $1,000 per capita. Urban property in 23 counties is less than $1,000 per capita, and in only 34 counties is it over $1,200.

The average per capita value of assessed real and personal property in the state is $1,743. The average owned by the rural population is $2,205 and by the urban population $1,403. This means that the homes and farms and other property which the farmers have with which to make their livelihood are worth over 50% more per capita than the value of the homes and factories and machinery that the city man owns.

The six counties that pay the highest average rural per capita tax are all sparsely settled counties that have few people and large areas of valuable timberland, so it is the taxes on large timber and wildland holdings that make these averages high.

### Comparison With Germany

Germany is nearly five times as large as Wisconsin and has over 20 times as many people. While the southern part of Germany is as




1. Creamery at Coon Valley, La Crosse Co., where fine butter is made.
2. Amery Pea Viner and Cannery.
3. Paper Mill at Niagara, Menominee River.
4. University Dairy Herd, Lake Mendota in Background.

far north as the northern part of Wisconsin the German climate is just as temperate as ours. Germany is served by railroads about the same distance apart as those in Wisconsin. They have a mile of railroad for each 7 square miles of area while we have a mile for each 7.2 square miles of area.

The agricultural production of wealth is much less than in Wisconsin in proportion to population. If the live stock and food products, as shown by our census of 1920, and the Statesman's Year Book, had been divided evenly each group of 100 people would have had the number of units shown in the following table:

| *Kind of Property* | *Germany* | *Wisconsin* |
|---|---|---|
| Horses and mules | 6 | 28 |
| Cattle | 28 | 117 |
| Sheep and goats | 17.8 | 18.5 |
| Swine | 24 | 62 |
| Wheat—bushels | 138 | 278 |
| Rye—bushels | 327 | 254 |
| Barley—bushels | 138 | 463 |
| Oats—bushels | 560 | 2,600 |
| Potatoes—bushels | 1,730 | 1,000 |
| Hay—tons | 44 | 190 |
| Corn—bushels | none | 1,700 |
| Sugar beets—tons | 14.6 | 5.2 |
| Tobacco—pounds | none stated | 2,000 |
| Dry peas—bushels | none stated | 30 |
| Mixed grains and buckwheat—bushels | none stated | 114 |
| Motor vehicles | one for each 350 people | one for each 5 people |

In mineral wealth Germany is much ahead of Wisconsin as they have large coal and potash deposits of which we have none. They also have much larger zinc and iron ore deposits.

In manufacturing and commerce their geographic situation and mineral resources make possible a much greater development than we have in Wisconsin. The only basis of measurement of this is money value, and in these days we have learned that money value oftentimes means little. So we have no satisfactory basis of comparing their manufacturing and commerce with ours.

## POPULATION IN WISCONSIN

Wisconsin is a new state. Many people are still living who were born when the whole state boasted fewer people than there are now in the capital city. In 1840 there were only 30,945 people in the state. If we plot the census figures for each ten years in a diagram we find that the growth has been quite uniform, and that we can draw a nearly straight line through the tops of the black bars. If we extend this straight line on into future years we can see what the population of Wisconsin will be if the past rate of increase continues. This increase has averaged 325,140 people in each 10-year period since 1840. If it keeps up for 50 years the census of 1970 should show about 4,250,000 people, and our population in the year 2000 should be double what it was in 1920.

It is interesting to look into the future and see what this population increase will mean to the industries of Wisconsin. We know that we do not possess unoccupied good farm land of sufficient area to double the number of acres we now cultivate. Consequently we cannot have

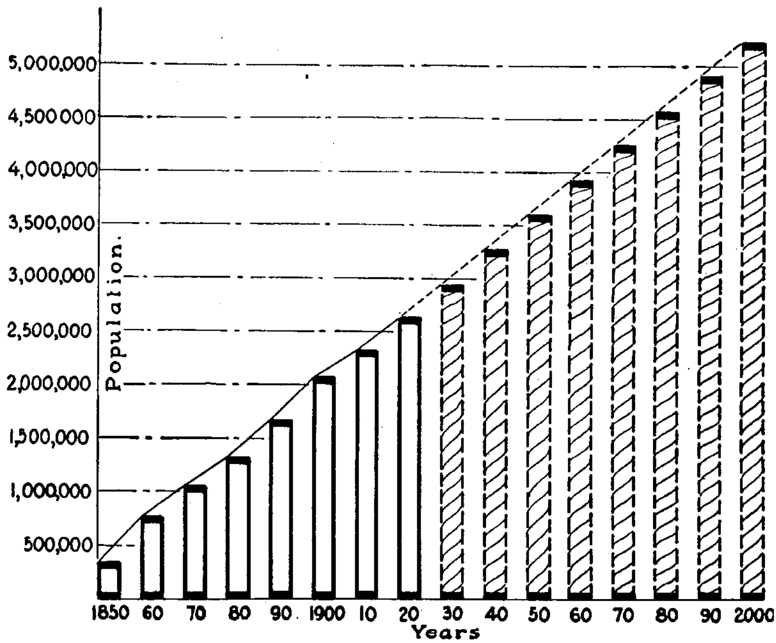



Fig. 13.—Population growth of Wisconsin.

as large a percentage of farmers in our population in the year 2000 unless they live on the produce of much smaller farms. A larger proportion of our people will then have to make their livelihood by other occupations. If the prosperity of the average citizen is to be as great then as it is now we must make just as serious efforts as a commonwealth to promote the increase of the industries other than farming as we have made in the past and are making now to improve our agricultural methods.

If we fail to do these things there is no question that the living conditions of our children and grandchildren will gradually become poorer than our living conditions are at present. These things are not easy to do. They demand the best thought and effort of every citizen who loves his fellowmen and is willing to do his part. Real material wealth is not measured in dollars. Rather it is measured in bushels of wheat, pounds of meat, yards of cloth, feet of lumber—in commodities. Unless we increase this real wealth as population increases there will be less to divide and each citizen will have to do with less—will have to lower his standard of living.

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## AGRICULTURE IN WISCONSIN

Wisconsin is one of the leading agricultural states of this country. Its outstanding leadership is in dairying. It has more cows than any other state. According to the State Department of Agriculture 53%

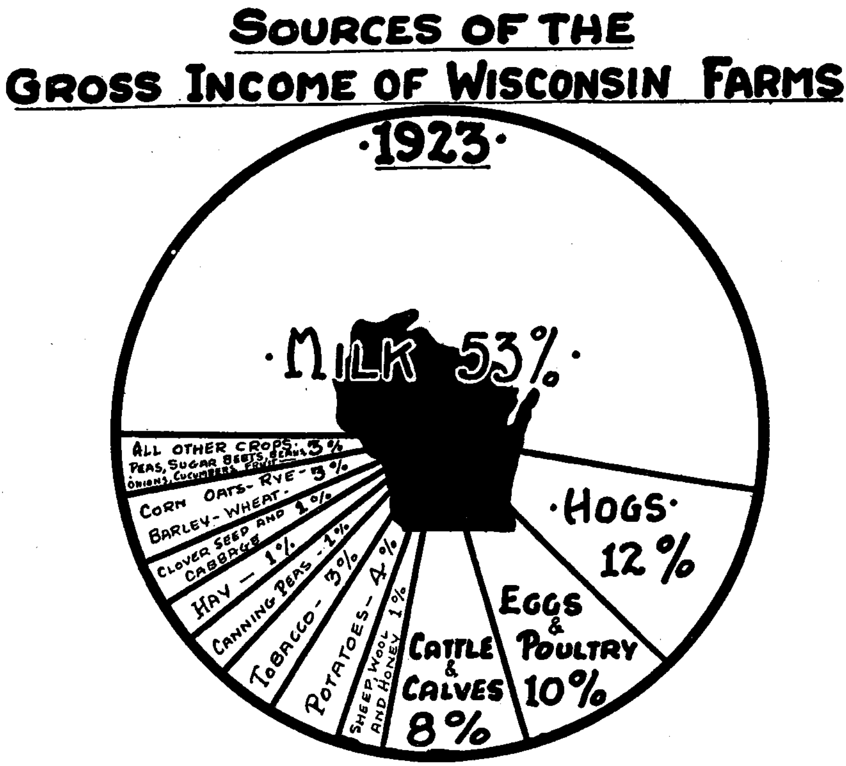



Fig. 14.—Farm Income, as given by the State Department of Agriculture.

of the gross income of $352,000,000 from Wisconsin farms in 1923 was from the milk these cows produced—10 billion pounds—enough to fill the state capitol from basement to the top of the dome 21 times, enough to fill 100,000 large tank cars and make a train over 1,000 miles long, or enough to fill a lake a mile in diameter with an average depth of eight feet.

This volume of milk gives Wisconsin first place in production of cream. From this milk it gets first place in cheese production with 56% of the total produced in the United States. It also leads in condensery products with one-fourth of the total United States production. In butter production it is exceeded only by Minnesota.

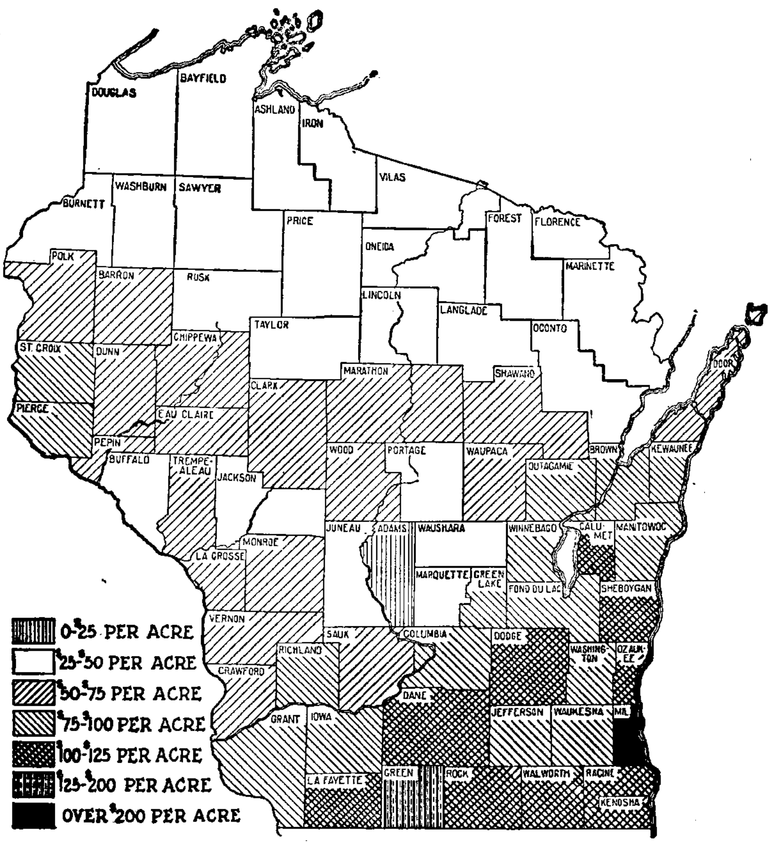



Fig. 15.—Map of land values in the various counties.

This proud position Wisconsin owes to its climate, its soil, and the quality of its people. But neighboring states have the same sort of climate and soil, and their people are not much different. Why then does Wisconsin lead? Because Wisconsin, was fortunate enough to have good leaders, public-spirited men, who saw 50 years ago what dairying would do for the state, and set out to preach it to the people. One of these men, Hoard, has a granite memorial erected at the University by subscriptions from dairymen all over the country. Another, Professor Babcock, who gave his great invention freely to the public, is still living, the proud possessor of medals and honors from all over the world in grateful recognition of his service to the dairy industry. Without gaining any great personal fortunes these pioneers in Wisconsin dairying and their associates have added hundreds of millions of dollars to the wealth of the state. To them belongs much of the credit for our leading position. To men of this kind must we look for future advances in industry of all kinds. Such leaders are among the most valuable of all our great resources.

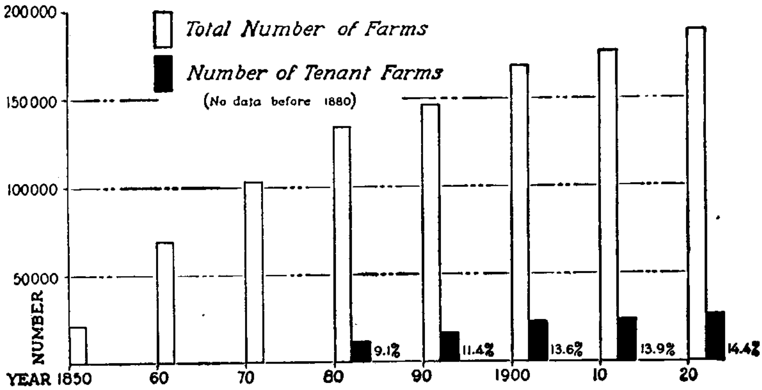



Fig. 16.—Increase in number of farms and tenant farms.

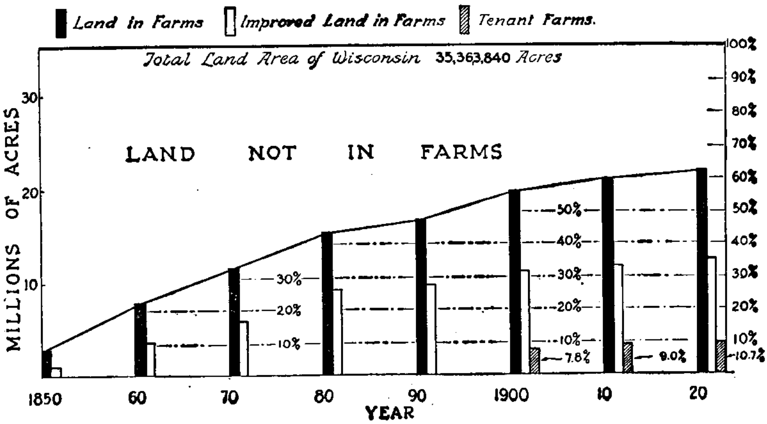



Fig. 17.—Land area of the state, improved land, total farm area, and tenant farm area.

The agricultural industry of Wisconsin is dependent on climate and soil and settlement. Climate and soils are discussed on pages 34 and 37 (in the article on "Surface Features of Wisconsin"). The effect of settlement is partly shown by the map showing land values in the various counties when this is considered with the quality of the soil. The values shown are for land alone, and do not include the value of buildings, machinery, and live stock.

To get a general mental picture of the agricultural industry in this state we need to know many things, how much land there is, how much of it we cultivate, how much is devoted to woodlots and timberland, how much is waste land—such as steep hillsides, marshes, and soil not suited for agriculture. We need to know what these lands are worth, what kinds of things they produce and how much of each, and how much these products sell for. Lastly we need to have a wide acquaintance with the people who live on the farms, their homes, their prosperity, and their intelligence.

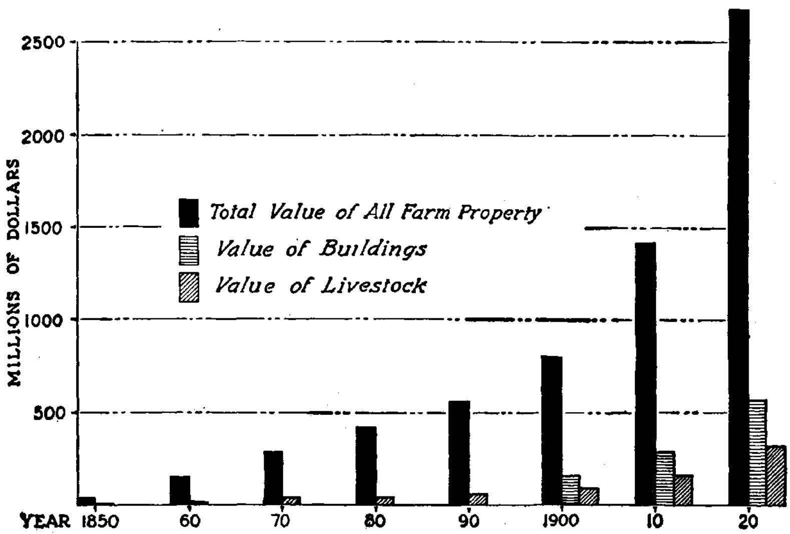



Fig. 18.—Total value of farm property, buildings and live stock.

The most interesting item in all this list is the people—at least those of us who live in the country think this very strongly. We cannot express the intelligence of people in figures, so we must accept the estimate of men who travel widely over many states and countries. If we believe what these men tell us, in few areas of equal size will we find the comfortable, prosperous looking farm homes and buildings that we find in Wisconsin. This gives us not only a measure of the quality of our people who live on farms, but a measure of their intelligence and prosperity as well. We can take pride in this portion of the picture of our agricultural industry.

There are, according to the 1920 census, 189,295 farms in Wisconsin with an average of 117 acres of land in each. The total census value of these, including land, buildings, machinery and live stock, is $2,677,282,997 or $14,143 per farm. This gives an average of $121 per acre. The land alone is given by the census as worth an average of $73 per acre, and the buildings, machinery and live stock as $48 per acre.

Seven diagrams are given here that show the growth of agriculture in Wisconsin since 1850 as shown by the United States Census figures. The first one shows the increase in number of farms and in farms occupied by tenants. The second one shows, both in acres and per cent of the total, the land area of the state, 35,363,840 acres, the acreage in farms, the acreage in improved land, and the acreage occupied by tenants. Many interesting facts appear in this diagram. It shows that 63% of all the land in the state was in farms in 1920. Of this 63% the land improved—cultivated or mowed or pastured—was 35%. Woodlots on farms occupied about 15% of the area of the state and the rest of the farms—about 13%—was unused steep slopes and marshes. The land not in farms—37% of the area of the state—was in timberland, cut-over land and marsh land chiefly in the northern part of the state. The diagram shows that in 1850—two years after Wisconsin became a state—only 10% of its area was occupied by farms, and only about 3% was cultivated. The land was rapidly occupied by farmers in the 30 years up to 1880, then only about a third as rapidly in the next thirty years up to 1910. Much of the land not occupied by farms is of excellent soil, but part of it is poor sandy soil that is fit only to raise timber.

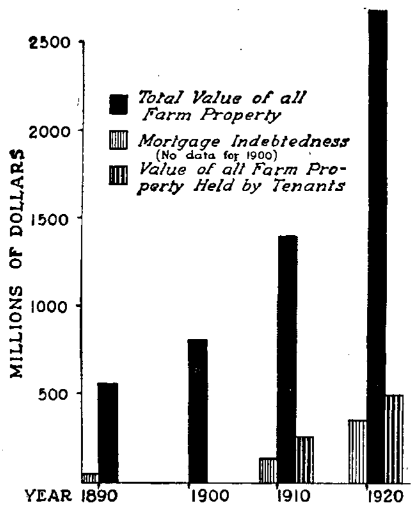



Fig. 19. Total value of farm property, mortgages and value of tenant farms.

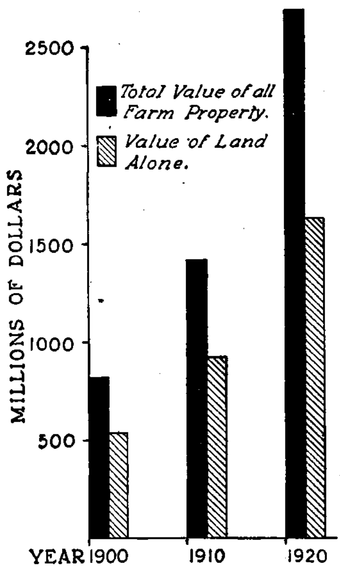



Fig. 20. Total value of farm property and land alone.

The other diagrams show the value of farm property and products, as given by the census, compared to various other interesting facts. The man who knows about Wisconsin agriculture and its history can see many things in these diagrams. Up to 1890 Wisconsin was

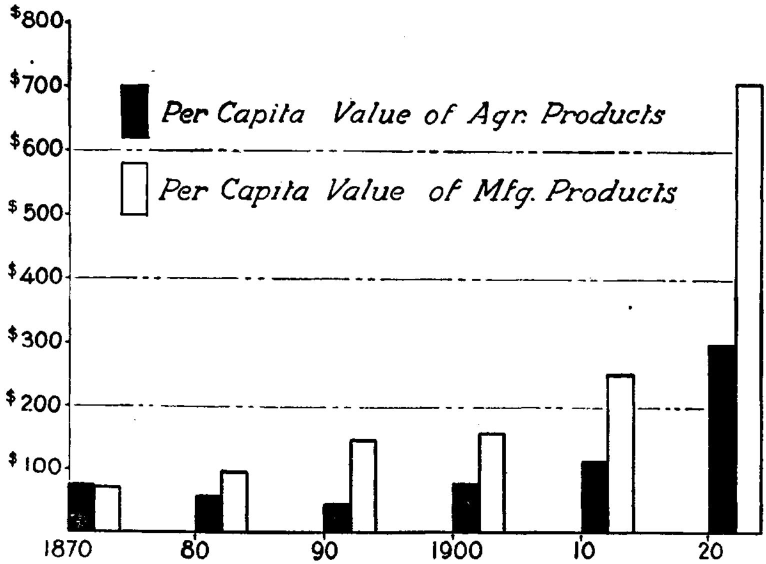



Fig. 21.—Value of Agricultural Products and Manufactured Products—Per Capita.

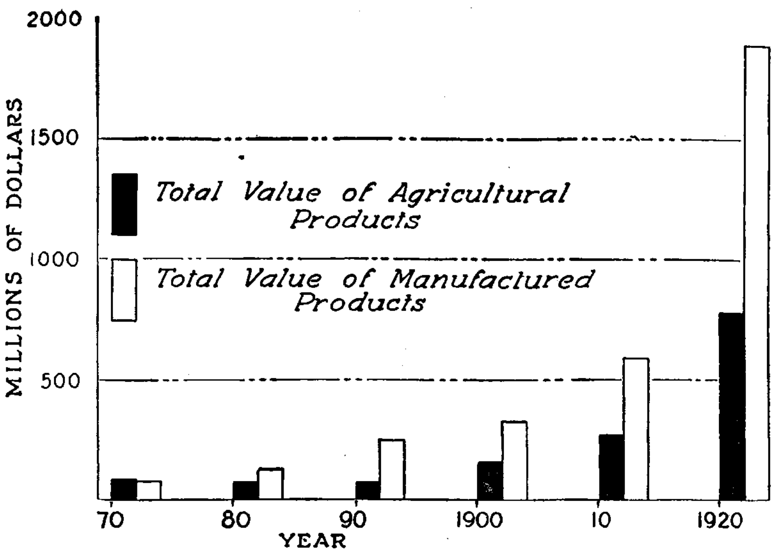
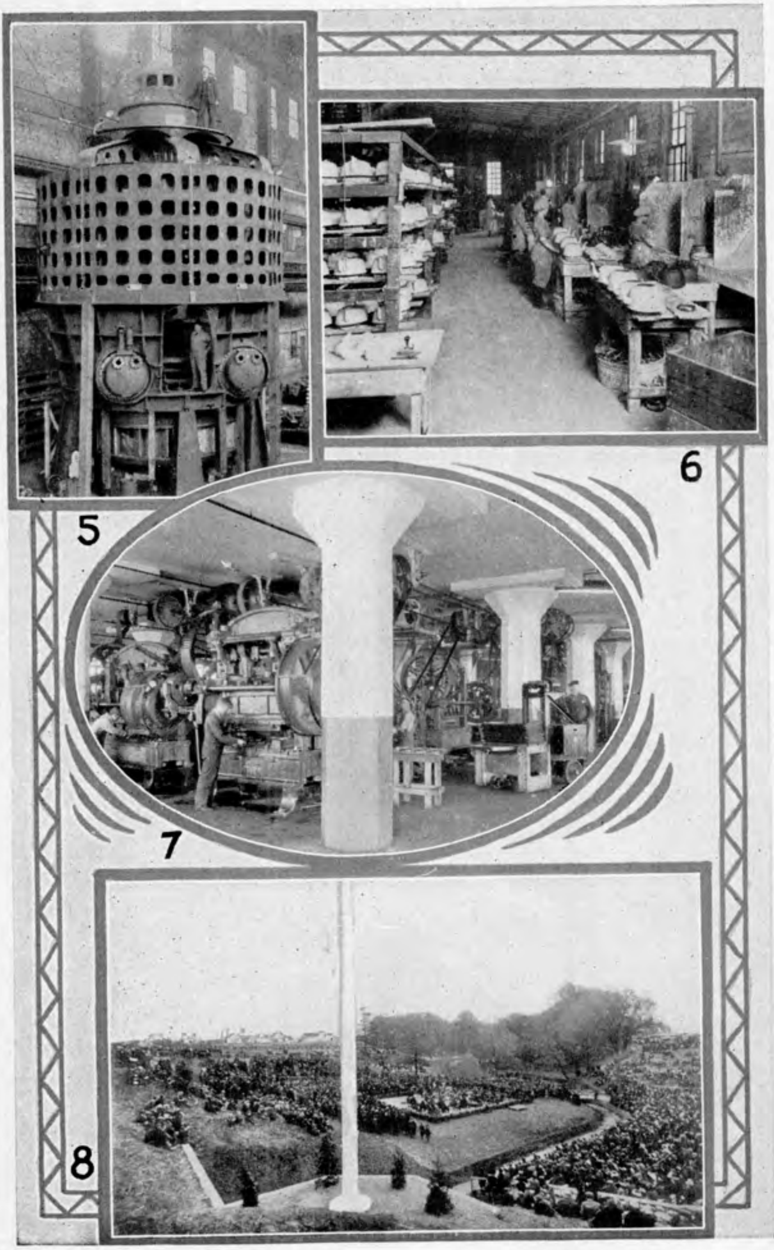



Fig. 22.—Value of Agricultural Products and Manufactured Products—Total.



5. Largest Hydro-Electric in the World, made in Milwaukee.
6. Enameling teakettles in a great Milwaukee factory.
7. Great Presses Stamping kerosene stove tops in Milwaukee.
8. Celebration in Outdoor Theater at Kohler manufacturing plant.

chiefly a grain growing state and the value of farm property showed only a steady normal increase with the increase of farm area. About 1890 the farmers started to go into dairying more extensively and farm values immediately began a more rapid increase. The value of farm buildings also increased rapidly because of the greater prosperity and the building of better barns and the thousands of silos needed for the fine dairy herds that added so greatly to the agricultural wealth of the state.

Another diagram prepared by the state Department of Agriculture shows at a glance where the income of Wisconsin farmers came from in 1923. Products sold from the farms amounted to $352,000,000 in a year of low prices. For the year reported in the 1920 census, farm products sold by Wisconsin farmers brought $551,000,000, an average of about $3,000 per farm. The value of all farm products given by the census for that year is $780,616,288. This sum is larger than the gross income of $551,000,000 because the census adds the total value of crops (some which are fed on the farm) to the value of the milk and live stock produced, so there is duplication in these figures. In the same way the total value of manufactured products given by the census is larger than the true total value. This may be seen from the following example. A manufacturer of brass makes rods which he sells to a screw manufacturer. The screws are sold to a carbureter maker who sells his product to a gasoline engine factory. The engine is sold to the maker of a farm tractor. As each manufacturer reports to the census the total value of his product the brass from which the screw was made would appear five times in the census total value of manufactured products.

## MANUFACTURING IN WISCONSIN*

The agricultural industry is controlled by the geographic factors of climate, soil, transportation, markets and population. In a similar way the manufacturing industries of a state are to a large extent controlled by geographic factors. Natural resources that furnish raw materials (such as products of the soil, timber and metals) and power (either water power or coal) are factors of great importance. Other important geographic factors are transportation, population and markets. The history of the development of the manufacturing industries of Wisconsin is most intimately related to these factors.

### Development of the Lumber Industry

Among the early manufacturing industries to develop were those connected with our vast timber resources. The rapid settlement of

* The census issues a report on the Manufactures of Wisconsin—a pamphlet of 45 pages which can be obtained from the Director of the Census, Washington, D. C.

the untimbered prairie lands south and west of Wisconsin furnished a large market. The logs could be cut and cheaply floated down the rivers to the mills where they were sawed into rough lumber. The sawmills were at first located down the streams below all waterfalls and bad rapids so the rough lumber could be made into great rafts and safely and cheaply floated down the quieter waters of the Mississippi and then down that river to the markets of Illinois, Iowa and Missouri where it was sold. The river men who piloted these rafts then walked back to their starting point. In this industry the factors of possession of a natural resource and cheap river transportation made it possible to supply a market at a price which the relatively poor settlers in those states could afford.

As railroad transportation became available, and then lower in cost and as wealth and population of these states increased, the market widened and prices advanced so it became profitable to manufacture some of the lumber into more finished products such as window sash, doors and frames. The sawmills began to move north to get closer to their receding supply of logs. As increased settlement furnished a still better market the manufacture of other lumber products began and the numerous factories for making furniture, refrigerators, woodenware, coffins, boxes and trunks came into being.

With this increase in population came the need for larger quantities of paper. Wisconsin with its great natural resources of water power and suitable varieties of timber was a natural site for the development of a paper industry to supply this need. Thus began the development of the great water powers for grinding wood to make pulp, first along the lower Fox river from Neenah-Menasha to Green Bay, and later along the Wisconsin and Chippewa. The census of 1920 reports 57 paper and pulp mills of which 30 are along the lower Fox River.

If we again consider the state to be made up of 1,000 communities with 2,632 people in each, we would find that the average area occupied by each is 7.5 miles square. It would contain one industrial establishment using wood as its raw material as there are 1,040 in the state. Of the 995 "gainful workers" in our community we find 61 are wage earners in this wood using establishment and that the total value of the product in 1920 was $263,119. The following table shows how this value was divided among the principal wood products. The "value added by manufacture" is found by subtracting the cost of raw materials from the selling price or "value of products."

| Industry | Wage Earners | Value of Products | Value added by Manufacture |
|---|---|---|---|
| Paper and wood pulp | 13 | $80,328 | $35,128 |
| Lumber and timber products | 22 | 57,221 | 35,830 |
| Furniture | 10 | 41,501 | 23,290 |
| Planing mill products not including those connected with sawmills | 4 | 20,457 | 9,232 |
| Wood boxes | 2 | 11,114 | 4,738 |
| Wagons–Carriages | 1 | 9,316 | 4,881 |
| Paper goods not otherwise listed | 1 | 8,222 | 2,741 |
| Wooden ships and boats | 1 | 7,535 | 4,605 |
| Paper boxes | 2 | 5,095 | 2,640 |
| Trunks and valises | 1 | 4,724 | 2,336 |
| Dairy, poultry and bee supplies | 1 | 3,065 | 1,404 |
| Wooden goods not otherwise listed | 1 | 3,064 | 1,824 |
| Coffins and undertakers goods | 1 | 2,663 | 1,601 |
| Refrigerators | 1 | 2,022 | 1,041 |
| Totals | 61 | $263,119 | $131,291 |

From these figures it is evident that if we do not renew our forests, and if we continue to let fires burn and destroy great areas of this valuable natural resource 61 wage earners in our average community of 2,632 will find the raw material lacking on which their occupation is based, and will be obliged to shift their occupation to something else. We will also find that the $258,425 invested in the woodworking factory in this community will find its value largely destroyed. This large sum would be a severe loss to any community of this size, and emphasizes the importance of a reforestation policy in Wisconsin, and a proper taxing policy that will permit the growing of timber as a business.

### Manufactured Agricultural Products, Food and Clothing

This group of industries, because it supplies what people need to eat and to wear, has a large value of total product, $775,359,000. This group also has had a history of great interest which has depended for its remarkable expansion on the geographic factors of natural resources, population, transportation, and markets. In the early days of the state, when Wisconsin was the frontier, wheat was the most important agricultural product. The flour milling industry grew up rapidly from this. Wheat was hauled by sleigh and wagon to Milwaukee and the milling industry centered there. As the wheat raising belt of the frontier passed on to the territory west of us the relative importance of this industry has decreased although it has continued to grow. In 1899 Wisconsin mills ground twice as much wheat as was produced in the state. In 1919 the total value of flour and gristmill products was $58,304,000.

Another early established industry was slaughtering and meat packing. This has continued to grow and in 1919 its product was the largest of any single manufacturing industry reported by the census—$102,182,000. Growing along with the meat packing industry—which furnished the hides—was the tanning industry. Milwaukee has long been the leading city in the production of leather. In addition to having a packing industry to furnish the hides Wisconsin was an excellent site for this industry because its forests furnished a large supply of oak and hemlock bark. In 1919 the leather industry was third in importance of manufacturing industries of the state with a product worth $94,762,000.

Factories using milk as raw material are reported under three heads by the census—cheese, condensed milk and butter. The total cheese product reported in the 1920 census was fourth in rank among all the manufacturing industries with a value of $91,463,000. Condensed milk was eighth with $73,342,000. Butter was eleventh with $56,642,000. If we classed these under one head as the "dairy products manufacturing industry" we would have the leader of them all with $221,447,000 as total value—over double the value of meat packing, the next greatest.

The figure on page 60 shows the values of some of the chief manufactured agricultural products. In addition to these are large values for leather gloves and mittens, $6,773,000; cigars and cigarettes, $5,889,000; woolen and worsted goods, $5,495,000; saddlery and harness, $5,143,000; chewing and smoking tobacco and snuff, $4,119,000; sausage (not made in packing plants) $4,024,000; and 10 other industries each making over $1,000,000 of manufactured agricultural products as reported in 1920.

### Metal Working and Allied Industries

This group of industries is first in value—with a total of $783,816,000—slightly exceeding the group of manufactured agricultural products. The metal working industries were first called into being to supply the needs of the agricultural and lumbering industries. Agricultural implements and sawmill machinery were among the first to develop to importance, and were a distinct response to the geographic conditions. Cheap water transportation on the Great Lakes for iron ore and coal made possible an abundant supply. The cheap raw material made possible a great development of the industries using iron and other metals as fast as railroad transportation and the population to make the markets were present in the upper Mississippi Valley.

Some of our largest metal working industries are relatively new. The largest of all is the manufacture of automobiles which is reported in the 1920 census as having a total value of products of $95,030,000. This is second in value of all our manufacturing industries. The second largest in the metal working group is "engines, steam, gas and water," with a total value of $90,953,000. This has had a tremendous growth since 1900 because of the development of water powers and the long distance transmission of electrical power, and also because of the excellent reputation of Wisconsin firms as builders of large power units. The largest hydro-electric unit in the world has recently been completed in a Milwaukee fac-

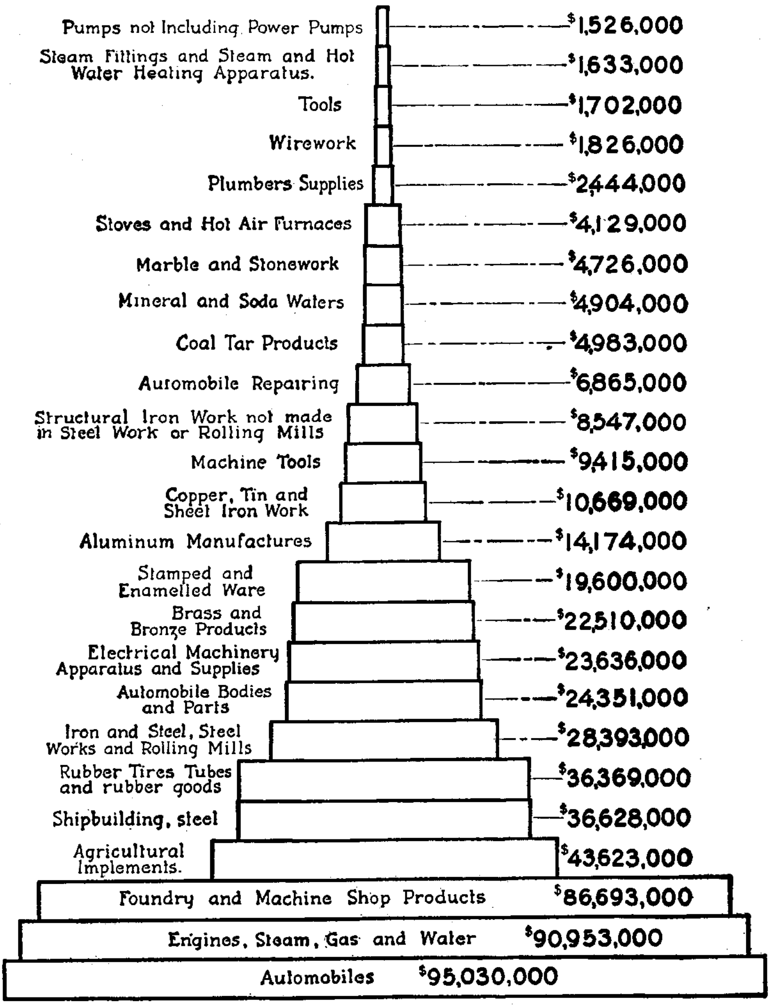



Fig. 24.—Pyramid of Manufactured Metal Products.

tory for use at Niagara Falls. You can go into large power plants all over the world, or into the important mining districts where great hoists lift the ore from deep within the earth, or wherever great powerful pumps are used to drain the mines, or furnish cities with their water supply and in a large percentage you will find a Wisconsin maker's name plate on the great machines that do their tremendous work so quietly and efficiently.

The figure shows the total value of products given by the 1920 census for the more important metal working industries and their allies such as the tire industry which has grown up with the automobile industry.

If we return to one of our thousand average communities of 2,632 people, in 1920 we find that it has ten manufacturing plants (there are 10,393 in the state) employing a total of 264 wage earners. One plant we have already described. It uses wood as raw material. It has 61 wage earners, and produces $263,119 worth of goods. Three are cheese, butter and condensed milk factories all using the products of the dairy industry for raw material. Two factories use some other product of the farms as raw material. These factories produce dressed meat, leather, flour, clothing, confectionery and ice cream, canned fruits and vegetables, bakery products, tobacco products, and many others. These five factories employ 61 people and turn out products worth $775,359—the manufactured agricultural products group.

Four factories make chiefly metal products with some miscellaneous and allied products such as rubber tires, musical instruments, chemicals, medicines, railway car repairs, explosives, motorcycles and many others. These four factories employ about 136 wage earners and turn out products worth $783,816—products made chiefly of iron, steel, brass, copper or aluminum.

One industry—the last of the 10 in our community of 2,632 people, is the printing plant that turns out our newspapers, books, magazines, and job work. There are not quite enough of these to give one to each of our 1,000 communities as there are only 802 in the state, but five wage earners in each community would work in a printing plant and turn out products to a value of $24,689.

The figure shows the total value of the products of each of our average communities.

| | |
|---|---|
| Wood and Paper | $263119 |
| Manufactured, Agricultural, Food and Clothing. | $775,359 |
| Agricultural Products | $780,616 |
| Metal Working and Allied Industries | $783,816 |

Total $2,602,910 of Products by 2632 People.

Fig. 25.—Pyramid of Manufactured Products for 2632 People.

The totals given in the figure represent some duplication, for instance the farm value of the milk that goes to cheese factories, creameries, and condenseries is listed in Agricultural Products. The total value of the manufactured agricultural products includes that as a cost in the total value of cheese, condensed milk, and butter. These figures are of value to compare the products of various groups of the people of Wisconsin and are the best the census affords. Better figures to represent real productive capacity are the "value added by manufacture" and the state figures for gross sales from farms. These are for agricultural sales in 1919 $551,000 and for "value added by manufacture" $719,709, a total of $1,270,709 for our community of 2,632 people. From this it appears that in that year the wealth produced by the factories of Wisconsin was about 30% greater than that produced by the farms.

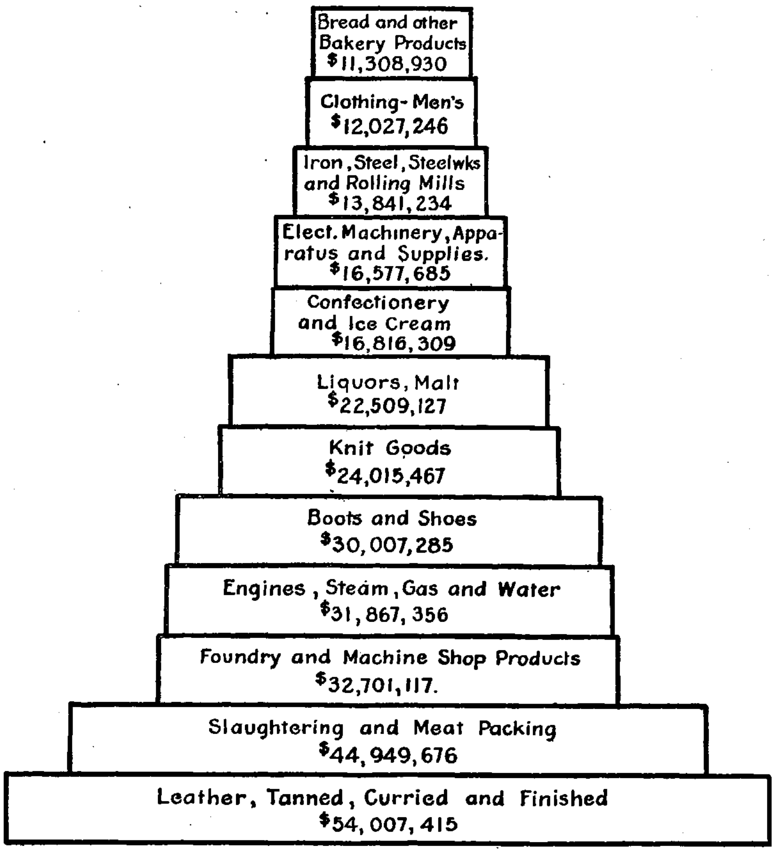



Fig. 26.—Pyramid of Manufactured Products of Milwaukee.

## Conclusion

The total value of manufactured products reported by the 1920 census for Wisconsin is $1,846,984,000. Of this total $1,127,275,000 was the cost of raw material and $719,709,000 was the value added by manufacture. It is interesting to note that Milwaukee with its 457,147 people—17.4% of the total number of people in the state, and 30% of the urban population—manufactured in 1919 products worth

$576,161,312 or 31.1% of the states total. It added value by manufacturing to the amount of $234,393,099 or 32.6% of the total value added by all the manufacturing industries of the state. The census lists 223 different classes of products turned out in the 2,093 factories of Milwaukee. The figure shows some of the most valuable products of Milwaukee factories.

Many additional interesting facts could be told of Wisconsin's industries, of the part played by many far-seeing men in developing them; of how the manufacture of aluminum ware in Two Rivers has made Wisconsin a leader in this; of the model city of Kohler near Sheboygan and its plumbing supply factory; of how Wisconsin is fourth in rank in the manufacture of knit goods with a product worth $40,778,000; of the interesting story of the development of the hemp industry from nothing to a leading position in a few years; of Wisconsin's leadership in the manufacture of concrete mixers with nearly half of the total of the country, of the new and interesting industry of making grass rugs in which Wisconsin makes 40% more than all other states combined; of the interesting and odd products from many other Wisconsin factories; but that is another story, as Kipling would say, and would fill many volumes of the size of this.

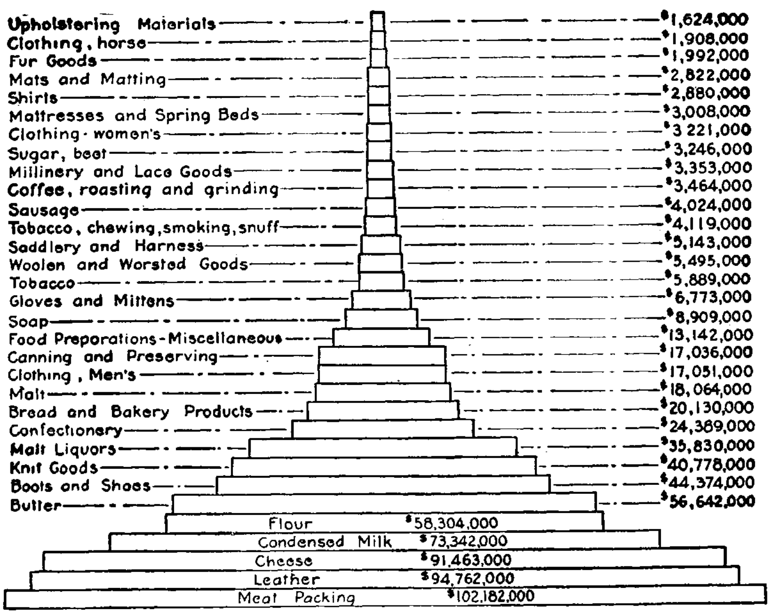



Fig. 11.—Value of the various manufactured agricultural products of Wisconsin.