The Geography of South Dakota

A Detailed Discussion of the
SURFACE, RESOURCES, CLIMATE,
PLANTS, ANIMALS, and
HUMAN GEOGRAPHY
Including the HISTORY of the Area.

A Study in Regional Geography

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PREFACE

The following study is based on extensive field work and nearly all the available literature on the subject. The regular field work, done under the auspices of the State Survey, when Ellwood C. Perisho was State Geologist, occupied most or all of four seasons and involved reconnaissance work in more than three-fourths of the counties of the state and detailed work in several. (see the Geography, Geology, and Biology of South-Central South Dakota and the Biology and Bio-geography of North-Western South Dakota, Bull. V and VI of the State Survey.) A residence in the state, extending over most of my life and including three years (1910-1913) as an instructor in the University of South Dakota, has greatly increased my knowledge of local conditions. Assistance in the field investigations was received from Dr. Perisho, then State Geologist, W. H. Over, Naturalist of the Survey, B. A. Iverson and Ralph W. Chaney, members of Survey field parties. Of the long list of publications dealing with the state from which facts have been obtained, special mention should be made of those of the first State Geologist, J. E. Todd. While writing the manuscript, many valuable suggestions were received from professors at the University of Chicago: Dean R. D. Salisbury, especially on chapters I-IV, VI; Dr. W. S. Tower on chapters I, V, VII; Drs. H. C. Cowles and Professor J. Paul Goode on chapters VI and VII; V. E. Shelford, on chapter VI; and Professor H. H. Barrows on chapter VII; and also my wife. Few changes have been made in the manuscript since February 1915.
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The Geography of South Dakota

CHAPTER ONE

INTRODUCTORY

Location, p. 7; Shape, p. 8; Area, p. 9; Boundaries and their selection, p. 9.

GEOGRAPHIC LOCATION AND ITS SIGNIFICANCE

South Dakota is nearly equally distant, about 1300 miles, from the Atlantic and Pacific oceans, having approximately the same latitude as North Dakota, Nebraska, Kansas, Texas, and central Mexico, and in mid-latitude, having, approximately the same latitude as Oregon, Wisconsin, southern Ontario, New Hampshire, northern Italy, and south-central Manchuria. The forty-third parallel forms most of the southern boundary of the state; the northern boundary is near the forty-sixth. The geographic center of North America is probably within the state. The eastern part of the state is in the Prairie Plains, most of the remainder in the Great Plains; an outpost of the Rocky Mountains (the Black Hills) occupies much of the southwestern quarter.

The location of an area is of very great geographic importance. All large areas differently located differ in regard to climate, geology and mineral resources, topography, political and industrial relations, and the stage of the development of the area.

The location in the northern Great Plains and Prairie Plains of the United States determines (1) the general type of climate, (marked seasonal changes, uncertain rainfall), (2) the general plan of the topography (the Great Plains section is a gentle piedmont slope, the Prairie Plains section has been glaciated), (3) that over wide areas the rock strata are nearly horizontal but that in the region of the Black Hills the strata are disturbed and ors are found, (4) that the population is English-speaking, chiefly Teutonic, and progressive, (5) that the area long was on or beyond the frontier and still is so in respect to manufacturing, and (6) that the major activities of the population are grain growing and grazing, results of the factors just enumerated.

South Dakota as a Frontier Area

Although the southeastern corner of the state was settled in the '50's and '60's, and most of the eastern third by the end of the '80's, much of the free land of the western half was not appropriated until after 1905. The experience and opinions of the pioneer “homesteaders,” many of whom were poorly prepared for the hardships encountered and who in many cases were but temporary sojourners in the state, have influenced greatly its reputation.

The states lying east of the longitude of Dakota, because of greater and more reliable rainfall and closer proximity to markets, have a relatively dense population, with better developed industries and larger cities. Directly west of South Dakota, there has been no great development until quite recently. The chief development was for a long time to the north (Washington) or south (California) of the latitude of this state, which is a partial explanation of the fact that although North Dakota and Nebraska had transcontinental railroads by 1890, the first
one across South Dakota was completed in 1889. The major cause of this lack is, however, the character of the Rocky Mountain barrier. The Black Hills intercept the southern half of the state, while west of the northern half there are no easy passes across the main chain. The development of adjacent and neighboring states to the north and south has been similar to that of South Dakota, their trade and travel being east-west routes. Consequently, there has been no great demand for north-south railroad transportation across these states and until quite recently most of South Dakota was relatively inaccessible by rail from either North Dakota or Nebraska. The Black Hills formerly were more closely associated commercially with Nebraska than with eastern South Dakota, because until 1907 only the railroads into these Hills were from the south.

Since the opening of the Puget Sound extension of the Chicago, Milwaukee & St. Paul Railroad (1907-09) has territory outside of South Dakota been commercially tributary to that state, as parts of southwestern North Dakota now are.

The commercial outlet of South Dakota has been towards the east. The grain exported has reached its chief market, the eastern states and northern Europe, by way of Chicago or more recently by way of the Great Lakes from Duluth to Buffalo and beyond. With the great development of the flour mills at Minneapolis and the increase of lake transportation which followed the deepening of shallow parts of the channel, the construction of larger locks at Sault St. Marie, the latter route has gained in importance. The live stock went chiefly to the great slaughterhouses in Chicago until the passing of the 26 hour law gave Sioux City an advantage. Sioux Falls became an important pork packing center in 1911.

South Dakota has no great advantages for wheat and cattle raising over the surrounding states. Likewise, grain grown in the state is used by the Federal Department of Agriculture, extends a considerable distance into South Dakota, not into North Dakota. The temperature is somewhat lower in Nebraska, and in this respect, sections of the eastern part of the state are more favorable for vegetation in the northern state. Hall and tornadoes are less frequent than farther south, and blizzards rarer than in North Dakota. South Dakota has more rainfall and is nearer to the great eastern markets than are Wyoming and Montana.

Shape
In shape South Dakota is a rectangle imperfect because of Lakes Traverse and Big-Stone which indent the northeastern corner, and the river boundaries of the southeastern corner.

The average length (east-west) of South Dakota is 376 miles (extreme length, 389 miles), and the average width (north-south) about 200 miles (extreme width, 298 miles). The shortest distance between New York and Washington D.C. is between Chicago and Jacksonville in the state, in each case, about 200 miles; between Berlin and Stockholm about 370 miles, and between Buffalo and Boston about 400 miles. These figures give some idea of the area of the state.

The rectangular shape of South Dakota, with the greatest dimension east-west, is in part the result of the commercial relations of the state.

Area
The area of the state is 77,615 square miles or about fifty million acres, of which 747 square miles are covered permanently by rivers and lakes. This 747 square miles of submerged land is in contrast with 3,824 square miles for Minnesota and 4,477 for New England. The state is the same size as New York, larger than New Jersey and New Mexico, or as New England with New Jersey and Delaware added. South Dakota is 50 per cent larger than the combined areas of the Netherlands, Belgium, Denmark, and Switzerland, and is almost as large as Great Britain, France, and Ireland combined.

From these figures it is evident that the resources of the state are completely utilized, it may support well a population several times as great as it now possesses.

Boundaries
Geographic factors influenced the establishment of at least the northern, eastern, and southern boundaries.

In territorial days (before 1889) the chief factor in regard to the determination of the boundaries was perhaps the location of this area near or beyond the western limit of compact settlement. The Missouri River, conspicuous and well-known, long served as a boundary of territories. The following enumeration of territorial boundary changes in many cases is suggestive of geographic influence in the locations of boundaries.

Between 1803 and 1812 Dakota was part of the Louisiana Territory. Between 1812 and 1816 the section west of the Missouri River was included in Nebraska Territory. The section east of the Missouri belonged, successively, to the territory of Missouri (1812-1825), Michigan (1824-1829), Wisconsin (1836-1838), Iowa (1838-1849) and Minnesota (1849-1858). From 1858 to 1861 it was unrecognized, and known as the “Land of the Dakotahs.” Dakota Territory, as organized in 1861, included what now are North and South Dakota, most of Montana, parts of Nebraska and Wyoming. In 1863 it was reduced to approximately what is now North and South Dakota. In 1864 it was again
extended, but a permanent reduction was made in 1868. Minor changes along the Nebraska-South Dakota boundary were made in 1870 and 1882.2

The Eastern Boundary. The eastern boundary of Dakota Territory was the western boundary of Iowa and Minnesota. In other words, the Red River, Lake Traverse and Bigstone, the meridian south from the end of the latter lake to Iowa and the Big Sioux River to its junction with the Missouri.

The Red River of the North nearly follows a meridian for a long distance. The fact that its source is in Lake Traverse increases its significance as a natural boundary since Lakes Traverse and Bigstone are the longest lake series in the world and were of importance as sites of Indian settlements with which there was fur trading before 1750. A short distance south of the end of Lake Bigstone, the Big Sioux River, also an important fur-trading stream in the early fur trade, having been visited by the French before 1700, comes to approximately the same meridian and continues south near it to the Missouri River, which stream in turn flows southward into the state of Missouri. This combination of waterways forms a rather striking geographic boundary line.

As the area between this dividing line and Wisconsin and Illinois was sufficiently large to permit the creation of two average sized states between Minnesota and Canada, it was rational that this strongly suggested north-south line should be adopted as the western boundary of Iowa and Minnesota. The absence of a geographically suggested boundary either to the east or west of this one and still sufficiently near to it so that the territory to the east as far as the Mississippi would give averaged-sized states, is the likelihood of the choice of this line.

In the adoption of boundaries for states, Congress has been influenced greatly by the areas of older states. In several cases the same or approximately the same meridians or parallels are used as boundaries of three or more states, and other parts of streams which formed the boundary for parts of older states in many cases were taken advantage of in bounding younger states.

Iowa, as admitted in 1845, had for its western boundary approximately the meridian which formed much of the western boundary of Missouri; but in 1846 it was extended westward to the Missouri and Big Sioux rivers. The rather sharp western bend of the Missouri near the mouth of the Sioux doubtless was a factor, in addition to that of the area, favoring the choice of the lesser stream as a boundary.3

When Minnesota was about to be admitted in 1858, the choice of its western boundary probably was influenced by the fact that the meridian followed approximately by the Red River and Lake Traverse was approximately the one roughly followed by the rivers which form the western boundary of Iowa and the meridian of Iowa and Minnesota. It is not known that geographic factors directly determined the selection of this particular meridian. The fact that it passed through the mouth of the Red River and the Missouri, near which point was located the then important Fort Union, suggests that they did, but search in U. S. House and Senate Documents, the Congressional Globe, and elsewhere has failed to reveal the cause for the choice of this meridian. During 1858 and 1859 several bills of invasion were introduced in the House of Representatives of the Thirty-fifth Congress. During the latter year the Territory was extended greatly westward south of the 45th parallel. In 1868, when Wyoming Territory was formed, this meridian again became the sole western boundary. In 1867 the western boundary of Nebraska was established on this meridian, so in adopting it, Nebraska followed Dakota.

The Southern Boundary. The southern boundary of Dakota Territory was established in 1861 when the Territory of Nebraska was divided. The 43rd parallel was followed to the Kewa Paha River, which was followed to the Niobrara River, which in turn was followed to its junction with the Missouri, which formed the rest of the boundary. In 1882, the unsatisfactory nature of a boundary determined by small, crooked strips of territory, the necessity of the railroad and the desire, and the desire to extend to the Missouri River. In 1870 a minor adjustment, made desirable by the shifting of the main channel of the Missouri, was made, and a small area was ceded to Nebraska.

The Northern Boundary. The Territory of Dakota extended northward to the Dominion of Canada. It was divided in 1889, into two states, along the seventh standard land survey parallel and a westward line on this parallel. This line follows the 49th parallel of north latitude. Its choice made the division of townships unnecessary, a division which would have been necessary had the 45th parallel been chosen.

The area demanded by Iowans was reduced in the northeast but extended by about one-third the amount of this reduction in the northwest. (Shambaugh, "The Boundary History of the Constituting States," pp. 256-258, 266-267; and his "Maps showing the Boundary History of Iowa," 1A. Jour. of Hist. and Politics, Vol. 2, p. 371, 1904.) The enabling act of Dec., 1856, gave the west boundary as the Red River, Lake Traverse and the Sioux River. The territory on its boundary, influenced by the location of the land specimens which had paid our Sioux Falls (Andrews, Hist. Atlas of Dakota, p. 85, Chicago, 1884), substituted Lake Big Stone and the meridian due south from its southern end to the Iowa boundary for the Sioux River, which was considered by the chairman to be too small in its upper course. The area of the land specimens was increased for the same reason, and in 1884 the territorial legislature subdivided Minnesota of some 900 square miles, including the territory upon which Watertown, Brookings, and Sioux Falls later were located. ("Maps showing the Boundary History of Dakota and Its Western Boundaries," Minnesota Hist. Soc. Coll., Vol. V, pt. II, pp. 677-687; and the "Congressional Globe" for Jan. 22, Feb. 25, 1857.)

Search in government documents, publications dealing with Nebraska or Dakota, or elsewhere, has failed to disclose any reasons for the selection of this precise boundary. The choice was made by the com- merce on territories, whose deliberations were not recorded. The charter of the committee had travelled extensively through the west and in his speeches in Congress repeatedly showed an appreciation of geographic factors.
been followed. It also divided the territory approximately into halves. Geographic influences which worked for the division of Dakota were (1) its large area—approximately twice the average size of the American states of today and nearly three times the average size of those which had been admitted already. North and South Dakota combined would have an area nearly three times that of the present medium sized states, such as Illinois, Iowa, and Wisconsin. (2) The community of interest between the more densely settled sections was very weak, because of the lack of communication. The lower (northern) portion of the Red River Valley was the first part of northern Dakota to be settled, while it was the extreme southeastern corner of southern Dakota which was first settled. Between these settlements was a tract nearly 400 miles in width, long sparsely settled, and crossed by neither navigable streams nor, until after 1887, by a railroad. With the coming of railroads, many lines which enter North Dakota came from Minneapolis—St. Paul, already a fairly important industrial center, while two of the more important lines which enter South Dakota came through Sioux City which is nearly due west from Chicago, a great railroad center. The chief railroad systems in South Dakota are the Chicago, Milwaukee & St. Paul, the Chicago and Northwestern, and the Chicago, Burlington & Quincy, while in North Dakota the chief ones are the Northern Pacific, the Great Northern, and the Sault St. Marie. Each of these lines has little or no mileage in the other state. Even today, as already remarked, the railroad communication between the two states is poor. (3) Many of the people predicted that what we have today, namely densely populated sections, would remain widely separated by sparsely settled stretches. (4) A non-geographic factor was the selfish ambition of many office seekers. Two states meant twice as many state offices.

The geographic factors of large area, lack of communication and widely separated settled areas, were appreciated and made much of by most advocates of division, in constitutional conventions, in instructions to delegates, and in memorials to Congress. The agitation for division and statehood is treated more fully in Chapter 7, (p. 155.)


CHAPTER TWO

GEOLOGY.

The geologic formations have influenced (a) the topography and drainage, (b) the soil, and (c) the character and distribution of the mineral resources.

Most of South Dakota is underlain by nearly horizontal strata of poorly consolidated, and in most cases, relatively recent geologic formations. The accompanying geologic map (Fig. 1) shows the general dis-

Fig. 1. Geological Map

1. Granite, Quartzite, Schists
2. Sandstone, Shale, Limestone
3. "Redbeds," Sandstone, Shale, Chalk
4. Shale
5. Sandstone, Shale, Lignite
6. Clays, Marls, Sanda


9Based on Darton's in Water Supply Paper No. 227.


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mations. In the northeastern corner of the state, Pre-Cambrian granite is surrounded by shale and chalk of Cretaceous age. The youngest extensive formation aside from the glacial drift of the eastern half of the state, is in the region between the Black Hills and the Missouri River, and is of Late Tertiary age.

(a) The relationship between the geologic formations and the topography and drainage is very intimate in the Black Hills region. The Hog-back-rim (a cuesta) due to the outcropping of resistant sandstone (Dakota and other formations); the Red Valley within the Cuesta, on the outcrop of softer shales (Spearfish red-beds); the Limestone Plateau, surrounding the core of the Hills, cut by superb canyons; and the "parks" on the crystalline rocks of the central mass are the larger features showing this relationship.

The buttes of the plains owe their existence in part to more resistant lenses of rock. Striking illustrations are the "tepee buttes," due in certain places (in the Pierre shales) to lenses of fossil shells, and in others (in the Port Union formation) to lenses of chert. Bad-land topography appears to be developed best on certain Tertiary formations; at any rate it is associated with irregularly consolidated clays, marls and sand.

There are numerous illustrations of the adjustment of drainage to structure, and to formations of unequal resistance.

(b) A comparison of the soil map of the state (Fig. 2) with the geologic map shows a noticeable correspondence in the distribution of certain soil types and geologic formations. In the Blue Hills the several geologic formations in many places may be recognized by the soils to which they give rise, even when the rocks are not exposed. The soils vary strikingly in color as well as in texture and in tendency to crack. Conversely, knowing the underlying formation in any given region, a reasonable prediction can be made as to the nature of the soil. Five striking cases of correspondence between soils and geologic formations are (1) the gumbo derived from the Pierre shale, (2) the red sandy-loam developed from the Spearfish red-beds, (3) the light colored silt-loam from the White River formation, (4) the sandy soil of the dunes associated with the Rosebud formation, and (5) the clay-loam developed from the glacial drift. The eastern half of the state has a rather uniform type of soil because of the glaciation of that section. The glaciers rather thoroughly mixed the ingredients derived from the underlying rocks. The drift contains in most places so little stratified material that most of the drift can be classed as till.

The character and distribution of the mineral resources are determined in general by the rock formations, as will be pointed out in the next chapter.

Fig. 2. A Generalized Soil Map

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4U. S. Geol. Surv., Parker, Alexandria and Mitchell Fossil
CHAPTER THREE

MINERAL RESOURCES


The mineral resources of the states are varied. The Black Hills are especially rich in ores and have yielded to date about 200 million dollars' worth of gold. For many years South Dakota ranked third among the states in the production of this metal, but recently it has taken fourth place. South Dakota leads the states in the production of lithia, and ranks third in the production of mica. There is a great variety of structural materials, most of which are present in large quantities, and there are somewhat extensive lignite deposits in the northwestern quarter of the state. In many of the state's flowing wells may be secured at no great depth and have been of enormous value.

![Map indicating the approximate area in which artesian flows may be obtained. Non-flowing artesian wells may be secured in all areas except parts of the Black Hills and the eastern border of the state.](image)

**Fig. 3.** Map indicating the approximate area in which artesian flows may be obtained. Non-flowing artesian wells may be secured in all areas except parts of the Black Hills and the eastern border of the state.

1. Artesian and Other Waters

1. Artesian Wells. Artesian wells are deep wells in which the water rises naturally, in many cases flowing out of the well. In about half the area of the state (Fig. 3) a bountiful supply of pure water can be obtained. The more important literature dealing with this topic was found to be two papers in Bull. 3, S. D. Geol. Survey 1902, O'Hare, C. C.: The Mineral Wealth of the Black Hills, and, Todd, J. E.: Mineral Wealth of the Black Hills, and, in the Bulletin of the U. S. and S. D. Geologic Survey and "The Mineral Industry." (annual) also some local data.

The following are some references to literature upon artesian wells in S. Dak: H. N. : The Geology and Underground Waters of S. Dak., Water Supply Paper 277, U. S. Geol. Survey, 1909. This summarizes and updates data given in the following less general reports: H. N. : Preliminary Report on the geography of South Dakota

In many cases the first cost of the well is the only cost for many years, there being no expense for pumping in the case of flowing wells.

At this time (1918) there are more than 5000 artesian wells flowing constantly, and of this vast quantity of pure water only a small portion is used. The waste would not matter if the supply of water were inexhaustible, but we are far from sure that it is. Already many wells yield less than formerly, and the flow from some has stopped entirely. Probably in many cases this is due to the wells becoming clogged, or to faulty construction; but in many cases it seems to be due to the local depletion by the many wells of the water supply stored up through the ages in the porous strata beneath the surface.

Most artesian water has moved for great distances, in some places hundreds of miles, under ground. Much of this movement is by slow percolation during which the water has become germ-free. In most cases the water enters the porous, sandy "water-bearing" layer of some region where the layer is near the surface, and flows down under a more or less impervious layer.

In the artesian district, flowing or "tubular" wells are obtained from four different horizons, ranging from 60 to more than 3000 feet in depth. The shallower wells (60 to 200 feet) are from sands which in a number of localities are found at the base of the glacial drift or "boulder clay." Flowing wells from this horizon are common in the Dakota River floodplain, near Artesian in Sanford county, and at a number of other points. Most of the shallower (100 to 400 feet) artesian wells are from a layer of sandstone in the Benton shale, which underlies the drift or both drift and chalk, where chalk is present.

The great source of flowing wells is the Dakota sandstone, from which nearly all the great flows come. This stratum in places is somewhat more than a hundred feet thick, and is filled with water. It comes to the surface as a ridge around the Black Hills and elsewhere along the foothills of the Rocky Mountains, several hundred miles from most of the wells and many hundred feet higher. Pressures as great as 250 pounds to the square inch have been recorded at some of the wells. The largest well, at Aberdeen, flows 2,500 gallons a minute (more than 100,000 barrels per day), a quantity sufficient to supply the needs of a city with a population of 15,000.

The depth from the surface to the Dakota sandstone varies in different parts of the state, as well as in the surface of the surface. In the Dakota Valley its depth averages about 900 feet, ranging from 200 feet near Mitchell to 1,500 feet near Aberdeen. The only well east of the Missouri that is much deeper than 1,500 feet is that at Gettysburg (2,100 feet). West of the river there are several wells more than 2,000 feet in depth, and one at Edgerton, 3,000 feet. The latter penetrates a sandstone lower than the Dakota. Nearly all the cities and villages in the artesian area now secure their water supply from artesian wells.


In 1912, Hon. Peter Norbeck, of the firm of Norbeck and Nicholson, the leading well-drilling firm in the state, and one which has made this estimate: "Probably the greatest recorded artesian pressure in the world." (Johnston, Willis, E.: Dakota: A Republic of Farms, p. 43. (Pierre, 1911)).

Sig. 17.
Most of the artesian waters have a temperature higher than the average temperature of the area for the year. In the Teton River Valley wells are distinctly warm, having temperatures of about 130° Fehn. The uses of artesian wells. It was not until the middle 1880's that successful attempts to secure wells on the uplands were made. For several years before there had been a few wells in the Missouri River flood-plain. The first was completed at Fort Randall in what is now Gregory county, in 1856. Until the late 90's the wells were beyond the means of most farmers. Improvements in methods of which greatly decreased the cost of construction, combined with good crops and a rapid rise in land values during the years following 1898, led to a great increase in the number of wells, a vast majority of which are for a farm upon which there is a flowing well than for another, even, in many cases, if the latter is located where an artesian well could be obtained at small cost. The lack of a suitable water supply has been a strong retarding factor in the settlement of many sections of the state. Artesian wells have contributed to the prosperity of the artesian basin in the several ways already discussed. The advantage which is most appreciated by the hard-headed farmers is the influence of the good water supply upon cattle. These thrive much better in pastures having a convenient and altogether satisfactory water supply, than in other pastures.

2. Shallow Wells. Shallow wells now are used but little in the area where artesian wells are obtained readily. The depth to a relatively permanent sufficient supply of water varies greatly with the relief, the mantle rock and the topographic location, but for much of the state the depth is between 20 and 60 feet, averaging perhaps 40 feet. The water may be obtained by drilling through the tillite and then through the glacial clay, which has an alkaline taste and in some places is not palatable. Because of the relatively impervious nature of bowlder clay or other clay, complete success of wells in those materials, furnish sufficient water to be considered "inexhaustible" in the popular use of those terms. As a rule, the water is obtained by drilling through the moraine and then through the glacial clay. The water table rises and falls greatly. Its great amplitude is not appreciated by most farmers, as shallow wells go dry in periods of extreme drought. At such times water for domestic use may be hauled long distances, even being brought in by train, and cattle may have to go far for perhaps an unsatisfactory drink. Most of the cities and villages not in the artesian basin or in the Black Hills secure their water from shallow wells. Sioux Falls, the largest city in the state, is supplied.

3. Springs. Springs are scarce in most parts of South Dakota. This is due largely to the relatively impervious clay which mantles much of the surface, particularly most of the glaciated section and that in which the Pierre and Benton shales outcrop (see geologic and soil maps, Figs. 1 and 2). Where porous strata should appear normally, on the sides of the valleys, the overlying clay is likely to have slipped down so as to cover their outlets, and seal up the water they contain.

The light rainfall prevalent over most of the state is another factor not conducive to springs.

In the Black Hills, as in most mountainous areas, springs are numerous. These are very large ones on the deep, compact purple limestone where it outcrops near Titford and Hot Springs. Other large springs flow from the gravels along valleys.

In the sandhill districts, notably those in Shannon, Bennett, and Todd counties, there are many surprisingly copious springs along the valleys.

A few large springs along the lower course of the Missouri and Dakota rivers receive their water from the artesian basin. This is be-
cause the Dakota Sandstone, the chief water bearing formation, outcrops in the vicinity.

Several platte topped buttes in the western part of the state have relatively porous horizontal layers near their tops, and relatively impervious layers of rock lower down. At the contact of such layers there are numerous springs in each of the forested buttes in Harding County, and in many buttes in the sandhills along the escarpments towards the southern border of the state. In the lignite area of the state there are many small springs whose water, in many cases, is dark-colored though rarely ill-tasting.

In Union and Lincoln counties many springs issue between the loess and the drift.

Gravel and sand deposits along some lines of drainage in the glaciated period are now subterranean watercourses and springs. Springs in Jerauld county and several other springs in the glaciated area, especially west of the Missouri river, are of this origin.

Springs and Human Geography. In the glaciated area, springs have been used very little and have influenced settlement slightly. This is because nearly all of the relatively few springs are close to the few streams.

The loess-covered area in Union and Lincoln counties is an exception. Here springs were used from the first and were determining factors in the location of many homes. Springs along the east side of the Wessington Springs determined the location of several homesteads, and copious mineral springs led to the location of the town of Wessington Springs.

Nearly all the towns and most of the homes in the Black Hills secure water for domestic purposes from springs, and springs were important factors in the location of numerous homes in that region.

The springs in the buttes are important in giving rise to permanent brooks. Near the mouths of nearly all of the larger valleys in the forested region of the state, many springs are located near spring-brooks. Water for domestic purposes is secured from shallow wells, which, in the sand, yield copiously.

Several Indian villages in what was the Rosebud and Pine Ridge Reservations were, or are, located along the contact of the less porous White River beds and the Rosebud beds, which are more porous. In the case of these villages, old Indians stated that the springs were the determining factor in their location.

There are several ranch houses in valleys near the contact between the almost impermeable Pierre Shale and the more porous overlying beds in several counties, notably Tripp, Gregory, and Fall River.

4. Mineral Waters. The mineral waters of South Dakota are varied. The water of many wells and springs contains sufficient amounts of hydrogen sulphide or of carbonates and sulphates of iron, calcium, magnesium and sodium to be evident to the taste, but the only locality which has become prominent as a resort, largely on account of mineral water, is the Hot Springs region in the southern Black Hills.

6. Streams. The streams are important sources of water for live stock, especially where wells yielding an abundant supply are lacking. Streams have been used but sparingly for domestic purposes, in part because of their muddiness and their great fluctuation in volume. Almost all the streams which are clearly seen, or are covered with ice, are in the Black Hills, in the larger buttes, notably those of Harding County and in the Badlands, or in the sandhills along the escarpments of each of the streams of the state, except the Missouri River, is small, and the only long streams which flow permanently throughout most of their courses are the Missouri, the Dakota, the White, Teton, Cheyenne, Missouri, and Powder rivers. The total length of these streams in part is about 20,000 miles. Many streams which have their sources in the Black Hills and the sandhills of Todd, Bennett and Shannon counties, though permanent near their sources, dry up farther down their valleys.

Lakes and Ponds. Lakes and ponds are numerus in the extensive glaciated areas. The streams are the source of water and are of less value than the streams as sources of water, largely because of the fact that most of them are very shallow. In most cases this means muddy margins, high summer temperatures, and considerable aquatic life, while many of them disappear during the dry seasons. Furthermore, many are covered by ice for a longer period than are streams. Only the larger lakes are sufficiently cool and clear so that they are used extensively by stock which has a choice between lake and well water. Ponds and lakes have been used by man himself, were used for purposes but little, and this chiefly before settlement was well established. Considerable quantities of ice, however, have been cut on lakes, and upon ponds in the smaller streams.

7. Rainwater. Cisterns have not been used as much as they should in South Dakota. This is due chiefly to the distribution of the rainfall. Most of the precipitation takes place in a relatively short period. In order to collect most of the rain which falls on roofs, cisterns have to be large. Such cisterns when in use are more injurious than good, especially when in use for a longer period. During the period between heavy rains, there is in some cases loss of water by seepage, and a deterioration of the supply retained. Protracted droughts discourage reliance upon cisterns as a means of water supply.

Earthen dams have been built across numerous shallow valleys, especially in the western half of the state, and the reservoirs so created are a very important source of the water supply for a large part of the state. Numerous small towns secure water for domestic purposes from shallow wells sunk near such reservoirs.

II. Clays and Cement Materials.

1. Clays abound in the state but have been little utilized and have not been systematically studied. Although bricks have been manufactured in the past somewhat extensively at more than twenty towns, including Vermillion, Yankton, Chamberlain, Pierre, Aberdeen, DeSmet, Madison, Englewood Hill City, and Box Elder, they have been made in recent years only at Bigstone City and Rapid City, and many of the bricks made at the latter place are of the sand-lime variety. The value of the bricks produced during recent years has averaged somewhat less than $10,000 a year, of which nearly half is credited to sand-lime bricks. South Dakota ranks forty-sixth in value of clay products among the states during several recent years. This low rank is not due...
THE GEOGRAPHY OF SOUTH DAKOTA

(3) Quartzite. Quartzites are present in several parts of the Black Hills, and equally hard cherry layers on buttes, notably on Cave Hills, but also on the Bijou Hills, east of the Missouri River, along the Missouri River. A large granite deposit is developed commercially in the southeastern corner of the state. The rock here has a bright color, in most places some shade of red. It is more easily worked, and yields blocks of larger size than can be obtained from this sort of rock in most parts of the world. It has been extensively quarried at, or near Sioux Falls, and Garretson. The foundations and lower walls of numerous buildings were built of quartzite before other satisfactory building stones, notably the Bedford limestone, could be found more cheaply. Of late years the quartzite has been quarried chiefly for crushing, for use on roads, and has been shipped extensively as far as Chicago.

(4) Bowlders. East of the Missouri River and a short distance west of it are many scattered glacial bowlders of granite, trap, quartzite, limestone, and other rocks. They are relatively few except in the moraine belts, but there they are found in such abundance that they will long supply the local demands for rough building stone.

Within a hundred miles of the Black Hills there are found, especially on the terraces of the streams which head in the Black Hills, many small bowlders and cobblestones. In the future they may be of some value.

(5) Marble. There is marble in two or three localities in the Black Hills, but it has been quarried only near Custer. The output to date has been small.

(6) Limestones. In the Black Hills there are several limestone formations, some of which are locally marble-like, which have been quarried for stone and for lime. There is an abundant and well distributed supply, and it is probable that the limestone of this section will have increasing importance. The value of these limestones in recent years appears to have ranged between $5,000 and $50,000. Precise figures for most years are not given in the Mineral Resources—South Dakota being grouped with other states whose production of limestone is low.

Chalk. Chalkstone, though it outcrops in the southwestern and northeastern corners of the state, has little economic significance, except along the Missouri between Yankton and Chamberlain, and along the lower tributaries of the Dakota. Formerly it was burned for lime and used as a building stone by the Menomonee colonies, and others of that region.

(7) Sandstones. Nearly inexhaustible supplies of chiseled sandstones are found in the Black Hills, and varieties suitable for rough building purposes are found in various other parts of the state, especially in the Black Hills in Harding county. In the Black Hills the more important formations yielding high grade sandstone are associated closely in the hog-back rim of the Hills. Tests have shown that the Dakota sandstone in many places is one of the best building sandstones. The National Sanitarium and many other large buildings at Hot Springs and elsewhere are made of it. The value of the sandstone quarried in 1908-12 averaged about $700,000.

(8) Sand and Gravel. In more than three-fourths of the state sand and gravel can be obtained only with great difficulty in sufficient quantities for local needs. In the areas where the Cretaceous clays (Pliocene) are almost lacking, and in the glaciated area they are present chiefly as small pockets of irregular distribution. There are somewhat extensive sandy belts in Sanborn and Brown counties. Good sands and gravels are abundant in the Big Sioux valley.
mined in the state. It has contributed more than 90 per cent of the value of the annual product of the mines and quarries and also was important in attracting settlers to the state. It was discovered near Custer by the Custer Expedition in 1874, and near Deadwood late in 1876. Permanent mining of the Hills commenced in 1876, before the purchase (for $4,500,000) of the Black Hills region from the Indians in 1877. For several years operations were restricted to placer mining. Until 1885 the Black Hills had no railroad, and machinery had to be freighted long distances, in most cases from Rapid City or Deadwood, S. Dak., or from Orderville, Utah. To meet this the railroads have been built in the Hills, completing the railroad from Deadwood to Rapid City. The southern edge of the Black Hills was reached by the Chicago and Northwestern Railroad in 1885, and Deadwood was entered by the same road late in 1890 and by the Burlington early in 1891. Since 1890 the mining has been chiefly of low grade ore.

The gold-bearing ores are found in considerable quantities in the (a) lodes, quartz, conglomerate, and quartzitic rocks ("lead"), (b) "cement" rocks or conglomerates of Cambrian age, (c) limestone of carbonate; and (d) recent unconsolidated deposits.

**Production of Gold in South Dakota since 1875, Mineral Resources, 1910, U. S. Geological Survey.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
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<tbody>
<tr>
<td>1876</td>
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<tr>
<td>1877</td>
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<tr>
<td>1878</td>
<td>2,250,000</td>
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<tr>
<td>1879</td>
<td>3,000,000</td>
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<td>1880</td>
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<td>1881</td>
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<tr>
<td>1890</td>
<td>3,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>18,000,000</td>
</tr>
</tbody>
</table>

In the southern Black Hills, the gold comes mainly from quartz veins in the middle Hills chiefly from placer deposits which are worked in the upper part of the Rapid Creek basin by means of dredges; and in the northern Hills chiefly from auriferous lodes ("lead"), slate breccias, fissure veins, and most important, impregnated zones. The Homestake mine is one of many in the Black Hills. The Homestake mine has produced more than all others, in spite of the fact that the ore worked has had an average value of only about $5.50 per ton. Its annual production since 1895 has averaged about $5,000,000.

**Silver** is second in value among the metaliferous products of the state. The total production to date is approximately $4,000,000. It is found in small but fairly regular amounts associated with gold and lead, with the latter especially in the Galena, Carbonate, and Spokanai localities.

(3) **Lead** is distributed widely and is secured each year in small quantities. (13 tons in 1905, 7 tons in 1910, 14 tons in 1911.)

(4) **Copper** deposits which appear to be of considerable importance, especially in the northern Black Hills, are known at various places, especially in the northern Black Hills, but as yet the production has been small, (3,000 lbs. of metal in 1905, 24,000 lbs. in 1909, 22,657 in 1917.)

9The Homestake mill and smelter were in operation July 1, 1878. (Tailent: The Black Hills, p. 56, St. Louis, 1899.)
THE GEOGRAPHY OF SOUTH DAKOTA

(5) Iron ore bodies apparently of some possible future importance are found in various places, and small quantities have been used for fixing purposes by local smelters. In 1893-94 165 carloads were shipped from Nahant to the smelters of Omaha and Kansas City.

(6) Tin is present near Keystone in the southern part of the Hills and near Tinton in the northern part. Although efforts to develop the deposits have extended over more than 35 years, the production up to 19 years was not more than 50,000 lbs. of metallic tin. Since that date there has been a small production nearly every year.

(7) Tungsten. This recently valuable metal was discovered in 1899 near Lead and near Harney Peak. The production during that and the following year was about 140 tons.32

(8) Manganese ores have been discovered at several points. In 1892 19 tons were shipped from Custer county.

Antimony, bismuth, nickel, uranium, and several other metals are present in quantities sufficient to encourage prospecting, but as yet have not been valuable commercially.

VI. Miscellaneous Mineral Products

Graphite deposits (pre-Cambrian in age) are abundant in many parts of the Hills, and in several places the content of graphite is sufficiently high to arouse interest in the economic possibilities of the deposits. Sixteen carloads of graphite were ground at the Mineral Paint works in Custer in 1900-01.33

For several years practically all the lithium minerals produced in the United States have come from the Custer district where the ore are found as lenses in pre-Cambrian pegmatite. The mineral spodumene arouses additional interest because of the vast size of some of its crystals. One showing in the sides of a drift for 36 feet without break is recorded.34 Many have a diameter of more than three feet, and a length of more than six.

Mica quarries were exploited extensively during the 80's, and since 1900. The quarries and sorting plants near Custer include some of the larger quantities of high grade mica in that vicinity. Although the "Mineral Resources of the United States" states that South Dakota ranks second among the states, precise figures of production are not available.

VII. Soils

The general distribution of the chief types of soils is shown in Fig. 24.

Most of eastern South Dakota has a clay-loam soil derived from the glacial drift of that area. This type is similar to that found in the parts of North Dakota, Minnesota, and Iowa which are free from loess, and has been named by the U. S. Bureau of Soils The Carrington Clay-Loam. Over extensive areas this soil is rich in humus, and hence is dark colored to the depth of a foot or so, and in depressions and on the lower parts of slopes, to the depth of two or more feet. This type of soil in South Dakota is considered to be superior in fertility to its representatives

in more humid areas, because nutritious salts are accumulated near the surface by the evaporation of soil moisture in semi-arid regions, while in humid regions the surface layers are depleted of salts by leaching.

The soil type perhaps next most widespread is the Pierre clay, derived by the weathering of the Pierre shale which "outcrops widely (Fig. 1). In many places this clay is very compact, and when wet, very tenacious, and is called 'gumbo.' It does not absorb moisture readily, has a strong tendency to cake when dry, and locally possesses too large a content of certain minerals to be attractive to ordinary plants. For these reasons, gumbo is an undesirable soil, though it yields very abundantly in years when the precipitation falls at opportune times. Small gumbo areas, often popularly called "alkali spots," are found here and there even in the glaciated part of the state, and have been explained as the result of masses of Pierre shale which had been transported by the glacier after the manner in which bowlders were carried. Small areas of this sort are being eliminated in many cases by building straw stacks over them. The straw, when decayed, contributes much mould, which counteracts the objectionable elements in the soil.

Clay-loams, silt-loams, and sandy loams, grouped as "loams" in Fig. 2, derived from many rock formations, are widespread in western South Dakota. For reasons discussed in the chapter on Bio-geography, clay-loams are considered to be relatively the most productive in ordinary "wet years" (clays are most productive in years of unusually favorable precipitation), and silt-loams in dry years. The sandy soils have a fairly rapid growth of native vegetation and can reasonably well by crops, but they blow away during dry years after being broken up.

Alluvium is found in nearly all the larger valleys and in most places is a desirable soil. Large sandy tracts are not numerous, and extensive gravelly areas are found almost exclusively in and near the Black Hills.

Lacustrine silts have accumulated to considerable depths in many basins in the glaciated part of the state. Most of the bed of glacial Lake Dakota is very fertile, partly for this reason.

Distinctly collan soils are limited to (a) loesses, which cover many hills in Lincoln and northern Union counties, (b) loess-like silt-loam found along the eastern bluff of the Missouri River, and (c) small dune areas in the south-central part of the state along the Missouri River near Elk Point, and at a few other scattered localities. Excepting the sandy parts, collan soils are in good repute among agriculturists, and bowlders are few except in the terminal moraine areas. In western South Dakota bowlders of a size to interfere with cultivation are of very local occurrence, chiefly on the flood-plains and terraces of streams head in the Black Hills. Scattered fragments of concretions are met with in a few small areas. Belts of land which are quite stony, with angular fragments of flint, are distributed sparingly. There are large log-like sandstone concretions (Fig. 4) about some of the buttes in the north-western quarter of the state, portions of which interfere with the tillage of some small areas.

32Harra, C. C.: Mineral Wealth of the Black Hills, Bull. 3, S. D. Geol. Surv., p. 72, 1906. As yet the U. S. Geol. Survey has reported no production from S. D.
33Ibid., p. 72.
36Based on Coffen's map.
CHAPTER FOUR

PHYSIOGRAPHY

General Features, p. 29; Prairie Plains, p. 32; Great Plains, p. 39; Black Hills, p. 45.

I. General Features

Eastern South Dakota is a continuation of the prairies of Iowa and Minnesota. Most of the western half of the state is part of the Great Plains, but in the southwestern corner, an outpost (the Black Hills) of the Rocky Mountains rises conspicuously above the surrounding plains.

1. Slope. The general slope of the state is from west to east. In the western half of the state the principal rivers flow eastward and in the eastern half they flow southward.

2. Relief. The highest point is Harney Peak in the southern Black Hills. This peak is 7240 feet above sea level, an elevation greater than that attained by any peak in eastern North America. The lowest point is Bigstone Lake in the opposite corner of the state. Its elevation is 965 feet. The relief of the state is 6275 feet, exceeding that of any state farther east except North Carolina (6711 feet), New Hampshire (8336), and Tennessee (about 6300).

Aside from the Black Hills and the small depression in the extreme northeastern corner, the relief is about 2600 feet or a half mile approximately. Most of the eastern half of the state has a relief of less than 500 feet, and large areas have a relief of much less than this.

It appears that the mean elevation of the state is about 2200 feet, the figure which, according to Murray’s calculations, represents the average elevation of the lands of the globe. Out of the total area of 77,615 square miles there are approximately:

- Below 1000 feet 270 square miles or ............. 0.93% of total area.
- Between 1000-2000 feet 42,300 square miles or 54.5% of total area.
- Between 2000-3000 feet 28,000 square miles or 36% of total area.
- Between 3000-5000 feet 10,700 square miles or 13.5% of total area.
- Between 5000-7000 feet 1,350 square miles or 1.8% of total area.

3. ruggedness. Though possessing this considerable total relief, most of the state is far from rugged. The chief exceptions are parts of the Black Hills, parts of the White River and other badlands, and some of the lands along the deeper valleys. Thousands of square miles in the Dakota Valley are nearly level. The total area with slopes of more than 15° certainly is less than 15 per cent of the whole. Even in the Big Badlands along the upper White River more than 50 per cent of the area is tillable as far as slope is concerned since most of the steep-sided buttes are separated widely by nearly level stretches. Figs. 5 and 6 illustrate such a “flat.” The Black Hills contain the largest tillable portion, but even in this mountainous area there are many farms along the fertile valleys and it is estimated that at least 5% of the area may be tilled.

4. Drainage. Most of the state lying east of a line which follows approximately the Missouri River across South Dakota (the line is shown on the soil map, Fig. 2) was glaciated by the Dakota lobe of the last (Wisconsin) ice sheet, and has the topography characteristic of plains glaciated recently. It is covered by a layer of drift which averages about a hundred feet in thickness. Most of the surface of this part of the state is gently undulating. Exceptions are many nearly flat areas where

...The difference between 1100 feet in the Missouri Valley near Elk Point and 3700 feet on the higher buttes without the Black Hills.

Prof. Jenny, quoted by McClure: Resources of Dakota, p. 166. (Aberdeen, 1887.)
former lakes have been filled, and several low terminal morainic belts, which locally are somewhat rugged. The average elevation of the eastern half of the state is about 1500 feet, but in the matter of elevation there are two distinct provinces (Fig. 7). These are: (1) the broad Dakota Valley with an elevation of approximately 1500 feet, and (2) the east and west coteaus or divides on either side, with an average elevation approaching 2000 feet. These broad divides are mesa-like, rather steep-sided, and nearly flat-topped. The drainage of eastern South Dakota is very poorly developed, and there are thousands of shallow “lake-beds.”

In the western half of the state, west of the Missouri River, the topography is in a mature stage of development, though there are broad terraces and tables, some of which are due to more resistant layers of rock, while others represent the tops of old peneplains developed in earlier cycles of erosion. On such uplands the slopes are very slight. The only undrained areas in this part of the state are the very shallow “bpeonuts”—basins made by the removal of the soil by wind. The rivers have cut rather deep valleys across the plains. Above the general level of the plains there are numerous conspicuous buttes and the Black Hills, while below it are the “badland basins” and most of the bad-land areas.

2. The Physiographic Provinces

Three main topographic subdivisions are rather distinct, namely, the Black Hills, the Great Plains, and the Prairie Plains. The Prairie Plains conveniently may be divided into three parts, namely, (1) the broad valleys in the southeastern corner, (2) the Dakota Valley, (3) the Coteaus, making a total of five subdivisions. The following map (Fig. 7) shows their location.

![Map of South Dakota](image)
1. THE PRAIRIE PLAINS

(1) The Southeastern River Valleys

The lower portions of the valleys of the Sioux, Vermillion and Missouri rivers are treated separately from the rest of eastern South Dakota, because (1) the broad flood-plains which comprise this subdivision are in distinct contrast with the rolling uplands on either side. These valleys lie for the most part some 50-100 feet below the South Dakota uplands, and from 200-400 feet below the adjacent uplands of Nebraska and Iowa. (2) Little of this subdivision was glaciated by the Wisconsin ice sheet, as was the rest of eastern South Dakota. (3) More abundant and reliable rainfall, a higher water-table, and a location which formerly made them more accessible than the remainder of the state from the East, have produced a somewhat distinct agricultural development and have given these valleys a prominence in the state which warrant a somewhat detailed treatment.

(a) Position. This irregularly shaped subdivision includes parts of several counties and nearly all of Union County. The limitations here adopted are indicated on fig. 7. The western limit is near Springfield, where the Missouri River leaves its post-glacial gorge—less than a mile wide, and enters a pre-glacial valley several miles wide. Similarly the Vermillion River below Centerville occupies a broad pre-glacial valley, while above that city its valley is much narrower. There is no definite northern boundary in the Sioux Valley. The glacial margin is indistinct, and the topographic changes gradual.

(b) Area. The area of this subdivision is about 2000 square miles, or nearly the size of Delaware.

(c) Topography. The topography of this region is essentially plane. The elevation of the lowest part, near Sioux City, is 1100 feet. The gradient of the Missouri River in this region is about 6 inches per mile, or but half its average gradient across the state. In this province the Vermillion has an average gradient of about 16 inches per mile, and the Sioux, irrespective of the falls and rapids near Sioux Falls, a gradient of more than two feet per mile. In spite of its lesser gradient, the Missouri River, because of its greater volume, has by far the swiftest current.

Natural levees are developed sufficiently well in each of the valleys to divert the tributary streams so that they enter their mains farther down stream than they otherwise would. The Vermillion and Sioux rivers themselves enter the flood-plain of the Missouri River several miles above the points where they join the main stream. The Elk Point quadrangle, within whose area these streams unite, affords therefore an excellent illustration of the barrier influence of uneven very low levees. Levees are one of the causes of extensive marshy lands within the Vermillion and Sioux valleys.

At present the Missouri River in this section is nowhere eroding the bluffs along its left bank, though it is under-cutting the western at many points. This may possibly be due to the influence of the rotation of the earth.

The falls and rapids near the city of Sioux Falls owe their existence to a change in the course of that stream. Instead of continuing its southward course, it turns in the city and flows northward over an escarpment of Sioux Quartzite. North of the city it turns again and passing around the end of a range of morainic hills which extends a few miles east of the city, continues southward to the Missouri River near Sioux City.

Fig. 8. The falls of the Sioux River in the city of Sioux Falls. The height of the chief falls is about 20 feet.

Fig. 9. A view across the Sioux River Valley towards the State Penitentiary. Courtesy C. M. & St. P. R. R. Co.

Sig.—3.
This change in the course of the Sioux is ascribed to the last glacier. A tongue of the Dakota lobe of ice reached a short distance beyond Sioux Falls from the west, deposited the morainic hills referred to in the preceding paragraph, and dammed the pre-glacial course of the river, which, as shown by a broad pre-glacial valley, had been by way of Centerville to the Missouri.

The Dalles and Fallsides of the Sioux River and Split Rock Creek in Minnehaha and Moody counties are gorges which these streams have eroded in the Sioux Quartzite. The walls are in places nearly vertical to the height of from 20 to 40 feet, and pinnacles of this resistant rock give certain evidence that these localities have not been glaciated recently. Picturesque erosional features (Fig. 8, 9) have given this area more than a local reputation for scenic beauty.

(2) THE DAKOTA VALLEY

(a) Location. The Dakota Valley, as this term is used here, includes the broad, nearly level stretch of land which lies between the Wessington Hills, Ree Heights and Coteau du Missouri on the west, and

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THE GEOGRAPHY OF SOUTH DAKOTA

The Dakota Valley has a broad, nearly level stretch of land which lies between the Wessington Hills, Ree Heights and Coteau du Missouri on the west, and the Coteau des Prairies on the east. It is a basin more than 200 miles long in South Dakota, and has an average width of more than 60 miles, and therefore an area of more than 13,000 square miles—larger than either Belgium, Denmark or Maryland, and half the size of North Carolina.

Brown, Spink, Beadle, Sanborn, Davison, Hanson and Hutchinson counties lie wholly within this province. The counties and parts of counties contained in this province are indicated on the outline map of the state dealing with the topographic provinces (Fig. 7).

(b) Topography. The central part of the Dakota Valley from Huron to the South Dakota state line is nearly level. This is due partly to glacial Lake Agassiz which occupied this region. Elsewhere within this great valley the relief is that of gently undulating ground moraine crossed by several low recessional moraines (Fig. 10).

The Dakota or James Rivers and some of its tributaries have breached this base only in its southern part (south of Huron). Near its southern end, there are gorges more than a hundred feet deep. These are somewhat serious obstacles to railroad building. The flood-plain of the Dakota River averages about a mile in width throughout the southern half of its course; and perhaps half a mile in the northern half of its valley.

Except in its central part, the Dakota Valley has many shallow, undrained depressions characteristic of ground morainal topography. Most of these swales are normally dry. Some of them usually contain small amounts of standing water, and popularly are called "sloughs." All the undrained depressions occasionally contain some water, and the sub-soil is so impervious that underground drainage is slow. There are few or no permanent lakes except in the recessional morainic belts, and these are small and shallow.

(c) Relief. With the exception of low cliffs about the deeper lakes and bluffs along streams in the southern half of the area, the relief is so slight throughout the Dakota Valley that each section line is followed by a road throughout nearly or quite its entire length. Railroad building therefore is comparatively simple. There are several stretches of straight track scores of miles in length, and many long sections have no bridges.

(d) Elevation. In elevation the Dakota Valley is peculiar in its upwelling—approximately 1300 feet from Scotland (elevation 1290 feet) on the south to Aberdeen (elevation 1300 feet) nearly two hundred miles to the north, and at widely scattered intermediate localities selected at random (Mitchell 1390, Woonsocket 1326, Huron 1290, Redfield 1298) the elevation is nearly the same. It is believed that in pre-glacial times the slope of most of the Dakota Valley was towards the north.

The trenching by the Dakota River referred to in the previous


For a discussion of the moraines see the Geologic folios and other references mentioned in the preceding note.

Although the National Geographic Board has adopted "James" rather than the more descriptive name of this stream, the latter name seems preferable and will be used in this publication for the following reasons: (1) There are several other James Rivers in the United States, (2) this river is wholly within the Dakotas, and its basin forms a large and highly important section of these states, (3) the act establishing Dakota Territory in 1861 specifically declared that "henceforth this stream shall be called the Dakota River" (though many call it "the Jim.")

See the Alexandria and Olivet sheets of the U. S. Topographic Atlas.

The Pleistocene History of the Missouri River, Science, pp. 266, 267, Feb., 1914.
Little Minnesota valleys with their head-waters in Lakes Traverse and Bigstone, more than 1000 feet below the summit of the coteau. The Missouri River, just west of the western coteau, is 300 feet below its summit to the north, and nearly 700 feet below the Bijou Hills to the south. The tops of these coteaus are somewhat even. Most of both were formerly covered by the ice sheet, except for a short time, at least, for a small part of the end moraine.

The eastern coteau lay between the Dakota and the Minnesota-Iowa lobes of the ice sheet, and is margined and crossed by the three chief terminal moraines (Antelope, Gary, Altamont), which are interlaced moraines in portions of this area. (Fig. 30) Three broad pre-glacial valleys, rather than by the facts of the case. The Dakota River itself was dry locally for a few days in 1893 near Forestburg in Sibley County; and has sometimes gone dry for a few days near Redfield in Spink County. It has been characterized as the longest unnavigable river in the United States.12

(a) The remaining and larger part of South Dakota east of the Missouri River here included under the heading “The Eastern and Western Coteau provinces.” The former, known as the Coteau des Prairies, or, more popularly, “the Lake region of South Dakota,” is the loamy, nearly flat-topped, broad divide between the Dakota Valley and the Dakotah Valley to the west, and the Red, Little Minnesota, and lower Sioux Rivers to the east. The latter divide between the Dakota Valley and the Missouri River. Its northern and more extensive portion is the southern end of a well-marked divide in North Dakota, known as the Coteau du Missouri, which is separated by the Missouri and Dakota valleys in South Dakota, is crossed by four well-drained valleys, and is therefore separated into four sections. From north to south there are (1) the extensive drainage basin of the Red River, (2) the historic Hay River divide, (3) the extensive drainage basin of the Little Minnesota River, and (4) the Bijou Hills, mostly in Jerauld County. The coteaus are indistinct towards the southern part of the state.

The only counties located wholly on the east coteau are Codington, Deuel, Hamlin, and Lake. On the western coteau is Campbell, Walworth, and De Smet, Sully, Hyde, Buffalo, Brule and Charles Mix counties. Portions of other counties lie within this subdivision. (Fig. 7)

(b) The area included within this subdivision is nearly 20,000 square miles, or almost half the size of Ohio or Virginia. The coteaus may be considered as extensive bodies of water, all of brief duration. In South Dakota the chief indications of their former existence are exceptions. Exceptions to this rule are the coteaus of the Wessington Hills, which are the remnants of a large body of water which resulted from the union of smaller lakes developed in the valleys of each of several of the eastward-facing streams of that region. Glacial Lake Red Rock in Brule county, Glacial Lake Anes in Charles Mix county, and Lake Agassiz in the northeastern corner of South Dakota, are other examples. These lakes, as extensive bodies of water, were all of brief duration. In South Dakota the chief indications of their former existence are

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Many lake-bed shores are distinctly steep. Their low cliffs at most points not more than a few feet high, probably are the result of the cutting of the waves supplemented by the thrust of the lake ice.

II. THE GREAT PLAINS

The most extensive physiographic province of South Dakota is the Great Plains (Fig. 7.) This is the long slope from the foothills of the Black Hills to the western border of the state to the Missouri River.

(a) The area of the Great Plains in South Dakota is approximately 35,000 square miles or nearly one-half of the state. All of the counties of western South Dakota except Lawrence, lie entirely or partly within this province.

(b) Topography. It already has been stated that the western half of the state is in a mature stage of erosion, but that within the province there are extensive nearly level areas, called benches or tablas, some of which represent former erosion levels and others the outcrop of more resistant horizontal rock formations. The general gentle eastward slope has been roughened by the erosion of running water. It is interrupted by somewhat deeply intronched stream valleys, and, more conspicuously, by buttes. (Fig. 11.)

The more prominent buttes, named from the southern part of the state northward, are: Porcupine Peak, Eagles' Nest, Turtle Butte, Sheep Mt., Bigfoot Butte, Cedar Mt., White-Clay, Grindstone, Virginia and Rabbit Buttes, Fox Hills, Castle Rock, Deers Ears and Haystack Buttes. The larger, possessing considerable timber, are in Harding County, and are, in the same order, the Jason, Porcupine, and Sheep Hills. The buttes are mostly on present or recent divides and have persisted because they were far from the main streams, and because of the presence of a resistant capping rock.

The steep-sided character of the buttes, which in no little degree is responsible for their conspicuousness, is the result of the cap rock, intermittent rains and wind. The wind has excavated a distinct depression around the base of many of the buttes, and in all cases has tended to prevent the accumulation of extensive talus. As a result of the extreme steepness, extensive slumping has taken place on the slopes.

References to literature on this province are: The bulletin of the South Dakota Geological and Economic Survey: Bulletin 52 (1905) and Preliminary Report on the Geology of South Dakota, by J. E. Todd, treats very briefly of the plains. Bull. 1 (1898), contains reports by Prof. Todd on reconnaissance trips through southern counties, (pp. 117-125), and into the northwestern part of the state (pp. 43-48). Bull. 3 (1902) has brief mention of this area in "Mineral Building Materials, Fuels and Waters of South Dakota," pp. 81-130, by J. E. Todd. Bull. 4 (1908) contains geology upon the geography of the northwest-central portion of South Dakota, by J. E. Todd (pp. 13-16, 182-207) and on Gregory and Tripp counties by E. C. Periaho (pp. 82-83). Bull. 5 (1912), dealing with the south-central part of the state, contains reports on the geography by S. S. Visher and on the geology by S. S. Visher and E. C. Periaho (pp. 41-60). Bull. 6 (1914), Visher's book, is upon the biology of Harding County, but contains various references to the geography.

Buttes occur in two general classes, which report upon geology and water resources. (Prof. Paper 32 on The Great Plains, and Water Supply Paper 227 on South Dakota), makes a brief mention of the subject of this month, but does not deal with the Bad Land Formations of the Black Hills Region, Bull. 9, S. D. School of Mines, 1910.


of many of the buttes.\textsuperscript{24} Basins which contain ponds have been produced by slumping on the flanks of Slim Buttes and the Short Pines Hills.

The summit areas of the forest-reserve-buttes of Harding County and Sheep Mountain in the Badlands total many square miles. Most of the other buttes have very limited flattish tops, and, therefore, have progressed much further on the road to extinction—the fate of all monadnocks.

Minor buttes are rather numerous. Mention has been made of the "Topoe Butte" in the chapter on geology (p. 18). They are in groups in certain sections, notably in parts of Harding, Meade, and Fall River counties, and decrease greatly the agricultural utility of the areas affected.

(c) Elevation. The 2000 foot contour follows up the tributaries of the Missouri River 15 to 20 miles from their mouths, but the divides are higher than 2000 feet almost to the Missouri River. The highest part of the plains, about 3700 feet, is on the Pine Ridge in Shannon County. About the same elevation is attained in the forested buttes of Harding County. The base of the outer rim of the foothills of the Black Hills has an elevation of from 3200 to 3500 feet. The average elevation of the Great Plains section is perhaps 2800 feet.\textsuperscript{25}

(d) The drainage of this province is almost complete. There are five rivers which drain sub-equal areas. From north to south they are

1. Grand River, \textsuperscript{26}
2. Moreau or Owl River, \textsuperscript{27}
3. Cheyenne River, \textsuperscript{28}
4. Teton or Bad River, \textsuperscript{29}
5. White River.\textsuperscript{30}

The gradients of these streams are considerable—averaging from 8 to 10 feet per mile. The run-off therefore is very rapid in contrast with the streams in the eastern half of the state.

There are water-holes of two sorts on the plains. (1) the most numerous are small depressions which have been excavated by the wind. Most of these are only a few yards across and a few inches deep, though some have an area of several acres or more, and a depth of a few feet. Some of the larger ones locally are called lakes—Timber Lake in Dewey County being an example. The prevalent direction of their longer axes is northwest-southeast, from which direction come the stronger and more frequent winds during the seasons when the surface is dry and most easily excavated.

(2) Valley water-holes are also very numerous especially in the upper, shallower parts of valleys. During times of very heavy rains, even these shallow valleys are filled with torrents which locally cut out little basins, which contain water for considerable intervals after showers, to the great advantage of mosquitoes, stock, and man.


\textsuperscript{25} There are detailed U. S. toponomastic maps of the section bordering the Black Hills only. The large maps of the state, Plates I and II, in Dorton's "Geology and Underground Waters in South Dakota" (Water-Supply paper 227, 1909) show contours at 250 feet intervals.

\textsuperscript{26} So-called by Lewis and Clark, because of the imposing scenery at its mouth.

\textsuperscript{27} The Western Great Horned Owl seems to nest especially plentifully along the banks and bluffs of this stream.

\textsuperscript{28} From 'chief,' the French word for dog—a name said to be given because of the many prairie dogs of the region.

\textsuperscript{29} The Teton Indians occupied this valley at the time of the earlier voyagers. Lewis and Clark named this stream the Bad River because they were mistreated here by the Indians. The name has persisted because of the bad reputation of the stream for sudden flooding.

\textsuperscript{30} From the color produced by the erosion of the badland beds.
Badlands. Rugged areas, largely barren of vegetation, are found in various sections of western South Dakota. Such areas are popularly called Badlands. The Big Bad Lands along the White and Cheyenne rivers in Stanley, Pennsonton, Mellette, Washabaugh, Washington, and Custer counties include perhaps 95 per cent of the more conspicuous badland areas of the state. Badlands and regolitic formation near the East Short Pine Hills and Slim Butte in Harding county. Badlands on other formations are distributed widely, especially along the streams and divides, and about the bases of buttes.

Badlands are not worthless lands: this is illustrated by Fig. 6 and proved by many farms and ranches. They were given this name because they were found by the Indians and early explorers to be hard to cross. This is due to three main characteristics: (1) Most of the slopes are very steep, too steep to ascend or descend with a wagon, so that the "hills" and "jump offs" offer great obstacles to travelers unfamiliar with the region. (2) Many of the small gulles have vertical banks, and in the absence of bridges, it may be necessary to go considerable distances in order to cross them. (3) Surface water in the badlands is scarce and uninviting to say the least, though not harmful. Shallow wells generally have good water.

The topography of the badlands—and South Dakota badlands are type badlands—very interesting. The sculpturing is fascinating and suggests cathedrals, towers, statutory, haystacks, the billows of an ocean, and many other objects.

Clays, marls, and sandstones, many of which are gaily colored, are exposed to view. These varied tints, in most cases reds, salmon, or yellows, but in some places purples and whites, add greatly to the attractiveness of badlands.

One approaching the badlands may gradually ascend a rolling, grassy surface, until he suddenly comes to a crest of ridges and finds himself gazing from a height of 250 to 400 feet upon a labyrinth of winding ravines and narrow ridges, which in some places widen into broad buttes capped with tables formed by harder strata or surrounded with slender pinnacles, reminding one of the spires of a cathedral. At other points the hardred beds stand out as cornices and buttresses around the more protected. While this may appear near by, further away he may see graceful rounded domes and ridges, which remind one of hay-stacks or railroad embankments, where they continue as narrow ridges, with sharp crests and ledges upon the same level for some distance.

Badlands are developed when certain conditions are combined. (1) The rainfall occasionally must come in heavy showers, or "cloud-hangs" but must not be sufficiently abundant and regular to form a close vegetal cover. (2) The materials must be equally and incompletely indurated. In most places they are clays or shales with only relatively thin layers of sandstone or limestones. In South Dakota the Tertiary clays (especially the Oligocene clays) seem to be most favorable, though the bad-land type of topography is developed in semi-arid regions in many formations, during the early maturity stage of erosion (a third condition).

On the steeper slopes of the badlands there is little vegetation.  

**III. THE BLACK HILLS**

The Black Hills mass is a truncated dome about 100 by 50 miles in extent, nearly the size of Connecticut, two-thirds of which is in southwestern South Dakota, the other third in northeastern Wyoming. Several peaks, such as Harney, Terry, Custer, and St. Elmo, rise more than 5,400 feet above sea level. The limestone plateau near the South Dakota-Wyoming boundary is eroded less and is higher than most of the rest of the area, reaching a height of more than 7,000 feet. Many canyons.


On the plateau the granite in the crest of this plateau a few miles to the northwest of this point is named on the topographic maps but locally is known as "Crooks Tower." (Talle, A. D.: The Black Hills, p. 114, St. Louis, 1899).
some of them more than 1000 feet deep, add much to the picturesqueness of the Black Hills. The Hills as a whole are a mountainous region which has an average elevation of more than 5000 feet, a rugged topography, extensive exposures of firm rock, and heavy forests, which as seen from the distance appear nearly black. This area is in distinct contrast to the surrounding less rugged area, plain, developed at an average elevation of perhaps 2000 feet on formations which are in most places poorly consolidated.

The Black Hills province is divisible into four distinct physiographic regions, three of which form zones which surround the fourth or central area. These are shown in a generalized cross section (Fig. 13.)

![Fig. 13. A Diagramatic Cross-Section of the Black Hills](image)

(2) The outermost are the hog-back ridges (cuestas) which form the foothills. Their crests reach an altitude of 4500 feet, and their slopes are too steep for cultivation.

(3) "The Red Valley," some 800-1000 feet lower, is in most cases only two miles or so wide, and is largely tilled.

(4) The "limestone country" zone, varying in width from two to more than 15 miles, and averaging nearly 6000 feet in elevation, forms a sort of plateau into which canyons are cut. The more notable canyons in South Dakota are those of Rapid, Boxelder, Elk and Spearfish Creeks, and Fall River. The limestone country is extensively forested but has some farms on terraces and on the gently sloping summit portions.

(5) The more open "park area," developed on the chisal, slate, and igneous rock, has many broad valleys lower than the limestone plateau, but includes the higher peaks such as Harney, Terry, and Custer. There is a good deal of cultivated land in the broader valleys.

The drainage of the Black Hills is by tributaries of the Cheyenne River, forks of which nearly surround this area. The north fork is known as the Belle Fourche River. The chief streams named from the south northward are Fall River, French Creek, Spring Creek, Rapid Creek, Box Elder Creek, Elk Creek, Spearfish Creek, Red-water Creek. Rapid and Spearfish creeks are the larger.

The gradients of the streams are what might be expected in a low mountainous area. Falls, however, are infrequent. A tributary (the little Spearfish) falls over a limestone deposit some 30 feet into Spearfish canyon. Fall river has a low fall over a resistant ledge of rock. Sink holes are few, and confined mainly to the thin limestone overlying the red-beds. There are caves, however, in the other limestones. Crystal Cave in Elk Canyon and Wind Cave near Hot Springs are both rather extensive, and there are many smaller ones. They seem to have been developed before the extensive dissection of the anticline dome by sub-aerial erosion had taken place.

Although the Black Hills lack snow capped peaks and some of the magnificent grandeur of more lofty and rugged mountains, they possess a great deal of scenic beauty. In contrast with the dry plains which extend for at least a hundred miles in each direction, they are very attractive. The Harney range is the part which is most picturesque from a distance. "From the east it suggests a vast mass of thunder clouds rising along the western horizon. Seen from the height south of Custer, the crest of the range has much the appearance of a saw lying with teeth upwards; and a view from the northeast presents a wonderful landscape of lofty mountain peaks, tremendous precipices, and a vast and almost inaccessible wilderness."26 From the peak itself "we see a wilderness of wooded peaks encircled by a broad valley, the Red Valley, which the Indians call the Race course, this in turn enclosed by a wall of foothills. All is curiously symmetrical—a castle of geologic dimensions, with domes and turrets and a broad moat within its ramparts."29 Fifty miles to the southeast, the milk-white cliffs of the badlands can be seen. Nearly as far to the north-east, the whitish Bear Butte stands conspicuous just beyond the dark pine forest. Eighty miles to the north, several lesser buttes including Deers Ears and Castle Rock, may be seen through the haze. To the northwest the mountainous landscape is continued by the Bearlodge Mountains. The light colored area there is the granitic culmination, Warrens Peaks. To the west, more than a hundred miles distant, the Bighorn mountains may be seen occasionally, it is said.

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29Ogden, A.: A Ride Through the Black Hills, Atlantic Monthly, April, 1892, p. 455.
Fig. 14. One of the thousands of superb views of the Black Hills.

Fig. 15. The famous Granite "Needles" near Harney Peak and Sylvan Lake in the southern Black Hills.
Fig. 16. Bear Butte, near the northeastern corner of the Black Hills—a striking landmark.

Fig. 17. In the foothills of the Black Hills near Sturgis.

Fig. 18. Sylvan Lake. A view in the Granite Area near Harney Peak, Custer County.
CHAPTER FIVE

THE CLIMATE

General Characteristics, p. 50; Factors determining, p. 50; Winds, p. 50; Temperature, p. 53; Length of Day, p. 58; Humidity, p. 59; Evaporation, p. 60; Cloudiness, p. 60; Precipitation, p. 60; Variability of weather, p. 66; Supposed changes in climate, p. 67.

I. General Characteristics

The climate is invigorating. Clear skies and stimulating breezes prevail. Though great ranges of temperature occur, the dryness of the atmosphere helps to keep the sensible temperatures more nearly uniform. The summer season is usually long and warm enough for raising corn. The normal annual precipitation is sufficient for the crops grown. The seasonal distribution of precipitation is very favorable, since slightly more than three quarters normally fall during the six months, April-October. The autumns and winters have relatively little precipitation, to which fact is due the naturally-cured hay furnished by the native grasses, as heavy autumn rains, when they occur, leach out much of the nutrition. The "openess" of the winters encourages grazing and permits a greater amount of social intercourse among the rural population than could be the case were there deep snows.

The chief climatic handicaps are: (1) irregularity in the amount and distribution of precipitation; and (2) unseasonable low temperatures in the growing season. Periods of drought are common, but the south-central quarter of the state has never had a general failure of both the corn and small grain crops. In the western part of the state especially, the normal amount of rain in some years may fall in such short, heavy showers that most of it runs off and has no benefit to the crops. Late killing frosts in the spring are not infrequent and are a menace to fruit growing and occasionally injurious to corn. Early autumn frosts occasionally damage corn and flax crops especially in the northern sections.

2. Factors Determining the Climate

The climate of South Dakota is determined by (1) the latitude, (2) the position of the state in the continental interior, and (3) the winds. The position of South Dakota gives it a continental type of climate with hot summers and cold winters, and means remoteness from sources of moisture. Because of the latitude (45°-46°) the days are long during the growing season. The state is located within the belt of prevailing westerly winds and is affected by many of the cyclonic storms which cross the continent in that belt. The winds are the chief agents in the distribution of moisture. They also greatly influence temperatures and relative humidity.

3. Winds

Northwest winds prevail during the colder six months and southeast winds during the warmer six months. Winds from other directions are of relatively short duration. The prominence of northwest and southeast winds is due to the influence of cyclonic storms whose centers pass eastward over or near South Dakota.

Most of the winds are of moderate velocity—the average being about ten miles an hour. There are very few calm days, about 10 in the year, though calm nights are frequent. In the valleys and lowlands the wind often increases in force as the day advances and dies down at nightfall, but this is not often the case on buttes.

The persistent and moderate velocities of the wind favor the use of windmills, which have become very numerous except where artesian flows may be obtained readily.

The rate of evaporation is higher than it would be if winds were less persistent. Thus they strongly influence sensible temperatures and increase transpiration from vegetation, making the water requirements of crops somewhat greater than in sections having less wind.

(a) Wind Velocities. The average wind velocity, (in miles per hour) for the most windy and the least windy months at four South Dakota and one northern Nebraska station is shown by Table 1.1

<table>
<thead>
<tr>
<th>Section of State</th>
<th>April</th>
<th>July</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huron, S. D.</td>
<td>13.8</td>
<td>16.4</td>
<td>11.6</td>
</tr>
<tr>
<td>Pierre, S. D.</td>
<td>12.1</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Rapid City, S. D.</td>
<td>9.3</td>
<td>7.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Yankton, S. D.</td>
<td>10.8</td>
<td>6.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Valentine, Neb.</td>
<td>12.0</td>
<td>10.0</td>
<td>11.0</td>
</tr>
</tbody>
</table>

The differences between the several stations appear to be due to differences in local conditions. Huron and Valentine are located on nearly level plains. The other stations are protected somewhat, Pierre from east winds by the bluffs along the Missouri Valley in which this city is located, and Rapid City from northwest and southwest winds by foothills of the Black Hills (Fig. 42.5)

(b) Gaëls. For the decade 1891-1900 Pierre had an annual average of 18.8 days with gaëls;1 Huron an average of 36.7 days, and Sioux City, Iowa, 27.3 days. The months with the most numerous gaëls and the average number in each for that decade is shown by Table 2.5

<table>
<thead>
<tr>
<th>Station</th>
<th>N</th>
<th>NE</th>
<th>E</th>
<th>SE</th>
<th>S</th>
<th>SW</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre, S. D.</td>
<td>80</td>
<td>21</td>
<td>16</td>
<td>17</td>
<td>13</td>
<td>33</td>
<td>188</td>
</tr>
<tr>
<td>Huron, S. D.</td>
<td>97</td>
<td>10</td>
<td>10</td>
<td>3</td>
<td>143</td>
<td>52</td>
<td>357</td>
</tr>
<tr>
<td>Sioux City, Ia</td>
<td>138</td>
<td>22</td>
<td>15</td>
<td>1</td>
<td>207</td>
<td>10</td>
<td>627</td>
</tr>
</tbody>
</table>

Table 3—Total number of days with gales—winds of 40 miles per hour and over from the direction as indicated during the ten years 1891-1900.

<table>
<thead>
<tr>
<th>Station</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre, S. D.</td>
<td>13</td>
<td>11</td>
<td>17</td>
<td>18</td>
<td>29</td>
<td>28</td>
<td>19</td>
<td>17</td>
<td>13</td>
<td>14</td>
<td>10</td>
<td>6</td>
<td>127</td>
</tr>
<tr>
<td>Huron, S. D.</td>
<td>17</td>
<td>23</td>
<td>14</td>
<td>15</td>
<td>22</td>
<td>49</td>
<td>42</td>
<td>28</td>
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<td>29</td>
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<td>262</td>
</tr>
<tr>
<td>Sioux City, Ia</td>
<td>20</td>
<td>29</td>
<td>29</td>
<td>42</td>
<td>32</td>
<td>26</td>
<td>12</td>
<td>20</td>
<td>19</td>
<td>16</td>
<td>17</td>
<td>23</td>
<td>273</td>
</tr>
</tbody>
</table>

1Summaries of Climatological Data of U. S. Bull. W., U. S. Weather Bureau, p. 73.
2Gales as defined in the report from which these data are taken are winds of more than 40 miles per hour.
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4. Temperature

(a) Mean Annual. Fig. 19 is a map showing the average annual isotherms for the state. The mean annual temperature of the state is about 45.5° for the eastern half and 44.5° and for the western half about 45.6°. The northern counties have an annual mean about 5° lower than the southern counties. For reasons to be discussed, the northeastern quarter of the state is the coldest and the southeastern quarter the warmest—while the southwestern has the least cold in winter. Greenwood in Charles Mix County, however, for many years reported the highest monthly and annual mean. The coldest station is Roslyn in Day County. Winds which are warmed by descent from the Rocky Mountains, but which soon lose their excess heat, make the western half of the state warmer than the eastern. Local topographic conditions at Greenwood in the Missouri Valley and at Spearfish in the Black Hills favor temperatures higher than normal at nearby stations. The Black Hills are a complicating factor in respect to temperatures.

(b) Mean Monthly Temperatures. The mean monthly temperatures for Huron, Pierre, and Rapid City are as follows:10

Table 4—Mean Monthly Temperatures

<table>
<thead>
<tr>
<th>City</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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</table>

10All temperatures are in degrees Fahrenheit.

S. W.; Summary for Sect. 84, U.S. Weather Bureau, p. 2, 1908.
For the state as a whole, the average temperature for July, the warmest month, is about 73°; for January, the coldest, about 13°. August is nearly as warm as July, and February nearly as cold as January; in fact, many of the lowest temperatures have been recorded in February.

(c) Mean Daily Temperatures. The following tables give the daily normal temperatures at Huron and Rapid City.

Table No. 5.—Daily Normal Temperature—Huron S. D.
1882-1905

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From the above tables it may be observed that at Huron there are 67 days (June 19-August 4 inclusive) with a normal temperature of 68° or above and at Rapid City 58 such days (June 23-August 23). At Huron there are 165 days (5½ months) with the daily normal temperatures 50° or above and at Rapid City 161 days (May 2-October 9 inclusive). Both stations have about sixteen weeks during which the daily normal temperature is below 32°. Rapid City has no day with a normal temperature below 20°, while Huron has 90 such days, and 33 days with normal temperature of 16° or lower. The temperatures at Rapid City are influenced by its situation at the eastern edge of the Black Hills where chinook winds often are strongly developed.

(d) Maxima and Minima Temperatures. Mean and extreme maxima and minima temperatures are of great significance to life—their influence on physical activities and apparently limit the range of species. Maxima temperatures of over 100° have been recorded for most of the stations, outside the Black Hills, and minima temperatures below -40° have been recorded from most of the long established stations except those in the Black Hills region. The extremes for the state are 115° and -50°—a range of 165°. Several stations have recorded an annual range of more than 150°.
The high maxima in South Dakota stimulate growth in some plants, notably corn, as long as sufficient moisture is available. If that fails, many plants prorly wither. Winds accompanying high temperatures frequently are “hot winds,” although such winds are not necessarily confined to days having high maxima. Where daily maxima of 100° to 110° occur in summer, as in most of the state, they may be expected not infrequently. These winds cause such rapid evaporation that plants which cannot absorb through their roots fast enough to equal the transpiration soon wilt. Plants acclimated to more humid regions may wither at such times, while there still is an abundance of soil moisture for plants differently constituted.

The influence of the extremely low minima temperatures in South Dakota is less clearly injurious than in the case of the maxima. Freezing pulverizes the soil by rupturing the cohesion between many soil particles. In extreme cases, however, cracks may be three feet deep and may be opened and aerated and deeper freezing permitted. Various plants are barred from the state because of the winter temperatures. The elimination is accomplished in two ways: (1) Drying winds continue to evaporate moisture from aerial parts when, because of the low ground temperatures, it cannot be replaced by the movement of sap. This factor is believed to be largely responsible for the absence of forests from many sections where the relative humidity in winter is low. (2) Freezing and thawing uproots some perennials. Red clover is not a success in most of South Dakota largely because it winter-kills in this manner.

(c) The Daily Ranges in Temperature. The greatest daily ranges occur in the winter season when cyclonic storms are most strongly marked. Daily ranges of more than 50° normally occur in all months at several stations in the state. Ranges of more than 50° occurred widely in January, 1913; but in January, 1914, the greatest local range was 56°. In March, 1914, several localities had daily ranges of more than 70°, while in 1912 the greatest local range in March was 55°. Daily ranges of less than 20° are rare.

Table 9.—Local-range—1913-14

<table>
<thead>
<tr>
<th>Month</th>
<th>Maximum range for any station</th>
<th>Average daily range (all stations)</th>
<th>Mean daily range by stations, later of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>71°</td>
<td>50°</td>
<td>26°</td>
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<tr>
<td>Feb.</td>
<td>57°</td>
<td>46°</td>
<td>25°</td>
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<tr>
<td>March</td>
<td>58°</td>
<td>60°</td>
<td>23°</td>
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<tr>
<td>April</td>
<td>54°</td>
<td>40°</td>
<td>24°</td>
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<tr>
<td>May</td>
<td>56°</td>
<td>42°</td>
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<tr>
<td>June</td>
<td>51°</td>
<td>40°</td>
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<tr>
<td>July</td>
<td>56°</td>
<td>45°</td>
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<td>August</td>
<td>55°</td>
<td>48°</td>
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<td>Sept.</td>
<td>55°</td>
<td>48°</td>
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<td>October</td>
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<td>November</td>
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<td>48°</td>
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<td>December</td>
<td>55°</td>
<td>40°</td>
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The mean daily range for the month does not clearly show the influence of the passage of cycloonic storms; in fact the higher means occur in July-November, inclusive, when cycloonic storms are least prominent. These months are the warmer of the drier months of the year. Warmth and aridity both favor large ranges of temperature. The differences between these daily means (average 26°) and the maximum ranges (averaging 58° and 46°) shown in columns 3, 1 and 2, Table 9, are largely the result of the passage of such storms.

(f) Diurnal Variability of Temperature. The maxima of consecutive days frequently differ by more than 25° and not rarely by 30°, and the minima by slightly larger figures. Such sharp changes from day to day result from the passage of cycloonic storms.

The great daily range and the sharp marked diurnal variability are of much geographic importance. Rapid changes of temperature are active factors in the disruption of rock. They also are withstood with difficulty especially by now-comers such as new-born animals. The normal range of more than 25° between night minima and day maxima generally means that the nights are cool enough for restful sleeping.

Unseasonable killing frosts are associated with the great daily range of temperature.

(g) The Length of the Growing Season. The interval between the

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Footnote: The mean maxima and the mean minima were computed from the monthly minima (Agricultural Summary for South Dakota, U. S. Weather Bureau, 1910-14, pp. 7, 8). The extreme maxima and the extreme minima are the highest and lowest temperatures recorded at the several stations during the period between the date of their establishment and 1905, (Bull. W., U. S. Weather Bureau, Summaries for Sections 33 and 34, 1913).
last killing frost in the spring and the first in the autumn—the crop-growing-season—averages nearly 130 days. For the northern half of the state it is nearer 120 days and for the south-eastern quarter it is 140 days. The northern border has the shortest season (115 days) and the lower Missouri valley the longest (150 days). The frost-free period around the base of the Black Hills, and on the slopes of some of the buttes where there is good air drainage is a week or two longer than the average for the state.

Fig. 26. Date of the average (——) and the last recorded („„„) killing frosts in the spring. From U. S. W. B.

Figures 20 and 21 are diagrams showing the dates of last killing frosts in spring and first killing frosts in autumn. The full lines indicate the average dates and the broken lines the latest recorded killing frosts in the spring and the earliest in the autumn. The interval between these latter dates is for the south-eastern section about 95 days and for the north-central, about 70 days. At the higher elevations (above 4500 feet) in the Black Hills, killing frosts have been recorded in every month of the year. Both the average and the minimum growing seasons in the eastern tier of counties of the northeastern corner of the state are nearly a week longer than in the counties adjacent to the west, far causes which are not evident.

Periods of several days with abnormally high temperatures followed by a killing frost in May, except in the foothills, unfortunately for fruit growing, are frequent. The cultivated plum crop, for example, was largely destroyed in the southeastern counties three times in the past ten years (1904-1913.)

(5) The Length of Day

The longest day for central South Dakota has 15½ hours of daylight, the shortest a little less than 9. From April 28 to August 17 each day

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**Fig. 21.** The average earliest (——) and the latest recorded („„„) killing frost in the fall. From Bull. V., U. S. W. B.

has more than 14 hours of daylight; and from May 20 to July 20 more than 15 hours of sunlight, and from 3 to 4 hours of twilight. The length of the day during the growing season helps to compensate for the short frostless season, since other conditions being comparable, crops mature more rapidly in latitudes having long summer days than in lower latitudes.

(6) Humidity

The following table shows the mean relative humidity at certain morning and evening hours during the growing season. The humidity for 8 P. M. during the growing season is low, 30 per cent to 57 per cent, with an average of about 47 per cent. In the afternoon it doubtless frequently is under 40 per cent, as the daily maxima usually are at least 10 degrees higher than the 8 P. M. temperature.

The average annual humidity of the northeastern part of the state is about 70 per cent; of the south-western quarter of the state 60 per cent, and of the remainder about 65 per cent.

**Table 10. Mean Relative Humidity for Morning and Evening Hours During the Growing Season**

<table>
<thead>
<tr>
<th>Location</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Year</th>
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<tbody>
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<td>Huron</td>
<td>8 A. M.</td>
<td>80</td>
<td>78</td>
<td>82</td>
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<td></td>
<td>8 P. M.</td>
<td>52</td>
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<td>Yankton</td>
<td>8 A. M.</td>
<td>79</td>
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<td></td>
<td>8 P. M.</td>
<td>74</td>
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<tr>
<td>Pierre</td>
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<td>57</td>
<td>49</td>
<td>48</td>
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<tr>
<td></td>
<td>8 P. M.</td>
<td>71</td>
<td>71</td>
<td>67</td>
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<td>70</td>
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<tr>
<td>Rapid City</td>
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Illinois has an average normal humidity of 66 per cent for this hour.
7. Evaporation

Because of low relative humidity, high summer temperatures, and persistent wind, the rate of evaporation is high. Experiments have shown that in most parts of the state, evaporation from a water surface would amount to about 40 inches annually. In the northeast corner, however, it would be only 30 inches, and in the southwest corner over 50 inches.\(^23\)

The rate of evaporation is important, for the amount of water that character of the native vegetation is in no small degree a response to the ratio between the supply of moisture and loss by evaporation.

The rate of evaporation has much to do with what is known as sensible temperatures. The difference between the temperature as felt by human beings (sensible temperature) and the temperature as shown by the thermometer often is great. Dry air at 100° may cause less discomfort than moist air at 80°. Sunstroke is rare in South Dakota skin and keeps the body from becoming too warm.

The very low temperatures recorded occasionally in winter are less uncomfortable than are much higher temperatures in humid regions. The thermometer registers —40° the lowest temperatures are usually associated with calm, clear weather.\(^24\) While there are days in the winter when the temperature is a few degrees above zero.

8. Cloudiness

South Dakota is known as the “Sunshine State,” not because it surpasses in this respect other states, especially those in the south, but because of the contrast between South Dakota and the Eastern States born in South Dakota came.

At Huron\(^25\) during the winter months there is 62 per cent of the total possible 100 per cent of sunshine; during the spring 64 per cent; during the summer 74 per cent, and during the fall 69 per cent. The year as a whole averages 72 per cent of the possible 100 per cent. The average annual hours of sunshine for South Dakota is 2750 hours.

The per cent of clear days in the year for 1908-13 averaged 46; of partly cloudy days 30, and of cloudy days 24.\(^26\)

The impression is current in the state that cloudy days in South Dakota are less numerous than cloudy days in the more humid states. The Midwest Bureau does not take observations in the density of clouds. A day when most of the sky is cloudy is recorded as cloudy. The effect upon the air and soil temperatures and upon life, especially upon the activity of animals and of plant growth, varies widely with the density of the cloudy canopy. South Dakota has few “lead days” in a year.

9. Precipitation

(a) Annual. The average annual precipitation in South Dakota is approximately 20 inches; in the eastern half about 22.5; in the western half about 17 inches.\(^27\) (Fig. 22.) In the former 53 per cent, and in the latter 81 per cent, usually is received between March 1 and September 30.\(^28\) (Fig. 23.) The amount of rainfall decreases toward the west and north. Because of the increase in altitude, the central portions of the Black Hills receive more precipitation, especially snow, than do the surrounding plains.

(b) The Sources of the Moisture. The Rocky Mountains force the precipitation of much of the moisture while the westerlies carry from the Pacific Ocean, so that little or none of it is dropped over South Dakota. Because winds from the north are warmed as they come into lower latitudes, they are drying winds. Moisture from the Atlantic Ocean is largely prevented from reaching South Dakota by the fact that the prevailing winds are westerly, while the occasional easterly winds do not come from the coast. Therefore the Gulf of Mexico is the great source of moisture for South Dakota, as for most of the Mississippi basin.\(^29\) The moisture-bearing winds are drawn to Dakota by the low pressures which accompany the passage of a cyclonic storm across the northern border of the United States. It is doubtful if moisture often is carried directly from the Gulf to South Dakota. The winds associated with cyclones move in a spiral direction and air which was moving northward when it left the Gulf would form an east or even northeast wind before it reached the latitude of Dakota. The rapidity of the passage of normal lows is an even stronger reason for this doubt. It is not until the lows have crossed the Rockies that they strongly attract air from the Gulf. In 24 hours after crossing the mountains, the center of the low usually will have crossed the Dakotas. Since the distance from the Gulf to central South Dakota is some 1500 miles, a velocity of 55 miles an hour would have to be maintained for 24 hours in order to have the moisture carried directly to South Dakota.\(^30\) The moisture en route to South Dakota may be precipitated and re-evaporated once, a few, or perhaps a

\(^{23}\)Salisbury, Barrows & Tower: Elements of Geography, Map of Mean Annual Evaporation on p. 77, (New York, 1912).

\(^{24}\)Climatology of the U. S. Weather Bureau, p. 498.


\(^{26}\)The Summaries of Climatological Data by Sections," Sections 33 and 34, Bull. W., U. S. Weather Bureau, 1912.

score of times before South Dakota is reached. It is obvious that each precipitation greatly increases the likelihood that some share will not reach Dakota, but will return to the Gulf in a river, be appropriated by a plant or animal, enter the underground circulation or when evaporated, be carried away from South Dakota by contrary winds. This is proved by the gradual decrease in rainfall with increasing distance from the Gulf.

Table 10a. Daily Normal Precipitation—Huron

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Table 11. Daily Normal Precipitation—Rapid City, 1888-1906

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Fig. 23. Average Monthly precipitation at nine well distributed stations.
(c) **Monthly Precipitation.** The monthly distribution of precipitation is favorable to agriculture. The months of heaviest rain are May, June and July. The least precipitation is received during January and February. (Fig. 23.) The following table gives the mean monthly precipitation at Huron, Pierre and Rapid City, representing the eastern central and western sections of the state.

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<td>4.6</td>
<td>3.6</td>
<td>3.8</td>
<td>3.2</td>
<td>4.2</td>
<td>4.1</td>
<td>4.3</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>1907-1908</td>
<td>4.8</td>
<td>3.7</td>
<td>4.0</td>
<td>3.3</td>
<td>4.4</td>
<td>4.3</td>
<td>4.5</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>1908-1909</td>
<td>5.0</td>
<td>3.8</td>
<td>4.2</td>
<td>3.4</td>
<td>4.6</td>
<td>4.5</td>
<td>4.7</td>
<td>4.7</td>
<td>4.9</td>
</tr>
<tr>
<td>1909-1910</td>
<td>5.2</td>
<td>3.9</td>
<td>4.4</td>
<td>3.5</td>
<td>4.8</td>
<td>4.7</td>
<td>4.9</td>
<td>4.9</td>
<td>5.1</td>
</tr>
<tr>
<td>1910-1911</td>
<td>5.4</td>
<td>4.0</td>
<td>4.6</td>
<td>3.6</td>
<td>5.0</td>
<td>4.9</td>
<td>5.1</td>
<td>5.1</td>
<td>5.3</td>
</tr>
</tbody>
</table>

**Fig. 24.** The average rainfall of the eastern half of South Dakota in the five growing months as compared with other states.

### Table 12. The Normal Monthly Precipitation

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Huron</td>
<td>3.5</td>
<td>3.0</td>
<td>3.3</td>
<td>3.2</td>
<td>3.7</td>
<td>3.8</td>
<td>2.6</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
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<tr>
<td>Pierre</td>
<td>3.7</td>
<td>2.9</td>
<td>3.2</td>
<td>2.7</td>
<td>3.6</td>
<td>3.7</td>
<td>2.5</td>
<td>1.7</td>
<td>1.6</td>
<td>1.6</td>
<td>1.8</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Rapid City</td>
<td>3.9</td>
<td>3.1</td>
<td>3.3</td>
<td>2.8</td>
<td>3.7</td>
<td>3.8</td>
<td>2.7</td>
<td>1.6</td>
<td>1.5</td>
<td>1.6</td>
<td>1.8</td>
<td>1.7</td>
<td>1.7</td>
</tr>
</tbody>
</table>

**Fig. 25.** The average annual rainfall at Yankton, Spearfish and Pierre, from 1892 to 1911.

### Table 13. Rainfall Per Month (Average of Huron, Yankton, Pierre and Rapid City)\(^2\)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1909</td>
<td>.85</td>
<td>4.16</td>
<td>3.84</td>
<td>2.84</td>
<td>2.36</td>
<td>2.24</td>
</tr>
<tr>
<td>1910</td>
<td>.71</td>
<td>1.67</td>
<td>1.70</td>
<td>3.04</td>
<td>1.84</td>
<td>2.21</td>
</tr>
<tr>
<td>1911</td>
<td>1.50</td>
<td>1.66</td>
<td>1.58</td>
<td>2.08</td>
<td>2.77</td>
<td>1.99</td>
</tr>
<tr>
<td>1912</td>
<td>2.34</td>
<td>2.74</td>
<td>1.66</td>
<td>4.50</td>
<td>2.84</td>
<td>1.76</td>
</tr>
<tr>
<td>1913</td>
<td>2.11</td>
<td>4.10</td>
<td>2.16</td>
<td>3.20</td>
<td>2.10</td>
<td>1.86</td>
</tr>
</tbody>
</table>

\(^2\)A rainy day is, according to the definition of the U. S. Weather Bureau, one having .01 or more inches of precipitation.

\(^3\)Data from which Fig. 26 was constructed were obtained from the "Summaries of Climatological Data of the U. S. by Sections," 1909, 1910, 1911, U. S. Weather Bureau. Fig. 26 is copied from Bull., U. S. Weather Bureau.


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\(^5\)Sig. -- 5.
The average yields of the chief crops for the state as a whole fluctuate widely from year to year. While wheat yielded but 6.8 bu. per acre in 1894, it yielded 12 bu. in 1895, 8 bu. in 1897, 19 bu. in 1900, 12.8 bu. in 1910, 4 bu. in 1911, and 14.2 bu. in 1912. Similarly the yield of oats has ranged from 7.4 to 33 bu. per acre; rye from 4.5 to 20.2 bu. per acre; corn 4.2 to 33.5, potatoes 23 to 105, and hay from .55 to 1.46 tons per acre. Fluctuations of far greater amounts have taken place within small areas. Nearly complete failures in one section may be counter-balanced in such averages by excellent yields in other localities.

Table 14. Crop Yields in Various Years in Bushels Per Acre

<table>
<thead>
<tr>
<th>Year</th>
<th>Average for South Dakota</th>
<th>Aver.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1894</td>
<td>6.8</td>
<td>12.8</td>
</tr>
<tr>
<td>1910</td>
<td>12.8</td>
<td>4.0</td>
</tr>
<tr>
<td>1911</td>
<td>7.4</td>
<td>22.0</td>
</tr>
<tr>
<td>1912</td>
<td>4.2</td>
<td>7.4</td>
</tr>
<tr>
<td>1886-90</td>
<td>12.8</td>
<td>22.0</td>
</tr>
</tbody>
</table>

(1) Snowfall. The average annual snowfall for the state is about 24 inches, but the variations from year to year and from place to place are very great. For example, 247.2 inches have been recorded in one winter (1910) at Greenmount, Lawrence County, in the Black Hills at an elevation of 6300 feet, and in 1886-87 more than 100 inches were recorded at many points in the eastern half of the state. In some other winters there has been only a slight snowfall in most sections. The snow usually remains on the ground. Sleighing is infrequent. Grazing may be continued throughout all but the exceptional winters. When such winters have come (as in 1886-87, 1897-8, 1897-8), there has been great winter loss of livestock. The loss in 1886-87 is said to have been more than 50% of the cattle on the range in the Black Hills region.29 Of recent years, however, stockmen have not relied entirely upon grazing and the losses have been far less.

(2) Hail. There is an average of about 30 days per year with thunderstorms.30 The summer rains generally are of the thunderstorm or conventional type, often giving heavy downpours in a few hours, but rarely more than two inches fall within 24 hours. Hail sometimes accompanies the thunderstorms in sufficient quantities to be destructive, but the losses due to it in South Dakota are far less than in some of the states to the south.

10. Variability of the Weather

The weather in South Dakota is variable, as is the weather of most sections of northern United States. The variability is produced chiefly by the procession of those cyclonic storms—high pressure and low pressure areas—which cross the continent in the general latitude of South Dakota. The lows usually are accompanied by cloudiness and precipitation; the highs by lower temperatures and clearer skies. A given cyclone or anti-cyclone usually passes in three days, the center crossing the state in one day. A rapid succession of changes in the weather therefore is typical for all parts of the state. The fluctuations in temperature from day to day frequently are more than 30°. The effects of such variation have been commented upon.

11. Supposed Changes of Climate

Many old settlers claim that the climate has changed. Droughts undoubtedly are less disastrous now than formerly, but the cause is probably to be found in other reasons than changes of climate. There is a better adjustment of crops to the area;—crops which are better able to withstand the conditions, and varieties which are better adapted have replaced the ill adapted crops and varieties introduced by the early settlers. The population is not so near the margin of want as formerly. With diversified farming and stock raising, a reserve supply of food and stock, and probably a bank account, a single dry year, or even two or three in succession, cannot cause as much suffering as similar droughts would have caused in pioneer days. The climatic influence of the artesian waters brought to the surface is doubtless negligible, and is more than offset by the drainage of many lakebeds. The U. S. Weather Bureau and others have made extended studies of the changes in climate reputed to follow settlement and have been unsuccessful in establishing that there have been any such changes. Professor Henry of the U. S. Weather Bureau has recently summarized and discussed this general topic in an illuminating manner.31 His conclusions are:

"It is apparent on inspection that the annual precipitation progresses from 1910 to 1894 in an exceedingly irregular manner and without, so far as discoverable, any approach to uniformity in time or space. One year of heavy rain may be succeeded by a second, third or even fourth year of abundant precipitation, and again a single year of heavy rain may be followed immediately by a year of light rain. The probability that the rainfall will be normal is very small. The distribution mostly to be expected is that which approaches closely to or falls slightly below the normal."32

29The Year Book of the Department of Agriculture, 1894-1912.
34Loc. cit., pp. 198, 201.
**CHAPTER SIX**

**THE BIO-GEOGRAPHY**

Introduction, p. 68; The Bio-Geographic Districts, p. 77; The Ecological Formations, p. 79; Steppe, p. 92; Prairie, p. 95; Meadow, p. 97; Woodland, p. 98; and Aquatic, p. 103.

1. INTRODUCTION

Although the native flora and fauna represent but a small portion of the life which in any area ultimately may be put to the use of civilized man, and may include few species of conspicuous economic significance, their study is well worth while for several reasons. (1) It makes practicable a comparison even of widely separated areas in respect to climate, geology, water and soil. (2) It greatly extends our knowledge of geographic conditions, making possible, for example, an intelligent selection of useful varieties of plants and animals which may be introduced with probable success. (3) The flora in many cases is an indication of the agricultural possibilities of an area. (4) Vegetation and animals affect run-off, erosion, and soil. (5) The native biota has vastly influenced human activities, and its study therefore is a prerequisite to a full understanding of the human geography of any region. These points will be taken up after a brief discussion of some requirements of species and some differences between the original and possible future biotas.

Each species has many and in most cases complex requirements such as proper amounts of (1) moisture, including water vapor as well as liquid water, (2) heat, including minimal periods when the temperatures are above definite minima, for example 32°, (3) light, including sunshine, (4) food, inorganic as well as organic, (5) appropriate anchorage for sessile forms, (6) proper sites in which to rear their young, (7) not too powerful rivals or enemies, (8) effective means of defense, and so forth. Moreover, various plants are fertilized by few and some of them by highly specialized insects. The range of such plants cannot extend much beyond that of such insects unless they are propagated vegetatively.

Climate may be favorable in almost any region to various species which are not found there, but if only one of the numerous requirements is unfulfilled, that species is barred. In a region where the climate is as variable as in South Dakota, an area perhaps may be favorable for a few native trees during most years, but not during the drought or the occasional unseasonable frost may keep the species out. Species which possess means of prompt re-introduction may soon reversely established after local extermination. The great significance of means of dispersal is indicated by the fact that the species which are most widely distributed over the globe are those which are distributed through the air by the winds, as willows, birches, poplars, balsam, and fungi, or those that are able to fly, as most insects, birds, and bats, while the next most widespread are those disseminated through the agency of civilized man. Deficiency in means of dispersal tends to retard greatly the spread and to restrict the ranges of many interdependent groups, as examples of which are tree-squirrels and nut-bearing trees, fruit-bearing birds and beetles, and shrubs. Herbs whose flowers depend largely upon wide-ranging mammals for their spread. Numerous animals are carried by others while in egg, larval, or adult stages. Examples are certain molluscs which attach themselves to the gills of fish, and some others which cause sickness and death in cattle.

There are numerous illustrations of the success of species which have crossed the barrier of sea, mountain or other unfavorable tract, and have become established in South Dakota. The English sparrow, (Passer domesticus) Norwegian rat, (Rattus rattus) and house mouse (Mus musculus) among the animals, the house fly (Musca domestica) tent caterpillar and potato beetle (Leptinotarsa decemlineata) among the insects, the Russian thistle, (Salsola) sweet-clover (Melilotus) and pigweed (Chenopodium album) among the plants are a few examples.

The complex biota may prosper if the conditions have been nearly exterminated over large portions of the state. (6) The elimination of competitors. The bison, antelope, and mustangs were rivalled of cattle, sheep and horses, and were of necessity nearly exterminated before the latter became common. Without the breaking up of the sod and the consequent destruction of the native vegetation of the area affected, the raising of nearly all crops would be impossible in South Dakota. For these reasons and perhaps others, the flora and fauna which will occupy this area when it is finally put to its maximum use by highly civilized man will be far more abundant, profitable, and diverse than that which originally prevailed, and it probably will be richer in species, although many native species will be exterminated over large areas. This entire process will take place along the limits of the area or the region of the world over will yield species which will be introduced and put to the use of man. (2) Some of the plants now useless doubtless will become useful, with the advance of civilization. Two decades ago it was not anticipated that it would be profitable to give to desert lands where it grows a value of as much as $20 per acre which it now does because it became profitable to extract the rubber which it was found to contain. (3) The improvement of native stocks by selection and hybridization will be accomplished, and there is great possibilities. (4) The acclimation of certain forms not at first successfully raised is practicable. (5) A thorough adjustment of the biota to the geographic conditions, especially climate and soil, would enormously increase the productivity of the area. (6) The higher population and preservation and increased local markets may make it profitable to put all portions of the area to more effective use. (7) Drainage or irrigation of areas susceptible thereto very greatly increases their productivity.

Because large areas in South Dakota were primitively, or still are very uninviting, does not prove that they will not support a large population in the future. The area irrigated by the Bellefourche project located mainly on gumoe, but a short time ago was exceedingly unattractive. Now it is worth more than $100 per acre. Areas, miles in extent, in which the range days could not permanently support a single steer because of the occasional lack of oilling water and winter food, can now, with the help of wells, a small amount of hay, and shelter, support scores per square mile. Great confidence is expressed by those best entitled to an opinion, including Prof. N. E. Hansen of the U. S. Experiment Station at Brookings, that within a few dozen miles of millions of acres of South Dakota will be sprinkled with luxuriant plants of certain Siberian and hybrid strains of alfalfa, and

"For an excellent discussion of these four methods see Hendrick, U. P.; "Multiplicity of Crops as a Means of Increasing the Future Food Supply." Science, Oct. 30, 1914, pp. 611-612."
thus the productivity of certain lands increased from nearly nil to exceed that of the present best grazing lands of the state.

Although the original biota thus differs widely from the biota likely to prevail under conditions of high civilization and dense population, its study is distinctly valuable as a preliminary step in the determination of the geographic conditions of the area.

Bio-geography extends our knowledge of geographic conditions in various ways: Some of them are listed below:

1. Climatic data of nearly all sorts may be greatly supplemented.

2. The general geographic conditions are indicated by the ecological aspects.

3. Slight variations in these general conditions are marked by corresponding changes in vegetation and animals.

4. Many differences in the various climatic factors are revealed.

5. Differences in soils are indicated in many places.

6. The nature of the subsoil and the depth of the soil is revealed at many points.

7. The depth to the water table is shown in many places.

8. Many slight differences of slope or elevation are made conspicuous.

9. The likelihood that an area will be flooded, or, in case of areas normally submerged, will be exposed, is shown in many places.

10. The value of certain areas for the production of certain crops is suggested.

11. The rate of erosion of slopes is suggested.

12. The directions or points of the compass are indicated roughly by various animals and plants.

13. The physiographic or even geologic history may be illuminated.

These points demand some further discussion.

1. Climatic data of nearly all sorts are greatly supplemented:

In mid-latitudes, especially in continental interiors, there may be great climatic variation from year to year and decade to decade. Records of a moderately satisfactory sort cover but a short period for most of the Weather Bureau stations in South Dakota. At but four stations do they cover twenty-five years, and at but thirty-four, most of which are in the eastern third of the state, more than fifteen years. Therefore the local climatic records permit only an imperfect knowledge of the climate of the state. By using the dominant species as an index, communities of Nebraska and Kansas which have nearly the same climate can, but that by that of centuries. The study of the native biota therefore makes possible in many places a very great extension of knowledge concerning the climate.

2. The general geographic conditions are indicated in most places by the ecological aspects of the biota and therefore furnish indices for comparison of areas:—Plants closely similar in appearance (ecological aspect) have evolved in various plant families under the influence of similar conditions. Certain spurge in the drier parts of Africa and the horsetails are represented there by forms which might be classed as arborescent. The plants of grasslands are chiefly herbaceous. Plants resembling the same are found in the tropical rain forests; even the grasses and horsetails are represented there by forms which might be classed as arborescent.

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3 and 4. Minor climatic differences are shown in many places by minor differences in the biota:

The effects of decreased evaporation or increased precipitation are shown by differences in the ecology of different areas occupied by a general ecological type, as between the southern and northern prairie, steppe or woodland. Plants such as the twinflower or bunchberry, which are restricted to the moister or more mesophytic sides of canyons at low elevations in the southern part of South Dakota are much more widespread in the northern part, and at higher elevations in the Black Hills.

The persistence and velocity of the wind at various exposed points is shown by the stunted (krumholts) character of the woody growth, and the direction from which the prevailing winds blow is shown in many cases by the lopsided shape of trees.

As an illustration of the indication of minor temperature differences the following case showing a conspicuous influence of a season somewhat long enough to free from killing frosts and also to kill off weeds in Harding County, in the northeastern corner of the state, wild plum thickets are numerous and extensive on portions of the slopes of the forested buttes, while they are rare elsewhere in that part of the state. The climate at the Weather Bureau station in the Black Hills is cold all the year round. All the forestless season usually too short for even wild plums. Their abundance on the slopes of the buttes indicates clearly a longer frostless season at that elevation. An observing horticulturist has located in this belt an apple orchard which has yielded well for several years. Similar belts are indicated by the native vegetation in the Black Hills and elsewhere.

5. Differences in soils are indicated by the material brought up by burrowing animals and in many places by different types of vegetation:
the red beds is made conspicuous at a distance of many miles, because
pines occupy the limestone to its very margin in most places.
6. The nature of the subsoil and the depth of the mantle rock are
revealed at many points:—
Materials brought up by burrowing animals are perhaps commonly
sufficient indications of the nature of the subsoil.
The thickness of the soil and of the mantle rock is shown clearly in
the distribution or character of various species of plants and burrowing
animals in areas where firm rock is near the surface, as in many parts
of the Black Hills and the quartzite and granite areas in the south-
eastern and northeastern parts of the state.
7. The depth to the water-table is shown in places where this depth
is not great. The establishment at such points, of the general water-

level makes possible an approximation of the depth to permanent water
in wide areas where the depth is too great to be reached by most local
vegetation.
The accessibility of underground water is strikingly shown by the
distribution of certain kinds of trees. (Fig. 26, 27, 28), the groves of
willow, ash, elm, and several other kinds occupying portions of the river
bottoms, the little thickets or single trees near hillside springs, all indi-
cate clearly available ground water.
Various sedges and rushes grow only in areas where seepage takes
place, at least part of the time. Lignite, which is relatively impervious,
causes seepage in many places where it outcrops on slopes. Vegetation
in such zones is fairly conspicuous, and has been used often in locating
"coal diggings."
It appears that prairie-dog towns are located only where the water
table is within reach of these able burrowers. The location of more

Fig. 26. Part of one of the lakes of the East Coteau or Lake Region. A lake
near Webster having more trees than the average.—Courtesy of the C. M.
& St. P. R. R. Co.

Fig. 27. A view in the Red Valley which surrounds the Black Hills.

Fig. 28. An alfalfa field in the Belle Fourche Valley, near Newell. The trees
are along the river.
than 100 towns examined in Harding, Perkins, Fall River, Stanley, and other counties seems to bear out this statement.

The rate of erosion of slopes is suggested:—

In most places bare slopes indicate rather rapid erosion, and slopes covered with vegetation, notably trees, indicate much less rapid erosion. In the sandhills, dunes which have remained relatively stationary for a considerable interval have in some cases groves on their north-facing slopes.

The directions are roughly indicated by certain plants and animals:—

The leaves of the compass plant (Silphium) usually have their edges in a north-south direction; several kinds of lichens and mosses are found chiefly on the north sides of trees and stones; the vegetation on a steep north-facing slope is somewhat differently in most places from that on a steep south-facing slope; several burrowing animals, (ants, badgers, prairie dogs), either in the distribution, up or in the direction of the burrow, give a rough approximation as to directions. Woodpeckers' holes generally are on the northeastern or eastern side of a limb or tree. The entrance to covered nests of such birds as the meadowlark, ovenbird and marsh wren in most cases is on the east.

The physiographic and even some points in the geologic history may be illuminated by the distribution of species, especially their presence or absence in areas now favorable to them. Bluffs along the valleys become covered with vegetation soon after the stream ceases to erode at their base. The age of trees on such slopes, as also of those in ravines and on terraces and alluvial fans, suggest the age of Water which other physiographic features. The presence of the Black Hills of numerous boreal species such as the white spruce (Picea alba) and northern marmot (Marmota dactyloidea) suggests that during the geological past the glaciated period such species were widespread in those latitudes. When the change of climate some have been stranded in the Black Hills. In addition to increasing geographical knowledge in the various ways mentioned above, the biota affects runoff, erosion, soil, and evaporation.

The percentage of precipitation which runs off is affected by the biota. Burrows of worms, insects, amphibians and mammals, footprints of heavy animals, and roots, especially decayed ones, prevent the entrance of water into the soil. Matted and coarse vegetation especially retard run-off.

Erosion is retarded by a vegetable covering. The disintegration of rock by temperature changes is also retarded by vegetation. The decay of rock by chemical means is facilitated by the secrections and remains of plants and animals. Animals in general accelerate erosion, especially on steep slopes.

Soil is mixed and extended by burrowing animals, which also increase aeration and oxidation. All animals and plants contribute organic matter to the soil. The roots of plants are potent factors in rupturing rock. By retarding the washing away of soil, however formed, plants are powerful agents in the accumulation of a deep soil. If otherwise would run off is conserved in soil clothed with vegetation, and given up gradually by evaporation, which process lowers the temperature and increases the relative and absolute humidity; therefore evaporation of soil moisture normally is increased by the vegetation cover.

Bio-geography and Human Geography. Human activities in an area are determined largely by the geographic conditions which prevail there. The bio-geographic reflects a slighty geographic location, are cultural resources, through climate, soil, topography, and water conditions influence and are influenced by biota.
The native biota is a geographic factor of great human significance. The following illustrations applicable to South Dakota indicate a few of its manifold influences.

1. A grassy area facilitates grazing and agriculture as wood have to be cleared, in most cases laboriously, before extensive tillage or pasturage is possible.
2. Where the soil is tough, laborious breaking necessarily precedes agriculture.
3. Plains which are periodically covered by dry grass permit of widespread prairie fires and necessitate foresight, care, and cooperation on the part of the settlers.
4. Where but little of the area is wooded, as in South Dakota, the importation of wood is necessary and wood is valued highly. The small area of woodland in South Dakota was less of a handicap than it might otherwise have been because, (a) lumber served as "return freight" in cars which were used for the export of wheat, cattle and other bulky commodities. In portions of the state which do not export large quantities of such produce, the cost of imported lumber is much greater; (b) barbed wire became fairly cheap before it was extensively needed in South Dakota for fencing; (c) ash groves widely distributed along the valleys and cedar thickets in portions of the western part of the state furnished a large share of the posts required. The character of the upland (nearly level and heavily sodded) made the hauling of posts and firewood less expensive than it might otherwise have been; (d) lumber mills were erected early in the Black Hills, the forested buttes in Harding County and along the lower Missouri River, and the local demand supplied, at least in part, for a time.
5. The type of the grassy covering has influenced greatly the grazing industry. In many portions of the earth, grazing is less profitable than in South Dakota. This is due in no small degree to the "natural hay" which formed here under the influence of the scanty rainfall of autumn and winter. The growth of many kinds of grass ceases before there are heavy frosts, and the nutrient largely remains in the dried standing grass until the rains of the following summer.
6. Where game birds and mammals are abundant, as they long a little to the firm establishment of many pioneers and some later settlers.
7. Where animals of prey, such as wolves, coyotes, bears, pumas, porcupines and other animals, are plentiful, as they formerly were or still are in parts of South Dakota, their numbers must be depleted before various sorts of livestock and poultry can become very profitable.
8. Where herbivorous animals of certain kinds, such as bison, prairie-dogs, rabbits, locusts, are very numerous, their reduction is an essential antecedent to success in various human activities. The same may be said of poisonous animals and plants.
9. Various animals, especially birds and insects, have been valuable allies of man in his struggle against undesirable animals and plants ("weeds"). Predatory insects, of which there are many sorts, including various spiders, hymenoptera, and ground beetles, are powerful enemies of numerous plant-eating insects. Various insects of which the milkweed bug and monarch caterpillar are examples feed solely or chiefly upon certain weeds.
10. Wild fruits, berries, seeds, nuts, and roots contribute to the food supply of many persons, and in some instances were of great significance to pioneers and others.

II. THE BIO-GEOGRAPHIC DISTRICTS.

Based on the biota, South Dakota may be divided into three districts (Fig. 29) which reflect differences of (a) climate, (b) topography, (c) soil, and (d) routes of immigration into the area. The districts are: (1) the Eastern Third of the state (largely Prairie), (2) the Great Plains, (3) the Black Hills. Representative or characteristic parts of these districts differ somewhat strikingly. However, sections of stream valleys in the Great Plains are transitional between that district and the first (the prairies), while the forested buttes, escarpments and foothills are transitional between the dry grassy plains (the steppe) and the forested mountainous Black Hills.

Fig. 29. Biogeographic Districts. Ia.—The Valleys of the Lower Missouri, Sioux and Minnesota Rivers. Iib.—The East Coteau. Ic.—The Dakota Valley. IIa.—The Upper Missouri Valley. IIb.—The West Coteau. IIc.—The Dry Plains. IId.—The Sand Hills. Ile.—The Badlands. IIe.—Gumbo Areas (other small areas not shown). IIg.—Buttes and Escarpments. IIh.—Foot hills. IIib.—Red Valley. IIc.—The Limestone Plateau. IIIa.—The Park Area.

(1) The Eastern Third of the state is largely prairie, but along most valleys there are meadows or somewhat dense groves of deciduous trees. This part of the state is fairly well favored in respect to rainfall, having an average of about 26 inches or nearly 50 per cent more than the average for the rest of the state; the higher parts of the Black Hills excepted. More than three-quarters of the precipitation falls during the six warmer months (April 1-Oct. 1). The warmest as well as the coldest parts of the state are within this district and the average annual and daily ranges are as great as in any other part of the state or even greater. This is the least rugged large part of the state, as most of it has a topography characteristic of a recently glaciated plain. The soil is chiefly clay-loam.

Many "eastern" plants, birds and other animals are found in this district, as it is contiguous with the prairies and savannahs of Iowa.
and Minnesota and somewhat similar to them. Most genera and a majority of the species of this district are most abundant (have their centers of distribution) in the southwestern part of the state. As a result, the flora and fauna of the predominant eastern species, it may be mentioned that more than 95 per cent of the birds and flowers commonly seen are somewhat common east of the 90th meridian. Nearly as large a percentage of the trees as the eastern affinities.

This district may be divided into (a) the broad river valleys of the southern, southeastern, and eastern coteau, and (c) the Dakota Valley. The topography of these subdivisions has been discussed (p. 50).

(a) Various species of trees, including the soft maple (Acer saccharinum), Kentucky coffee tree (Gymnocladus dioica), black walnut (Juglans nigra), and the red mulberry (Morus rubra) are native to the upper Missouri and South Dakota valleys. The sugar maple (Acer saccharum) is represented in the state only in the shaded ravines about Lakes Bigstone and Traverse near the headwaters of the Little Missouri River. Numerous smaller plants characteristic of the eastern moist woods are limited to these valleys, and many typically eastern species, notably several species of warblers and vireos, are seen, chiefly as migrants, only in this extreme eastern part of the state. The fox squirrel (Sciurus niger) also is found only in this subdivision.

(b) The eastern Coteau originally had far fewer trees than subdivision (a), but at present there are numerous groves which were planted soon after the region was settled. A large number of square miles of wood-lots recorded by the census of 1900 from South Dakota are within this section. The presence of many marshes and lakes has made this an attractive region for various, largely eastern, species of aquatic plants and water birds, and with the growth of the artificial groves, various eastern birds of the woods become common in most parts of this region.

(c) The Dakota Valley originally had more woodland than the East Coteau, but fewer planted groves have become established, and although most of the sky-line is made by trees, not nearly all farms have wood-lots. Thriving groves are especially rare in the northern and western parts of this wide valley, since the precipitation decreases in those directions.

(2) The Great Plains bio-geographic district includes most of the state west of the Dakota Valley, except the Black Hills. This district is mostly a steppe, chiefly occupied by short grasses, low herbs and shrubs. Groves are few, being nearly restricted to a fringe of cottonwoods and boxelder along the few fairly permanent streams. This district is notably more arid than the preceding, the rainfall being less regular as well as less abundant. The topography is mostly the result of fluvial and pluvial erosion, and is moderately rough in many places. The soils are more varied, and large areas of each of several types. Many eastern species of plants and animals, especially those living in the valleys, here reach their western limit of their range, and a number of western species, especially among those of the uplands, reach here their eastern limit. Several conspicuous forms appear to have spread eastward or westward, or both, from the Great Plains; however, a number of species have entered the district from the southwest.

Several subdivisions of this district are readily recognizable, (a) the postglacial part of the Missouri flood-plain (above Charles Mix County) and the lower sections of the flood-plains; (b) the Western Coteau, transitional in regard to many species, between the typical dry plains and the Dakota Valley; (c) the central part occupying much of Stanley, Meade Perkins and other counties; (d) the sandhills of the southern border are similar to those of Nebraska, and contain representatives of very dry species not found elsewhere; (e) the badlands in the southwestern quarter, especially along the upper part of the White River, have many species which are near or at the northeastern limit of their range; (f) the gumo areas (Fig. 29) bordering on the Black Hills in the valleys of the Cheyenne and Bellefourche rivers have many plants species which are characteristic of such clay soils; (g) the forested buttes and escarpments are intermediate or transitional areas between the grassy Great Plains and the forested Black Hills: Both coniferous and deciduous trees are important, and there are many species of plants and animals found in the Black Hills and the Rocky Mountains, as well as some distinctly eastern species.

(3) The Black Hills District, a bio-geographic as well as physiographic unit, is a mountainous area largely forested with conifers. Because of increased altitude, the precipitation is above the average for the state, while the average temperature and the rate of evaporation are lower, with the result that there is sufficient moisture for many species which require a good deal. Many Rocky Mountain species reach their easternmost position in the Black Hills. Many of eastern species appear to have followed up the east-west valleys which cross the plains in this district. The ice-cap covered eastern South Dakota, the climate of this region was doubtless less arid than now. During the last glacial period, the unglaciated plains doubtless were more favorable to eastern species than they now are. A few conspicuously boreal species are found here also. The latter, of which the white spruce (Picea glauca) is a striking example, reached this area when the ice sheet occupied eastern South Dakota, and the climate of the portions of the plains was sufficiently cool to be congelial. Those in the Black Hills now are separated from their nearest relatives (in central Manitoba) by several hundred miles of dry plains.

As might be expected of a somewhat isolated area such as the Black Hills, a number of indigenous species are recognized, several mammals, (a red squirrel, Sciurus hudsonicus, (d) marmot, marmota dacota, a wood rat, Netomma floridanensis baileyi and others), one bird (the white-winged junco, Junco alpinus), and several plants, belonging to various groups.

There are several bio-geographic and as well geologic, physiographic and ecological sub-divisions of this district, (1) the foothills, (2) the red valley, (3) the limestone plateau, (4) the park area on the schist. The canyons and the higher peaks also have several peculiar species.

III. The Ecological Associations

Variety of the native biota and bases for its classification. In the treatment of the biology of the diversified area such as South Dakota, it is desirable to sub-divide the region into sections having many features in common. In this state there are native or 60 kinds of mammals, 300 kinds of birds, 96 kinds of reptiles, snakes, lizards, and turtles, 7 species of amphibians, many more than a thousand species of insects and more than 2,000 species of seed plants. In addition there are fishes, mollusks, crustaceans, and many smaller forms. Of this vast variety of life every many are inconspicuous and not ob-
served by non-specialists, although without doubt each species has its part to play in the biologic economy of the whole. This is made the more likely when it is noted that nearly every species occupies a definite place; for example, the species of the shaded ravines are not at all the same as those of the plains.

It is, therefore, necessary to subdivide these areas into groups and communities of plants and animals. Communities or associations having many similarities may be grouped into what technically is known as a formation. The formations of South Dakota are (1) grass-covered plains, (2) prairie, (3) woodland, (4) meadows, and (5) aquatic. The former occupies the most extensive area and the latter the least extensive. The areas occupied by these several formations are characterized by distinct and characteristic features of topography, soil, water conditions, climate, vegetation and animal life. Individual plants (with a few exceptions) are stationary, but the species moves by means of the seeds, runners or off-shoots. In the case of animals, most species and individuals are able to move about, consequently the animals are partially confined to a given association. The coyote, for example, may be found in each community, but in some, as the stream, pond, or marsh, its presence obviously indicates a visit. In the case of plants, the areas in which they rear their young are considered to reveal the associations to which they truly belong.

1. THE STEPPE FORMATION OR GROUP OF COMMUNITIES.

A. As a Whole.

1. Distribution.

About three-fourths of the state is covered by vegetation characterized by its patchy or scattered distribution and, in most associations, by its shortness.

The steppe group of associations has its center in the Great Plains section, occupying most of bio-geographic District I (Fig. 29), and is represented in small exposed areas on clay soil and in the western part of the eastern third of the state (District II). The grassy tops of most of the flat-topped buttes of the western third of the state, and many treeless portions and lower elevations in the Black Hills also are occupied by members of this formation.

2. GENERAL GEOGRAPHIC CONDITIONS OF THE STEPPE.

The climatic conditions of the Great Plains are severe. The rainfall is irregular in its distribution. It sometimes falls in heavy show-

The author is under obligations to the U. S. Biological Survey for determining the varieties of numerous mammals and a few birds, to P. A. Ryberg and Aven Nelson for naming plants; to Alexander Rutheven for determining reptiles and amphibians; and to L. P. Morse, W. M. Mann and others for naming insects.

*Reference to literature on the steppe: The physical geography is treated in earlier chapters of this paper where additional citations are given. Little has been written on the biology of the South Dakota steppe. The sections on the biology of the South Dakota Steppes of D. Geol. Survey Bull. 5, pp. 61-159, 1913, and on the biology of Harding County, Northwestern South Dakota, by D. Geol. Survey Bull. 7, pp. 11-100, 1914, are chief. The birds of Stanley County are treated in the Auk, April, 1899, pp. 144-153; of Fall River Co. in the Wilson Bulletin, March, 1914, pp. 5-6, and March, 1916, pp. 33-36; of Harding County in the Auk, for January, 1911, January, 1912, and July, 1913, summarized in Bull. 5, The plants of the South Dakota Steppes, by J. Geol. Survey Bull. 1, pp. 67-84. The only other articles are short lists of birds and plants of the same region by Reagen, A. B., and Jones, Sheridan, D. Geol. Survey Bull. 4, 1908.

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THE GEOGRAPHY OF SOUTH DAKOTA

Abundant Monocotyledons, other than the grasses, are wild onion and prairie lilies.11 Diocotyledons other than the composites and legumes are numerous. There are several crucifers (mustard family), including12 shepherd’s purse, wall flower, and Lesquerella, Sophra, Arabis. Several species of Scrophulariaceae are conspicuous because of showy flowers. Chenopods13 are plentiful in the more clayey or more sandy areas. Three genera of scorches or beard’s tongue15 help adorn the plains. The roses, wild flax, milkwort, false mallow, puccoon, plantain, Oenothera, and Lepidium are also represented abundantly.

(b) Birds. Among the birds the only permanent resident present by many individuals is the desert horned lark.27 Longspurs of some species are in all seasons the chestnut-colored, and McCown’s longspur nesting here abundantly and the Lapland longspur4 singing here. Two other members of three species, the lark bunting and the western vesper sparrow are very numerous. The former is quite characteristic, as is the desert horned lark. Other winter and nesting birds are the Brewer blackbird, burrowing owl, Sennett’s night hawk, upland plover. Formerly the long-billed curlew and the prairie sharp-tailed grouse were common. Several birds nest in the groves of scattered trees along the streams (considered under woodlands), but often feed upon the steps far from their nests. Examples are the ferruginous, rough-legged Swanson’s and sharp-tailed hawks. The cliff and barn swallows, nesting on cliffs or about buildings, are also seen often.

(c) Mammals. No conspicuous species appear to be confined in its range to the steppe of South Dakota, though several varieties are. Of these the plains coyote, plains pocket-gopher, certain mice and voles may be mentioned. Other mammals abundant in the steppe are the19 prairie dog, badger, jackrabbit, large and little skunks, gray wolf, kit fox or swift, long-tailed weasel, striped skunk, and the formerly the antelope and bison.

12Allium reticulatum and A. rubrum; Leucocirium montanum and Fritillaria atropurpurea.
13Capsella bursa-pastoris, Erysimum asperum, E. inconspicuum, Lesquerella tenuellii, L. argentea; Sophra indica; S. pinata; Arabis hirsuta.
14Oenothera nuttallii; Onagra striatulata; Geura coecinea; Meridix serrata.
15Chenopodium album, L. fremontii, L. incanum, C. Watsonii, C. pratensis,
16C. denticulata; Atriplex argentea, A. canescens; A. nuttallii, A. sucheyana; Suaeda, beata.
17Castellea flavas; Orthocarpus lutesus; Pentstemon acuminatus, P. albidos, P. eriophora, P. grandiflora.
18Rosa arkansana, R. fendleri, R. woodsii; Linum lewisii, L. rigidum; Polygala alba; Malvastrum longifolium, L. lineatifolium; Onosmodium occultum; Plantago argentea; P. E. cordifolia; Geomarca glomerata, O. perennis; Cogonialla macrocarpa, C. montana.
19In the interest of brevity and simplicity, technical names are used here only in case the common name does not indicate the plant or animal under discussion with a definiteness sufficient for the purpose at hand. Since the American Ornithologists Union adopted distinctive names for the American birds at an early date and as these names are now familiar to all students of birds, these common names may be used here without misunderstanding. The scientific names of various widely distributed and well known animals, such as the pronghorn antelope, bison, gray wolf, striped, common mule and rattle snake are given only once. As most common names of plants apply to more than one species, technical names usually are necessary to distinguish genera and species. Reference to a plant by its incomplete name only implies that the species is one from which several distinct species will be found, or the one mentioned only a few lines above.
20Corydalis claviceps; Geum (Rheum) lutescens; Permerus maniculatus; P. leucopus aridulus; Poregnatius fasciatus; Cynonymia ludoviciana; Taxidea t. tayadensis; Lepus c. californicus; L. c. canus; L. c. campestris; L. c. mexicanus; L. c. pallasii; L. c. nigri; L. c. nevadensis; L. c. arcticus; L. c. canus; Pteropus australis; P. p. infraspinus; Lepus americanus; Stenocircus leucopus; L. cinctus; L. c. occidentalis; L. c. nevadensis; L. c. canus; L. c. arcticus; L. c. canus; L. c. nevadens
The relatively firm turf which prevails in the more favorable portions of the steppe hinders the establishment of annuals, which therefore are much more conspicuous in the more arid and more sandy portions. Frequent prairie fires occur where there is a fairly close turf, for reasons already mentioned. Fires are powerful factors in preventing the spread of trees and shrubs. The large shrubs are restricted chiefly to the more arid or more rugged portions where vegetation is discontinuous in its distribution and where combustible material is separated from it relatively widely. During the six or eight months in which there is little vegetative activity because of lack of sufficient heat or moisture, evaporation from all exposed living surfaces is continued by the intensely drying winds which frequently prevail on the steppe. Plants not presenting living surfaces from which extensive evaporation takes place cannot soon be replaced where the wind is unobstructed over other species. If planted on the steppe, most of the shrubs and trees not especially resistant to loss of moisture through the bark are killed during the months of inactivity rather than during the normal summer season.

2) Compactness of stalk is illustrated by almost all the plants. Few abundant upland species reach a height, in ordinary seasons, of much more than a foot, and exceedingly few reach three feet. The majority have most of their bulk within six inches of the soil. Genera, such as the rose, sunflower, sage and golden-rod, which have representatives in other ecological formations, are in most cases represented on the steppe by the most dwarfed species of the genus. Two striking exceptions are the plains rose, whose leafy stems are a simple bush less than five inches tall, which bears but one flower, and the plains sunflower which in most cases is less than seven inches tall, and in the driest years, especially on clay, many individuals which are less than four inches high. The conspicuous nature in the flora by the Compositae points to compactness of flowering parts. Even the grasses (grama, buffalo, wheat and others) have the spikelets somewhat compactly arranged instead of loosely as in typically prairie and woodland species.

Compactness of growth decreases exposure to the winds. In most formations, an insufficiency of sunlight results in a diffuse and extended growth. There is no such insufficiency during the growing season in the steppe. Size in many cases is related to conditions during growth. Cultivated plants normally are larger than other individuals of the same species, which in turn are larger during moist seasons, than during dry seasons.

3) There are many plants which have developed a shallow, wide-spreading root-system. This appears to be a response to the many slight showers, the water of which does not soak in deeply. The buffalo and grama grasses have their roots mostly confined to within a foot from the surface. In contrast to these there are such deep-rooted plants as Psoralea, a rather coarse herb, which has almost all of its finer roots at a depth greater than four feet, and in some cases penetrates hard sub-soil more than six feet, and looser materials still farther. Certain genera, including the sages (Artemisia) and Gutierrezia, have both well developed lateral roots and rather deep tap-roots. Most plants which are abundant on the more impervious soils have shallower root systems than those in the looser soils. Shrubs and coarse herbs have done down to greater depths which go down to greater depths than those of lesser plants, probably because of their greater exposure to the winds. They need firmer anchorage and a more reliable water supply than is found near the surface. The plants showing shortage of water in enlargements of the roots are chiefly the blazing star, the Indian turnip, (Psoralea asculenta) and the bush-morning-glory (Ipomoea leptophylla). The caeti (Opuntia, Curaelparia) are the only plants which store considerable amounts of water above ground.

4) The plants have either small or narrow leaves, and a few like the prairie-pink, Gutierrezia, and the caeti are almost leafless. Abundant species with resin include the cone-flower, gum-weed, and Psoralea.25 The prairie species have thick epidermis, which in many cases is covered by numerous dry scales. The sages (Artemisia, Euphorb Iana) Psoralea and Antennaria have a grayish coloration due to such scales.

These characteristics of leaves and cover clearly retard evaporation, and thus appear to be responses to the moisture conditions of the steppe.

5) The seeds of nearly 90 per cent of the abundant species on the steppe are distributed by the wind. The tumble-weed habit, in which the aerial part of the plant becomes detached from the root and is rolled across the plains by the wind, is developed almost entirely by plants of the wind-swept plains. Several species with this habit, belonging to several families, are represented abundantly in South Dakota. The chenopod family is the chief one, and is represented by the giant tumbleweed. The Russian thistle, and the bug-weed. Two legumes, the Indian turnip and the wild alfalfa, two species of the Amaranthaceae, a composite and two grasses also have this habit.

Persistent surface winds, few places of lodgement such as bodies of water, very rugged areas, thickets and other places unfavorable for steppe plants, and the scarcity of other agents of dispersal almost all have contributed to the predominance of species dispersed by the wind.

6) The ability to mature quickly is possessed by most plants in the formation during periods of severe drying. The period of maturity is short, averaging about 120 days and having a minimum length of more than a month less. The growing season is shortened usually still further by the drying weather in August and September. Few conspicuous plants are ripened in the summer, most ripening is thus delayed until the next season, and many need even less time. This is in contrast to the condition in most other formations.

7) The climate of the steppe is variable. In some years the vegetation is two crops a year, and the next year may be far behind. Delayed rains occasionally cause a surprisingly late flowering. We have found flowers of the rose and even of the pasque flower late in August, following July and August rains and a very dry spring and early summer.

8) The characteristic steppe plants have a wonderful resistance to prairie-fires and grazing, which may frequently destroy the aerial parts. Many typical plants such as trees and shrubs of other ecological associations are killed by the destruction of only a small part of the aerial growth. Certain steppe species are killed, however, by too frequent fires (often than once in three years for example) or by close pasturing.

After a series of wet years there are many new immigrants into the steppe. A dry year or two decimates or eliminates species which are only visitants to the steppe. The characteristic species seem to be almost unjured by even prolonged drought. In the summer of 1911 for example, there were localities which for two years had...
been so dry that almost no grass had grown; yet when the unusual rains of August came, the ground was green within a few days.

(10) The vegetation does not start quickly in the spring; but, after it has started, it spreads out and grows, surprisingly few of the more characteristic plants being killed. The native steppe vegetation is seldom affected noticeably by early autumn frosts. In areas less likely to have unseasonable frosts, many species are severely injured when such frosts occur.

(11) The succession of flowers in an ordinary year is striking. There are at least five well-marked periods, the prevernal, vernal, postvernal, autumnal, and autumnal. During one period the plants are dominated by or contain one or more of the more common flowers, and during the succeeding periods by still others. The early bloomers of the steppe include Cynomorium scapium, pasque flower (Viola nuttallii) and prairie lily. Among those blooming in June are the beard’s tongue, onions, camas (Zygodon nodosus), loco, buffalo bean (Astragalus), wild flax, and in July neghead (Brasenia), prairie clover, wild alfalfa (Psoralea), false mallow, stemless evening primrose (Gaura), and spurge are prominent. During August, the numerous species of asters, golden-rods, and the sea-bane (Semenica canus) are in bloom. The sage is in full bloom early in September.

Accompanying this progressive activity there is a shifting in floristic composition of the region. Early in the season the plants are related mainly to the eastern or mountain species, while as the season advances, conditions become more severe and the active or dominant species are successively related to plants of the prairies, drier plains, and finally the desert.

This succession corresponds with changes in the temperature of the air and soil, and in the moisture content of soil and atmosphere.

(12) Many of the more abundant species are yellow, although several conspicuous flowers are white, orange, or purple. There are few reds, deep blues, or violets. Very few are streaked or mottled. In the vast majority of cases the flowers are small in size as compared with those of other plant formations, and few are particularly fragrant. The color probably is related to the light conditions, and the fragrance to the windiness, which also doubtlessly affects the size of flowers.

(b) Birds. The birds of the steppe possess two or more of the following characteristics:

1. Nests are necessarily built on the ground.
2. Many kinds sing while on the wing. Examples are the lark bunting, longspur, Sprague’s pipit, and frequently the western meadowlark and horned lark.
3. The songs and calls are loud compared with those of birds of woodland or prairie. Because of climatic conditions of the steppe, representatives of species in many cases are farther apart than in most other areas. Calls and songs fulfill their chief purpose only when they are heard by other individuals of the species, and therefore need to be relatively loud in the steppe.

4. Social flocking is less prominent than among the birds of the woods or prairies, where not only a great variety of birds migrate in large flocks, but birds wander socially about in other seasons, especially in winter, and several abundant species nest in colonies. The grackle, crow, swift, swallows, night-herons, black-birds, marsh wrens, northern flicker, and bobolink and bobwhite are examples that build cliffling nests with sticks and dry grass, whereas in the steppe, for instance, the cliff swallow which nests here and there in the badlands, is be exceeded, none of the abundant birds of the steppe nest in colonies. The scattered distribution of life on the steppe, noted in the preceding paragraph, is exemplified in the distribution of the nests of the steppe birds. The lark bunting and longspurs, and occasionally the Swainson’s hawk migrate in flocks which however, soon break up. Flocking in the winter is largely accidental. Birds gather where food is available, in areas swept by the wind or in patches of tall vegetation which are not snow-covered. Woody fields, where seeds are abundant, often are the site of such gatherings.

5. Many have the ability to withstand strong wind. For example, seed-eaters feed during the winter in apparent comfort on wind-swept hills.

6. Females and nestlings are almost all protectively colored. This is evident from outside the nesting sites. Most species are highly migratory. Few individuals remain during winter, and these are of species different from those of other species, except in the case of the desert horned lark. Even this species migrates somewhat. The aridity and the inactivity of other life combine to win the cold to encourage the desertion of the steppe during the winter season.

7. Most birds have the ability to withstand the intense heat of the sun. This is especially notable in the nestlings which are often on dappled shade.

8. The birds of the steppe of necessity must require but little drinking water. Heavy rains are rare.

9. The power of acute long-range vision appears to have been acquired by a much larger number of birds of the steppe than by those inhabiting woodlands. Clearness of atmosphere, slightness of relief over large areas, and the widely scattered distribution of life all probably have encouraged the development of acute long-range vision.

(c) Mammals. The mammals of the steppe have all acquired two or more of the following characteristics:

1. Ability to run swiftly. Examples are the antelope (20 miles an hour), jackrabbit (28 miles an hour), coyote (24 miles an hour), kit fox (20 miles an hour), and gray wolf (30 miles an hour).

2. It is possible to run more swiftly on dry grassy plains than through woods or brush, in marshes or across rough, ragged hills. For this reason the inhabitants of such plains have come to be the fleetest runners. Long distance running was developed among some of the larger mammals, apparently because of the relative scarcity of places of retreat.

2. Ability to burrow. Examples are the pocket-gophers, striped gophers, badgers, prairie dogs, mice, voles. About 70 per cent of the species remain in burrows all year, and nearly 50 per cent of the species spend much of their time underground. Burrows are retreating from heat, cold, wind, and some enemies, and for the prairie dog, at least in some cases, furnish access to the underground water supply.

3. Many have acute long-range vision. The fleet runners all have.

Velocities are those attained by the normal, healthy adult when pursued by greyhounds, and are quoted from Seton, E. T.: Life Histories of Northern Animals, (New York, 1909).
This appears to have been developed by the same factors mentioned in the discussion of the vision of birds.

A gray or brownish type of coloration which harmonizes well with dead leaves is possessed by nearly all. The skunk, an exception, is less in need of protective coloration than are the other mammals of the plains.

5. Ability to do without much drinking water. Water for physiological activity and for perspiration is secured mainly from the food eaten. Footprints of most steppe animals are seldom seen in mud about water holes. This is especially true in regard to the rodents, including the jackrabbit.

6. The daily period of activity is chiefly in the early morning, in the evening, and to a lesser degree at night.

Voluntary activity of almost all abundant mammals of the steppe is very limited during the heat of the summer, though as many as may be in the shade. Activity generated by heat which must be eliminated by perspiration, which in turn requires water, an article which often is precious.

7. Hibernation. The long-distance runners and the carnivores do not hibernate, but, with the exception of the rabbits, rodents, the most numerous mammals on the plains, do, and for longer periods than related species in other formations. Hibernation is a response to the unfavorable conditions which prevail during the winter months. The larger herbivores, the bison and antelope, migrated chiefly in response to irregularity of rain and snow. Wolves, which preyed upon them, accompanied them in their wanderings.

8. A few of the mammals of the steppe are gregarious; the bison and antelope, probably for protection from wolves and bears, and in response to the lack of numerous places of escape; but also in winter for the heat accumulated in a closely packed herd. Prairie-dogs are grouped in towns for protection against coyotes and the hawk, they being probably by the somewhat restricted soil and ground water conditions which they appear to require.

9. Reptiles. The reptiles of which the bull-snake, rattle-snake, plains garter snake, and blue-racer, and the horned-lizard are chief, possess a surprisingly effective coloration: hibernate for nearly half the year, or even longer; can get along without drinking water; and are of small size as compared with related forms in more humid areas. Although the vast majority of reptiles lay eggs, three of the rarer lizards (the rattler, plains garter snake, and horned-lizard) bring forth their young alive. This may be in response to the "hard" conditions imposed by the climate.

10. Insects. Concerning the insects of the steppe, the following points may be made:

1. The diurnal period of greatest activity is in the forenoon from 7-11 o'clock, after the chill of the early morning is gone but before the heat becomes oppressive. Cotton is carried on chiefly between 11 o'clock and one. During the rest of the twenty-four hours most of the insects are quiescent except when disturbed.

2. Seasonal activity is limited nearly to the warmer and more moist three or four months of the year, chiefly June, July and August. Most species are dormant from the colder and drier months of the year. Most species are dormant during ten or eleven months of the year, when many are represented chiefly by eggs.

3. Many forms burrow or occupy mammal burrows, in so doing having retreats from wind, heat, and some enemies. Steppe species in many cases burrow to much greater depths than related species of other communities.

4. There is a predominance of hoppers or fast walkers. The development of hopping as a chief mode of progress is not so much discouraged on the steppe as in several other formations by frequent collisions with tall vegetation. The habit of running is favored by bare soil and is more marked among insects of the drier than of the moist parts of the steppe, and still more among those of the desert.

5. Few species spend much time on the wing. The windiness of the steppe discourages extended flights. The occasional large flights of locusts form conspicuous exceptions to this rule.

(B) THE BUFFALO-GRAMA GRASS OR CLIMAX STEPPE ASSOCIATION.

This is the short-grass association par excellence and in many respects is the most characteristic steppe association. In the central part of the steppe region it is found on a variety of medium soils, lighter clays, silts and loams, and is the dominant association of the wide stretches. As the heavier and lighter soils are altered to loams by mixture and other processes, and as the drainage is perfected and ruggedness decreased, this association is extended at the expense of the other steppe associations.

To the east of the Great Plains province, the buffalo-grama grass association is represented on the high prairies on well-drained clay loess. In the more arid belt to the west it is found where the run-off is less rapid, as on the flatter tops of buttes and on terraces.

One of the two dominant grasses, the short, curly, buffalo-grass, is less tolerant of sand than is the taller grama grass, various species of which are of secondary importance in distinctly sandy areas.

The life of this association is more varied than that of other parts of the steppe. Many of the species have a short life and generally in one part of the steppe is found so large a number of species. In addition, the Tripeawn grass is abundant upon the more silty and loamy areas, and the needle grass (Stipa), and June grass (Elymus cristatus), on the more sandy soil. The small milkweed (Asclepias pinnula), the pincushion cactus (Manillaria vivipara), and Parosela aurea are rather numerous. Nearly all the birds of the steppe nest usually occasionally in this association. The black-tailed pronghorned antelope appear to have been at home here. The striped gopher is most abundant here, but reptiles and toads are less abundant.

(C) THE NEEDLE GRASS OR SANDY LOAM STEPPE ASSOCIATION.

This association occupies uplands on sandy-loam soil and is characterized by the needle, devil's, or spear grass and June grass just mentioned. In areas of rather uniform soil and topographic conditions these two grasses may dominate. In more sandy areas, coarse herbes of astragalus, lupines and psoraleums are very conspicuous and especially on slopes. In soils having a large percentage of silt or clay, there are patches of buffalo and grama grass. The lead-plant is in evidence in areas of coarse sand, or gravel mixed with finer materials. These are represented less abundantly, have showy blue flowers. During the weeks preceding the shedding of the needles, this association is perhaps the most beautiful of those of the steppe, because of the needles which glint in the breeze, and the blue flowers then conspicuous. These are set off by the yellow
brown and yellow flowers so widespread on the steppe. When the needles are ripe they are readily attached to clothing by long hair on their base and by the help of several twists which develop as the needles dry, readily work inward and often cause pain. For obvious reasons, hay containing many needles is much less desirable than common prairie hay cut at other times. During the grazing, especially by sheep, the grass with needle grass is confined preferably to the season before the seeds begin to ripen in July, or after the needles have fallen.

(D) THE WHEAT GRASS OR CLAY STEPPE ASSOCIATION

The dominant grass or clay is the western wheat grass, sometimes popularly known as salt grass. It is widespread in areas where shales and sands are exposed. The generalized map (Fig. 3) shows the area of clay soils, and thus the region in which this association is most widespread. This grass has a very much larger percentage of its growth less than two inches from the soil than do the other widespread steppe grasses of fairly level areas. It also responds to an increased supply of water in a more satisfactory manner than the other steppe grasses; in fact in some places and in some seasons, it attains a height of two feet. It therefore is a valuable hay crop along the flood-plains and on other areas which are flooded frequently, but upon which the water does not stand long. Because clay is relatively impervious, the percentage of absorption is slight except where the water stands for a time. Because of these geographic factors, entering farmers and stockmen erect wing dams and dig contour ditches in favorable places, and use flood waters to produce excellent meadows.

Although wheat grass is present in a rather pure stand in areas which are arid, in many places varieties other species are conspicuous. The variety of abundant plant and animal life is normally less in this than in other parts of the steppe however.

On well drained slopes on the "gumbo," the vegetation is scanty except in wet seasons, and the soil is little concealed. Among the scattered growth of grass, various chenopods, the crucifer peppergrass (Lepidium) and prickly pear cactus and the dock (Rumex venosus) are conspicuous in many places, as are also the Dakota vetch and the gumweed.

On the somewhat alkaline soil of many "bloom--outs" and other undrained depressions, alkali grass replaces wheat grass, while the smaller prickly--pear is in many places exceedingly abundant. Two or three kinds of cacti are often conspicuous.

On valley flats the spurge, "snow-on-the-mountain" (Euphorbia marginata, E. Arundinacea) is dominant in some seasons in many places, especially near the bluffs and in prairie-dog towns. It is perhaps the most conspicuous annual growing on the steppe. The bur-tomato (Solanum rostratum) is another annual which is sometimes conspicuous in similar situations, and also in deserted fields. Since valley flats receive the run-off from an extensive area, there is a sporadic occurrence of numerous species belonging to other associations, many of which, however, do not mature their seeds.

The wheat grass association is at many points contiguous to groves along the streams and to shrub associations, especially the bush buckbrush:


This grass is Distichlis spicata; the cactus, Opuntia fragilis; the most numerous Chenopods, Arctriplex canescens, and Monolepis nuttalliana. The purslane, Telairetum virgatum, is sometimes conspicuous and nearly always characteristic of bloom-outs.

E THE BUNCH-GRASS OR DRY-SOIL STEPPE ASSOCIATION

The dominant feature of this association is the bunch grass, which attains a height of uniform height of about 15 inches. It is stiff, sparingly eaten, and is conspicuous throughout the year. It is seldom covered by snow for more than a short time. This association has two distinct phases, (1) on slopes in rugged areas, in dry streams and in meadows, where the soil is loam or sand; (2) on relatively pure sand. The latter may be subdivided into (a) the more nearly level areas and (b) the sandhills. The first phase occupies a small total area, but a widespread, being present in each of the districts and in most of the sub-districts of the area. The second phase is most widespread in middle and western Nebraska where sand commonly heaped into dunes is dominant. The area of dunes reaches a very short distance into south-central South Dakota. This association also is present in some places along valleys where the alluvium is very sandy.

The determining geographic factors in this association appear to be a scarcity of moisture in the surface layers of the soil, and a soil which is badly penetrated by roots. Because of the area of sand, although the runoff is slight, there is normally but little moisture in the upper six inches or more. This is the result of the active evaporation which persists until the capillary tubes are broken. Consequently vegetation possessing only shallow root systems, as does much of that of the buffalo-grass and wheat grass associations, is barred. The vegetation of this association is characterized by the possession of deeply penetrating root systems, in many cases with prominent "vap-roots."

The Spanish bayonet or soap-weed (Fig. 7) is conspicuous, while Mentzelia and the pasque flower are numerous on the steeper slopes outside the sandhills. The bird most generally nesting in this association is the western meadowlark. The western meadowlark is locally numerous. Several mammals, notably the jay rabbit, coyote and badger, are often seen rear their young in the rugged areas dominated by bunch-grass. Such areas afford

Yucca glauces; Mentzelia nuda and M. decapetals; Pulsatilla hirsutissima.
The more conspicuous herbs other than grasses are perhaps the annual eriogonum, spiderwort, brome rape, Alliopsis, Atronia, the spurgers, showy Gillia, green milkweed and three members of the aper family. Legumes are numerous, and the native prairie clover, Pseudoria, is found in many numbers. The more common composites are the wormwood, the viscid aster, and Franseria acanthicarpa. The borders of the brooks, often quite gay with flowers, are not truly a part of the steppe.

Most of the animal life of sandy regions is associated with the springs and streams. The areas occupied by the typical sandhill vegetation have a sparse and not distinctive fauna so far as the larger animals are concerned. Of much typical fauna can be found in the western vesper sparrow, lark bunting and the western meadowlark. Sandy areas within the prairie region of Sanborn County, eastern South Dakota form eastern outliers of the breeding range of the prairie shrub-tailed grouse. The mammals most frequently seen are the jack rabbit, the cottontail,18 the plains chipmunk and the pocket gopher (Geomys fruticicolus). Because of the relative wildness of rough, sandy areas, they form retreats for wide ranging mammals such as wolves and coyotes. Of the reptiles, the most abundant snake is the hog-nosed adder. The yellow striped swift is plentiful in the more southern sandhills and another lizard occurs, as does a land turtle. Several insects are abundant in sandy areas, including certain tiger beetles and the ant lion.

The sandhill area along the southern margin of the state has an exceptionally varied flora and fauna. In addition to species of more general distribution, mentioned above, the following are abundant there:41 Hall's bunch grass, on the ridges; the western sandhill dune grass, on the dunes; and the few trees, especially the hackberry, cottonwood, and elm in depressions, or on the more extensive, north-facing slopes. Among the herbs, the prickly poppy, sand thistle, Fleece leaf campanula and a fourth representative of the Caper family, are very conspicuous in season.

(P-H) THE LOW SHRUB GROUP OF ASSOCIATIONS

This group of associations is represented in small areas, mostly by narrow bands, in the steppe formation. The buck-bush, is a transition stage between grassland and woodland, and the sage brush between grassland and desert. Most of the area ordinarily classed as badlands belong to the buffalo-grass and the wheat grass associations. However, on the steeper slopes, the portion most distinctly "badland," almost the only vegetation consists of various shrubs.

(F) The buck-bush or wolfberry, (Symphoricarpus occidentalis), a shrub which as a rule is about 16 inches tall, forms patches in and adjacent to groves along valleys throughout the area. It also is found here and there on slopes, especially where soil moisture is plentiful, which often is the case on north-facing than on other slopes. Even far from woodland, there are patches along flood-plains where the ground

water is within reach. The buck-bush patches, many of which have a diameter of several rods, have where dense, little value for pasturage and almost none for fodder. They are cut by the mower with difficulty, or sand holes bed by plow or fire. The most places in secondary species in these patches. The chief grasses, in most places, and in all but the ravines, are bluejoint (Andropogon furcatus), and wild rye (Elymus canadensis).

In the steppe, the sagebrush is the dominant shrub, long-billed curlew, upland plover, marsh and Swainson’s hawks and other large birds, as well as western meadow-larks and Brewer’s blackbirds often nest here. Of the small mammals and rabbits and gophers (Citellus triticeps, C. Franklinii), and the large field mice (Microtus ochrogaster) are at home here. Spiders are especially abundant. The true sagebrush (Artemisia tridentata) is represented very locally in South Dakota or North Dakota on soil along the lower terraces of some of the streams of the western part of the states, notably the Big Horn. In these states it is a shrub occurring less than half the height prevalent in more arid regions to the west. However, the number of individuals per square rod in many places is greater than farther west.

The lance-leaved sage (Artemisia longifolia, A. filifolia) is more widespread and is here a taller shrub, reaching a height of some two or three feet. In the western third of the state it occupies the soft soil chiefly on terraces.

The vegetation between the clumps of sage in some places is dominated by patches of buffalo grass. Upon soil which is almost bare, the curious foliaceous lichen Parmelia molliscula is abundant in many places. Clumps of this lichen are conspicuous.

The most conspicuous characteristic of the sage-brush of this state is the sage hen, which was numerous a few years ago. It is being exterminated rapidly.

The most notable insect is the large black and white sage-moth, which is very conspicuous for a few days in July or August. The larvae feed upon sage leaves.

**BADLANDS**

Badlands are developed in many places on clay in the Great Plains; those in the south-central part of the state and in Harding County in the northwestern corner are especially extensive. Large sections of these badland areas are comparatively barren. Still larger portions are nearly level and grass covered. (Fig. 5.) The latter are discussed under the wheat grass and buffalo-grass associations.

**Conditions.** In regard to precipitation, these areas fare about the same as does the rest of the steppe. Their average temperature is probably greater because of many slopes and the partial protection from the wind. The whitish clay reflects the sunlight, resulting in a great intensity of light at times. During other hours of the day, a given spot may be in the shade. Shade can always be found along the arroyos and behind steep-sided buttes. The rapidity of erosion in badlands, and the tendency for the clay to crumble and crack, are two factors apparently very important in controlling the vegetation. Another perhaps even more important factor is the inability of the materials to absorb or hold water.

In the White River Bad Lands there are some sandhills, and some of the nearby badland buttes are capped with sand. Erosion is evidently as rapid on such buttes as elsewhere, but a rank vegetation flourishes, apparently because of the water absorbed in the sand.

(II) Characteristic plants and animals of the badlands. In the more rugged badland areas (Fig. 12) vegetation is scanty. Such as there is, is mainly shrubby and possesses length tap roots. Various shrub species are especially conspicuous, especially the rabbit bush, Gutierrezia, Dracophyllum, blue-aster; goldeneda; false bone-set; and several species of sage. Other plants are the gumbo-lily; Mentzelia; Salt bush; prickly pear; grease weed; and locally, Chenopodium watsontii. At the foot of the buttes, the showy spurge, and thistles, tomato, frequently are found. Along the channels, the buffalo-berry forms many large thickets, and on the more shaded side of many buttes, clumps of western red cedar may furnish many good fence posts.

The badlands, because of their relative inaccessibility, are the home of several carnivores. Gray wolves and coyotes are more frequently met here than elsewhere. Bobcats are plentiful. The puma or mountain lion was formerly not rare. A few antelope still feed on some of the ‘bats.’ Big horned sheep, and mule deer formerly were common and the big horn may yet be extinct in the White River Bad Lands. The mammals most often seen in badlands are the striped chipmunk and gray rabbit. The chief birds are the rock wren, Say’s pheobe, cliff swallow, violet green swallow, western lark sparrow, turkey buzzard, and prairie falcon. Rattlesnakes are not lacking, though far from common. The horned lizards (‘toads’) are seen occasionally.

(c) The badland life displays several peculiarities. The plants are mainly long-lived perennials, chiefly shrub species, and possess powerful tap and anchor roots and narrow and pubescent leaves. Such shrubs offer great resistance to erosion, undercutting, and slumping. They also are conservative, late-flowering, and present to cattle very little edible material. Many very slender species have yellow flowers. In addition to these perennials, there are various annuals which thrive during wet years on the molder alluvial flats.

The animals are grayish in color with the exception of the bats, swallow, swift, and vespertile. The crows and ravens furnish homes for the chipmunk, bat, bobcat, Say’s pheobe, prairie falcon, and rock wren. The cliff swallow and white-throated swift find cliffs suitable for nesting sites. Several of the larger mammals, notably the big horned sheep and mule or black-tailed deer, are powerful jumpers.

**THE PRAIRIES OR FAIRLY MOIST GRASS-COVERED PLAINS**

1. Distribution.

The eastern third of South Dakota (Fig. 29) is occupied chiefly by a single association, characterized, as far as the vegetation is concerned, by fairly short grasses which almost completely cover the ground, giving a firm turf, and by the widespread absence of native trees or bunch-grasses.

2. Conditions.

The moisture conditions are less severe than upon the steppe. There is more precipitation and its seasonal distribution and regularity is more

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47The following are the names of the remaining badland mammals and reptiles mentioned: *Lynx rufus*: *Felis concolor*: *Antelopus canadensis*: *S. elaps*: *S. obesus*: *Odocoileus hemionus*: *Odocoileus hemionus*: *Crotalus influenza*: *Pythonomus douglassi*: *Hamadesmus canaliculum*.
favorsable. (See the discussion of Bléo geographic district I, p. 1.) In regard to temperature and windiness there are no marked differences between the two districts. The prairie has less sunshine than the steppe, and the relative humidity is higher, and the rate of evaporation is less rapid. The soil, a glacial clay-loam, is fairly uniform over wide areas.

There are two phases, distinguished, so far as the plants are concerned, by the manner of growth. On the lower prairies, which receive, in addition to the normal rainfall, run-off from the high plateaus and are therefore more moist (mesophytic) as well as nearer to the ground-water level, there is a taller, more luxuriant, and denser growth of vegetation than upon the well-drained uplands.

3. DOMINANT PLANTS AND ANIMALS OF THE PRAIRIE

(a) Plants. The grasses are mostly turf-formers having, with a few exceptions, an average height at maturity of a foot or more, with over half of their bulk more than six inches from the sod. The dominant grasses are species of Koelreuteria, Sporobolus, Eragrostis, and Panicum, with red-top, false red-top, screw grass and blue-joint abundant in wide areas. There are several native species. The chief herbs are the prairie clovers, golden-rods, vervains, asters, blazing-stars and Indian turpentine.

There are several distinct seasonal aspects in the vegetation. The prairie is characterized chiefly, by Puccinia graminis, the pasque flower and the Indian tobacco; the vernal by the buffalo bean, white anemone, pennyroyal, violets, and many others; the autumnal aspect by the lead plant, vervains, pine apple flowers, black-eyed susans, and others; the serotinal stage by prairie clovers and blazing-stars, and certain grasses, and the autumnal stage chiefly by goldenrods, asters, and sunflowers.

There are two shrubs, low and relatively insignificant, which are widespread, the prairie rose, and the lead plant or "shoe-string."
In evidence. Examples are the milkweed, showy spurge (snow-on-the-mountain), beard tongue, cinquefoil, golden-rod, and certain sunflowers. Patches of blue-buck and wild roses are common and furnish shade in which tree seedlings start.

In the moist grassy ravines or "draws" blue-joint (Calaoegrostis canadensis) or blue-stem (Andropogon furcatus) is dominant, with tickle (Agrostis) panic (Panicum Scriberianum) grasses common. Along running water or on boggy soil the short-grass (Spartina cynosuroides) is predominant.

The vegetation of the low meadows grades into that of the marsh. The short grass (Spartina), wheat grass (Agropyron), in some localities incorrectly called salt grass, and blue-stem (Andropogon) is most conspicuous. Sedges (Carex, Cyperus, Scirpus) dominate in some places.

(b) Birds. The marsh hawk, boboling, dickcissel, short-eared owl, and, in a certain sedge (Carex sp) the short-billed marsh wren are the chief birds nesting in meadows in this state. In the western part of the state the long-billed curlew and the western grasshopper sparrow, and in the northwestern corner the Baird's sparrow nest most frequently in the tall grass of the moist draws.

(c) Other Animals. These areas are so limited in extent in this state that perhaps no vertebrates are restricted to them. However, various meadow mice (Micotus, Eutamias, Peromyscus) are most abundant and jack rabbits (Lepus c. canepstris) and cotton tails (Sylvilagus floridanus similis, S. Nuttalli grangeri) more frequently have their nests in draws than on the more exposed upland. Burrowing animals are rare in the moister portions of the meadow, doubtless because of the proximity of ground-water and the consequent likelihood of flooding.

(4) The life and the environment. Most plants possess roots apparently able to penetrate to the water-table. The rank growth of vegetation reflects favorable conditions. Several birds nesting in the meadows are of large size such as the marsh hawk, short-eared owl, and grouse. The rank vegetation affords protection for their nests, such as could not be found elsewhere in this region.

IV. THE WOODLAND.
(A) In General.

1 Distribution of Wooded Areas.

Woods are found along flood-plains, (b) in ravines and gulches, (c) on steep slopes or bluffs, (d) on the upland in the Black Hills and certain buttes.

Little of South Dakota is forested. It is estimated that there is about 2,500 square miles of natural forest, of which more than 2,000 is in the Black Hills. In addition, there are some 600 miles of planted wood-lots and wind breaks. A fairly heavy stand of timber is found in the Black Hills and in parts of the Sioux Forest Reserve in South Dakota (Sulf Buttes, Caya Hills and the Short Pine Hills). There are also extensive groves of large trees in the lower sections of the Missouri flood-plain. Smaller groves of smaller trees are found in the flood-plains of many other streams. Even in the Great Plains there are some trees along the permanent streams. There are some trees in many of the steep ravines, especially those that slope north. Few tree species are native on the uplands; the pine (Pinus scolporum) in the Black Hills and the burr oak (Quercus macrocarpa) in Gregory and Tripp counties and along the lower Sioux valley being chief.

The native forest trees of the state are of two types (1) deciduous, mostly restricted to valleys, and (2) coniferous, broad-leaved, but not dominant in the valleys, except locally at high elevations in the Black Hills.

2 The Geographic Conditions

The general climatic conditions of the woodland areas differ only in degree from those of the general area. The temperatures are somewhat less extreme and probably average lower; the precipitation is probably not greater, though because of greater absorption, it is more effective; the interior of the woods is much less windy than the open. If the deciduous trees of the state have roots which penetrate to the level of permanent ground-water, the tree and hardy trees such as the green ash and the western cottonwood are celebrated for their deep tap-roots. The trees shade the ground and the lower vegetation, locally making the light and temperature conditions at least periodically very different from those prevailing in the open. The trees and under-bush check the winds, and in so doing decrease the rate of evaporation. The abundant vegetation furnishes nesting sites for birds as well as food for many insects and other animals.

3 Dominant Plants and Animals.

(a) Plants. The chief trees are (1) the yellow western pine (P. scoporum), the most important lumber tree of the Black Hills and of the forested buttes of Harney County. It is represented along Pine Creek as far east as the 101st meridian, (2) The western red cedar (Juniperus scoporum) is found sporadically on the Missouri River bluffs, and more abundantly on the buttes, especially in the badlands, and in the Black Hills. Probably hundreds of thousands of fence posts have been cut from "cedar bricks" in the western half of the state. (3) The western cottonwood (Populus Sargentii) is widespread along flood-plains. It has been chiefly for fire-wood. (4) The green ash (Fraxinus lanceolata), forms many groves in the floodplains of the eastern third of the state, especially about the forested buttes. It is valued for posts. (5) The boxelder (Acer negundo), hackberry (Celtis occidentalis), elm (Ulmus americana, U. fulva) and peacheat and black willows (Salix amygdaloides, S. nigra) are fairly widespread but of much less importance than the trees mentioned above. The burr oak (quercus macrocarpa) is of minor importance except in Gregory and Tripp counties.

The larger shrubs include the wild plum (Prunus americana, chokecherry (P. melocarpia), June or service-berry (Amelanchier alnifolia, A. spicata), hawthorn (Crataegus macrantha, C. mollis, C. Sheridana), and in certain sections the sumac (Rhus glabra), black haw (Viburnum lentago), and the skunk-bush (Rhus triloba). Among the more abundantly represented lower shrubs are the buck-bush (Symphoricarpos racemos, S. occidentalis), wild rose (Rosa woodsii, R. Fendlerianna), western poison ivy (Rhus rydbergi) and various wild currents and gooseberries.

The chief lianes (climbers), are the wild grape (Vitis vulpina), woodbine (Parthenocissus vitacea) and bittersweet (Celastrus scandens).

There are many herbs. The more abundant grasses are the wild rye (Elymus), blue-joint (Andropogon) and blue grass (Poa). And other of the meadows along flood-plains are the broom corn (Oryzopsis hymenoides) and the tallgrass (Andropogon). Other conspicuous and widespread herbs include the horset fern (Monarda Bataloua).
M. mollis, M. mentheefolia), cow parsnip (Heracleum lanatum), false solomon-seal (Smilacina stellata), carrion flower (Smilax hispida), twisted-stalk (Streptopus amplexifolius), thistles (Carduus filipendulas, C. virginianum), golden-rods (Solidago arguta, S. canadensis, S. serotina, S. pitchers), and violets (Viola canadensis, V. cucullata, V. scarpholus). In the more deeply shaded woods, especially in ravines, numerous additional genera and species are represented.

(b) Birds. There is a considerable variety of bird life in the woods, including in most of the state, the western mourning dove, bobwhite, hairy woodpecker, northern and Bachelder's downy and redheaded woodpeckers, common and redshaded flickers, screech owl, sparrow hawk, crow, blue jay, black and white kingbirds, alder flycatcher, common and arctic sandpipers, boreal chickadee, goldfinches, rose-breasted grosbeak or western blue grosbeak, western chipping sparrow and western lark sparrow, white-rumped shrike, yellow warbler, yellow-breasted and long-tailed chats, warbling vireos (V. g. gilva, V. g. swainsoni), western house wren, catbird, brown thrasher. In the western part of the state there are several mountain birds. Those especially conspicuous are the magpie, pine jay and Canada jay, and the western robin.

(c) Mammals. Formerly the white-tailed deer (Odocoileus virginianus macrourus), puma, and black bear were abundant in all wooded areas. The first is extinct except in the Black Hills and the Sioux Forest Reserve, while the others are to be found in the Black Hills, it anywhere in the state. The wood rabbit (Oryctolagus cuniculus), a species of cottontail, white-footed mouse (Onychomys leucogaster) and other mice, gray gopher (Oitellus franklini), and certain bats (Myotis l. luciolus, Eptesicus f. fuscus, Nycteris l. borealis), are the more numerous mammals found in the woods. The porcupine (Erethizon dorsatum) and chipmunk (Eutamias m. minimus, E. pallidus) are plentiful in the western half of the state and bob-cats (Lynx c. canadensis, L. r. rufus), and raccoons (Procyon l. lotor) are not rare. The fox squirrel (Sciurus niger) is fairly common in the southwestern corner of the state, and the Dakota red squirrel (Hudsonicus dakovensis) in the Black Hills.

(d) Other animals. There appear to be no snakes characteristic of South Dakota woods. The lizard known as the swift (Scoloporus) is seen occasionally in the southeastern quarter. Tree frogs (Acris gryllus) are rare in the state, but not absent. The American toad (Bufo americanus) is somewhat common. Seven genera of land snails are recorded from the woods of the state by Wm. H. O. of the State Survey, who kindly supplied most of the data on molluscs given in this chapter.

(4) Some Characteristics of the Life of the Woods. Most of the plants have a deeply penetrating root system. This is probably due to the porous alluvial soil and the fact that the water table is within relatively easy reach. The trees exposed to the persistent winds develop strong anchor roots. Because of the generally low relative humidity, the leaves of most trees are small, and the bark of the trunk and limbs thick. The low sunbeams are extreme, especially in the wet mesic woods (basswood, Tilia americana), restricted to the more shady ravines in the most moist area, the extreme southeastern corner. Most of the shrubs and herbs also have small leaves, or other methods of retarding evaporation. Many species yield berries and rely upon animals for seed dissemination. Some of the trees, notably the cottonwood, willow, ash and box elder, which grow in the more exposed situations, depend upon the wind to carry their seed.

Most of the birds nest in trees. Many are sedgable in their habits, at least in certain seasons. Species nest in loose colonies. Most common species are highly migratory, apparently a response to the hard winters; but during the winter several species, in most cases non-migratory, are found in the woods. The western tree sparrow, long-tailed chickadee, redbelli and Bohemian waxwing, are locally common in winter. Various other characteristics of woodland birds have been mentioned or contrasted in the discussion of the birds of the steppe. About one-fourth of the mammals of woods are somewhat arboreal, about one third their young on the ground, and about two-thirds spend most of the time on the ground, while about 40 per cent have burrows in which the young are reared. However, only about six per cent spend most of their adult lives underground.

(B) GROVES ALONG FLOOD-PLAINS

As previously noted, there are many groves in the flood-plains of the eastern third of the state, and a few smaller ones along the permanent streams even in the most arid section. Since flood-plains receive the run-off from the other wooded areas, it is natural that the other wooded flora should be more varied than in any other association. In addition to the species mentioned in the woodlands, there are sporadic representatives of conifers, oak, sumac, and many herbs and other species more common on bluffs and in ravines.

(C) RAVINE AND GULCH WOODLAND

This, the most humid (mesophytic) association of the state, is represented most extensively in the valleys of the smaller tributaries of the Missouri, Sioux and Minnesota rivers, in ravines on the side of Wessington Hills in Jerauld County and the Pine Ridge in the south-central port of the state. The hackberry (Celtis occidentalis) and ironwood (Ostrya virginiana) are fairly common, and in the southeastern counties the sweet gum (Liquidambar styraciflua) and Kentucky coffee (Gymnocladus dioicus) are also represented. The dogwood (Cornus stolonifera), hawthorn (Crataegus mollis, C. macrocarpa, C. Sheridanii) and hawthorne (Viburnum lantago) are more abundant than in the flood-plain woods. Grasses are less important. Prominent herbs in addition are the wild licorice or loosestrife (Stledrema ciliatum), the nettle (Urtica gracilis), alumn-root (Hoechera hispida, H. valvifolia), snake root (Sanicula Marylandica, S. eudendron), beggar's tick (Washingtonia longistylo), and bedstraw (Galium triflorum). Twners are Smilax hispida, Olea eawlensis and hop (Humulus lupulus). Dutchman's breechers (Dicentra cucularia), jack-in-the-pulpit (Arisaema triphyllum), columbine (Aquilegia canadensis), Trillium erectum and many other plants common in the woods to the east of South Dakota are represented in the woods of the southeastern and northeastern corners of the state.

The birds in addition to those common in woodlands, and in greatest numbers in wetter places form a characteristic group in these woods. Many waders stop in such areas during their migration. It is not known that there are any mammals peculiar to this association.

The copes found near the heads of various north-facing ravines are a special phase of the ravine woodland. Their location is
mined by the presence of a spring, or at least of seepage. Plums (Prunus americana), chokecherry (P. melanocarpa), ash (E. lanceolata), Juneberry (Amelanchier alnifolia), and hawthorn (Crataegus sheidiana) are the more common trees and shrubs, the blue thistle (Cirsium vulgare) the most conspicuous herb, and the Arctic tern the most common bird.

(D) WOODS ON BLUFFS

In the southern part of Gregory and Tripp counties, and on portions of the bluffs of the Missouri in Clay and Union counties, and of the Sioux in Union and Lincoln counties there are scattered clumps of big-leaf maple (Acer macrophyllum) and sumac (Rhus glabra) with patches of buck-bush (Symphoricarpos racemosa) here and there. The chief grasses are bunch grasses (Andropogon, Aristida). The western field sparrow nests commonly in this association.

(E) PINE FORESTS

There are about 1,400,000 acres of forest reserve in South Dakota, approximately 100,000 acres in Harding County, and the rest in the Black Hills. In the Black Hills there are tens of thousands of acres fairly well-timbered but not in the federal reserve. The geographic conditions in these forests have been treated in the discussion of the Black Hills biogeographic district and in the chapters on physiography and climate. The chief commercial tree in the reserves is the Rocky Mountain pine (Pinus ponderosa) scopulorum. The red cedar (Juniperus scopulorum) is important at lower elevations, and the white spruce (Picea glauca) on the summits of the Black Hills. Ash (Fraxinus) and other trees (Elm, hackberry) valuable for fence posts, are found in the valleys at low elevations.

In addition to the pine, cedar, spruce and ash there are elms (Ulmus fulva, U. americana), birches (Betula papyrifera, B. fontinalis, B. glandulosa), poplars of several sorts, including the cottonwood (Populus [occidentalis] sargentii), quaking aspen (P. tremuloides), and narrow-leaved poplar (P. angustifolia), and other trees and shrubs, making a total of about 150 species of woody plants, representing about 30 families. Of these some 37 species are trees and 74 species shrubs. The herbaceous flora is very rich.

Among the more common birds are the Lewis woodpecker, western woodpecker, white-winged junco, pinon jay, western tanager, cedar waxwing, Audubon warbler, western house wren, long-tailed chickadee, western robin, and montain bluebird.

The chief larger mammals are the chipmunk (Eutamias m. minimus), Dakota red squirrel (Sciurus hudsonius dacotensis), wood-chuck (Marmota dactyliotis), wood rabbit (Sylvilagus audubonii bairdii), white-tailed deer (Odocoileus americanus macrourus O. texanus), bobcat (Lynx r. rufus) and pocket gopher (Thomomys talpoides nebulosus). The ripples are the green garter snakes. Amphibians are salamander (Ambystoma tigrinum) and a species of frog.
poor in species, while that on the near-by wet ground is very rich; that only two or three species of mammals spend much of their time in the marsh, but the bird does so. The most aquatic birds merely dive occasionally; none can hatch their eggs except in relatively, although in some cases not entirely, dry nests. The turtles of the state are aquatic (except a box turtle in the sandhills of Bennett County) and the young also, although the toads leave the water soon after hatching, and the frogs spend most of their lives on land. The invertebrate fauna is far richer than that of any other formation in the state but it has not been studied in detail yet.

4 Characteristics of Aquatic Life

Aquatic plants and animals have striking characteristics. The plants are chiefly semi-aquatic grasses and herbs, most of which are biennials or short-lived perennials. Very few are annuals. Ordinarily there is an abundance of available water, and transpiration can be freely indulged in; occasionally, however, the soil becomes partially dry. The plants which are most successful in a region where such drying-up occurs frequently are those which can resist evaporation. Fertilization occurs largely through the agency of insects, and the seed distribution by means of waves, currents, and animals as well as by the wind. Several "ticks" (Bidens) obviously adapted for animal distribution. Many, if not most aquatic plants also propagate by root-runners. The birds nest chiefly in reed-beds or floating nests. The females put in eggs, in almost every case, streaked and consequently protected. All species are from infancy swimmers or waders. The bills are chiefly short and adapted to impaling, or to probing (the tip of the upper mandible being capable of independent movement), or are supplied with strainers.

The mammals are all semi-aquatic and rear their young above the water-level, in burrows or houses. The muskrat, mink (Mustela vison latifur) and beaver (Castor c. canadensis) are examples. The muskrat and turtles travel freely on land and lay their eggs or bring forth their young there, but spend much of the time in or on the water. The amphibia are of two sorts, the aquatic salamanders (Amblystoma hernium) and the semi-aquatic frogs (Rana pipiens, Acris gryllus). The adaptations of frogs to life on land, by the growth of legs and other changes, is too well known for more than mention, but the changes undergone suggest the striking differences between the habitats. Fishes resemble tadpoles in many respects. The habit of swimming against the current, which most fish inhabiting swift streams have, is an interesting method, also used by various invertebrates, of preventing their being washed away by the current. Almost all of the insects characteristic of aquatic areas spend a portion, in many cases the larval stages, of their life in the water. Examples are mosquitoes, dragon-flies, damsel-flies, may-flies, water beetles and water-beetle.
Lakes differ from ponds in respect to depth; bodies of standing water deep enough not to freeze to the bottom are in this region usually called lakes, even though their expanse is slight. The shallower lakes or parts of lakes may have an abundant vegetation of submerged plants, five species of ducks, water crowfoot (Ranunculus), milfoil (Myriophyllum), pondweed (Potomoganemet), hornwort (Ceratophyllum demersum) or in some of the larger lakes of water lilies (Nymphaea advena). The duckweed (Lemna minor) is an abundant floating plant in many lakes. Marshy tracts are found about many, and the fluctuation in level of a majority, since a majority have no outlets, is sufficient to produce marginal portions which resemble temporary ponds.

A large number of birds occur as migrants; for example, some twenty-five species of ducks are recorded from the lakes of South Dakota. Several species of water birds secure their food from lakes or from marshy tracts adjacent. Three grebes (pied-billed, eared, and western) are fairly common or locally abundant in South Dakota, as are several ducks (rudy, scaup, baldpate). Mallards, pintails, and blue-wing teal also nest abundantly in marshy tracts bordering lakes, as do other birds mentioned under "marshes." The Franklin gull nests on many of the larger lakes of the northeastern part of the state, but secures most of its food (chiefly grasshoppers) from fields and grasslands.

The only abundant mammal is the muskrat, but the mink, which prey upon it, is not uncommon, and the beaver, formerly was plentiful. Bird life, particularly the common South Dakota ducks, turtles, third or green, and the snapping turtle, are found in lakes, but the latter is more abundant in streams.

There are three species of bivalve mollusks and various snails. Several fishes (carp, black bass and bullheads) inhabit both lakes and ponds. The snapping turtle, which is widely abundant along streams, is the largest. The fish of the state are few in number as well as comparatively small in size. This condition appears to be correlated with the character of the streams. It is seldom that a catfish (Ictalurus) weighing more than ten pounds is caught in the smaller streams. The Missouri River, the deepest stream of the state, and the record for the state is placed at twenty-five pounds. In the lower Mississippi River the same species attains a weight of 160 pounds.

The streams of South Dakota may be grouped into rivers, creeks and brooks. Rivers are of two distinct types, (a) the sluggish streams of the eastern section of the state, and (b) the swift streams of the western part. Streams which flow nearly every year in parts of their courses usually are called creeks. Brooks differ from the other streams in being fed chiefly from springs and hence normally clear. They are also permanent and swift flowing. The "creeks" in the Black Hills are considered here as brooks. The brooks in the sandhills and in the forested buttes are nearly all very short. The fauna and flora in or bordering streams is rich in species.

Plants.

In many places there are trees along streams; western cottonwoods and several willows are very generally distributed; the dogwood overhangs many brooks and also pools in creeks. The horse-tails (Equestum), and several species of sedges (Carex, Scirpus, Cyperus) and rushes (Juncus), notably the spike-rush (Eleocharis) are abundant on the moist margins of streams, where several species of dock (Rumex) are very conspicuous late in the season. The water plantain (Alisma) arrowhead (Sagittaria), and several species of buttercups (Ranunculus, Halerpester) are found along streams not liable to frequent wide fluctuation of volume, or if such fluctuations occur, do not then transport large quantities of silt. In rivers and the less permanent parts of the creeks vegetation is chiefly microscopic. In the deeper pool of creeks various attached species are found, including the water buttercup (Ranunculus), false water-cress (Rorippa), pond-weed (Potomogeton) and stone-wort (Hana fortil) may be found. In brooks, the true water-cress (Cardine) is abundant, and in many places the stonewort (Catalan) and there is a rich flora along the margins. The willow herb (Epilobium), mint (Mentha), hyssop (Gratiola), water horehound (Lycopus), water hemlock (Cicuta), arrowgrass (Triglochin), marigold and beggars' tick (Bidens), monkey flower (Mimulus), and John's wort (Hypericum), thoroughwort (Eupatorium), skull cap (Scutellaria), and others are widely abundant along brooks.

Animals.

Several birds are found most frequently along streams. Examples are the belted kingfisher, great blue and little green heron, and the black-crowned night heron, spotted and solitary sandpipers, kildeer, and green and blue-winged teals and pintail ducks. The wood duck formerly was common along the streams of eastern South Dakota. The American dipper or water ouzel is abundant on the streams in the Black Hills.

The mammals found about the streams are the muskrat (Fiber zibellii), beaver (Castor canadensis), which still is found in each quarter of the state, and mink (Mustela vison latifera). Formerly the latter (M. canadensis) was represented.

The reptiles are the garter snake (Thamnophis sirtalis), which is very abundant, and snapping turtle (Chelydra serpentina). In creeks the last is found only in the deeper pools.

The only amphibian which is widely abundant along streams is the pickerel or pickerel frog (Rana pipiens). The fish of the state are few in number as well as comparatively small in size. This condition appears to be correlated with the character of the streams.
water shrimp (Gammarus) and the planarian flat-worm (Planaria, Dendrocoelum), are exceedingly abundant about some streams, as is the snail Zonitoides. rawfish (Cambarus) are widespread. Water-beetles, water-panmen (Corixa), backswimmer (Notonecta), damsel flies, may-flies, mosquitoes and black flies (Simulium) are numerous. The larva of the latter builds a case of tiny pebbles about itself, and the "houses" of 'caddis flies' are very abundant on submerged rocks in the swifter and clearer streams.

From the preceding discussion, it appears that the native flora and fauna have been influenced powerfully by geographic conditions. The human life, treated in the following chapter, has been affected to a lesser degree, but nevertheless, greatly.

CHAPTER SEVEN
HUMAN GEOGRAPHY

1. Present conditions, p. 109; the evolution of the present conditions, or The General Historical Geography, p. 129.

(A) The Population and Its Composition

The population of this area, as returned by the several federal and state censuses, was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Increase Over Preceding Census Year</th>
<th>Percentage Increase</th>
<th>Density per Square Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>11,925</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>1880</td>
<td>33,711</td>
<td></td>
<td></td>
<td>323</td>
</tr>
<tr>
<td>1890</td>
<td>345,682</td>
<td></td>
<td></td>
<td>323</td>
</tr>
<tr>
<td>1895</td>
<td>330,278</td>
<td></td>
<td></td>
<td>575</td>
</tr>
<tr>
<td>1899</td>
<td>475,797</td>
<td></td>
<td></td>
<td>351</td>
</tr>
<tr>
<td>1900</td>
<td>455,185</td>
<td></td>
<td></td>
<td>351</td>
</tr>
<tr>
<td>1910</td>
<td>549,485</td>
<td></td>
<td></td>
<td>351</td>
</tr>
</tbody>
</table>

The federal census records a large but relatively decreasing foreign-born element in the population (17.2% in 1910, 22% in 1900, 26.1% in 1890). The proportion of foreign-born persons is higher in the rural than in the urban districts (17.4% vs. 16.3% in 1910). Five counties reported no foreign-born persons in 1910, fifty-one reported between 10% and 25%, and four counties more than 25%. Of the foreign-born in 1910, 37% were Scandinavians (Norway, 20.8%; Sweden, 9.9%; Denmark, 6.3%), while natives of Germany made 21.4%, Russia 18.1%, Canada 6%, Austria 5.3%, England 4%, Ireland 3%, Holland 2.6%, leaving 7.6% for all other nationalities represented.

The percentage of the population reported as native-born with one or both parents of foreign birth (37.2% in 1910, 38.3% in 1900, 34.4% in 1890), is nearly twice as large as the foreign-born element. Of these two elements making up the so-called population of foreign origin, (54.4% of the total population in 1910, 66.9% in 1900, 75.5% in 1890), in 1910 Germany had contributed 26%, Norway 19.1%, Russia 10.4%, Sweden 7.2%, Canada 6.5%, Ireland 5.5%, Denmark 4.7%, England 4.7%, Austria 4.3%, Holland 2.1%, Scotland 1.3%, Finland 1.3%. If to the large per cent (26) accredited to Germany, the Germans born in Austria and Russia and their children could be added, it is probable that the Germanic element in the state would exceed the Scandinavian (31.1%). Most of the Russians are Teutonic Mennonites and most of the Austrians are Teutonic Bohemians.

The rest of the white population (43.1% in 1910, 32.1% in 1900) is native-born of native-born parents. Of this element more than half (53.4% in 1910, 41.4% in 1900, 65% in 1890) were born in other states or territories. The seven states that contributed most, with the per cents for 1910 and for 1900 are Iowa (15.7, 9.9); Nebraska (8.8, 2.0); New York (2.1, 2.5) and Ohio (1.8, 2.3); all other states contributed between 11.2% in 1910, and 11.8% in 1900. When grouped by geographic divisions, it appears that of this native element 74.6% in 1910 and 71.2% in 1900 were born in the "West North Central States," as this division is defined in the Census reports, while the "East North Central States" supplied 17.8% and 18.6% respectively. The "Middle Atlantic Division" contributed 7.7% in 1910, and 5.8% in

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2Ibid., p. 590.
3Ibid., p. 591.
1900, leaving but 3.9% in 1910 and 4.5% in 1900 for the population contributed by the other divisions of the Union. The percentage of the population native to the West North Central States aside from Iowa has fallen off slightly, as the increase (3.5%) shown by this division is more than covered by the large increase (5.8%) from Iowa. The East North Central Division has lost but slightly (1.5%), while the representation sent to the Middle Atlantic and New England sections decreased about a third, in each case, between 1900 and 1910.

As the number of Indians has remained about stationary (19,137 in 1910, 20,225 in 1900 and 19,554 in 1890) they form a decreasing proportion of the entire population (5.7% in 1890, 3.3% in 1910). Negroes have comprised about 0.1% of the population since 1890.

Fig. 29. Density of Population of South Dakota, by Counties, 1910.

(B) The Distribution of the Population

Fig. 30 shows the density, and thus the distribution, of the population of South Dakota by counties in 1910. The population is most dense in the eastern, especially in the southeastern, part of the state, and least dense in the extreme northwestern county, and in the Indian reservations, present or recent, in the north-central and south-central parts of the state. Mining and irrigation support in the Black Hills region a population much denser than occurs elsewhere in the western half of the state. With the exception of parts of the reservations and of the Black Hills, the population in a general way decreases in density with increased distance from the southeastern corner of the state. It was noted in earlier connections that with the exception of the Black Hills, there is a similar decrease in the amount of rainfall and in the length of the growing season with increased distance from the southeastern corner.

In discussing the distribution of the population, it will be convenient to treat separately the distribution of towns and of the rural population. Since more than two-thirds (66.7%) of the population live outside of towns, the latter will be discussed last.

The density of the "rural" population (all persons not living in places of more than 2,500) is very similar to that indicated in Fig. 30. However, Cokedomon, Lake, Davison, Hughes, Lawrence and Yankton counties are less densely populated than indicated by Fig. 30, due to the exclusion of the populations of the cities of Watertown, Madison, Mitchell, and Yankton respectively. With the exception of Yankton County, a map of the rural population by counties supports the generalization made for the distribution of the population even better than did the map (Fig. 30) of the entire population.

1. Location of Dwellings

Areas subject even rarely to inundation have relatively few homes. A large majority of the buildings in the valleys are on higher ground near the bases of the bluffs, in many cases on alluvial fans and pediment slopes. Many of the latter also are occupied by "bluff roads." Most of the relatively few homes located on the flood-plains are on spots somewhat higher than their surroundings. Similarly very few homes are located within the "lake-beds" exceedingly numerous in the glaciated part of the state, with the result that a large proportion are near the margins of such depressions. In the more rugged parts of the state, notably the Black Hills, the badlands, and the bluffs along the streams, the steeper slopes were avoided in locating homes. Throughout most of the state, however, the topography is that of a gently undulating plain, and on nearly every quarter section of land there are many suitable building sites. Considerably a larger majority of the homes are located within a few rods of the section line road, and near the middle of one of the sides of the "quarter." This is the most convenient location from the standpoint of access both to the highway and to all parts of the quarter. Rural free delivery and telephones have increased the desirability of being near rather than far from the main highway. Many farms consist of more than one "quarter," and in such cases the home is likely to be near the middle of the farm, which lies on both sides of the section-line road. As already noted, there are roads along most section lines, this being practicable because of the slight relief over wide areas. Since most towns of the state are laid out in relation to section or half-section lines, and most rural homes are near such lines, it follows that the latter are the determining factor in the detailed distribution of most of the homes and most of the people. A geographic feature is responsible for the precise location of these lines. In the area east of the Missouri River, the survey of which was made by assigning the mouth of the St. Francis River in Arkansas as the starting point. An east-west line through the mouth was made the baseline, a north-south line (which happened to be 90° 58' west from Greenwich) which made the prime meridian. Had the position of the mouth of the St. Francis River been different, and because of the shifting of the Mississippi River it frequently has changed, the distribution of most of the homes in eastern South Dakota, as in parts of certain other north central states, would have been different than it is. The land survey of that section of South Dakota west of the Missouri River used the 44th parallel as its base line.

2. The Location of Towns

The location of almost all South Dakota towns, except some in the Black Hills, is associated closely with railroads. They are spaced...
at intervals of about ten (eight to twelve) miles along the tracks. Railroads are sufficiently plentiful east of the Missouri so that few localities are more than fifteen miles from a station, and yet few towns are less than eight miles apart. Thus towns have substantially equal advantages in regard to the size of the territory most readily accessible to them.

The seat of local government is such a valuable asset to a town that in most cases the county seat has become the largest town of the county. Consequently, in most new counties there was great rivalry between the towns for the county seat, and the political ambitions of many towns were powerful influences in favor of small counties rather than large ones. Some of the county seats are junction points of two or more railroad lines, and such towns have outstripped less favored ones.

The relative size of incorporated cities and villages is shown by the size of the circles.

**Fig. 31.** The Density of Urban Population in South Dakota, Census of 1910.

With few exceptions, the larger cities are fifty miles or more apart. To a certain extent they serve the surrounding towns, as wholesale centers, and sites of relatively advanced educational facilities and amusements. Manufacturing is increasing rapidly in the larger cities.

In regard to towns, the state is divided readily into three sections, though the boundaries are less distinct than they were before 1905: (1) the eastern half of the state; (2) the Black Hills region; (3) the Great Plains section.

(1) The Towns of the Eastern Half of the State. Of the ninety towns which in 1910 had a population of 500 or more, all but fourteen are east of the Missouri River. Every one of the ninety towns has a railroad, and ten of the fifteen east of the Missouri, having a population of more than 1,500, have two or more lines. Of the other five, one is the capital, one is the site of the State University, and another the site of the College of Agriculture. The other two are barely within this group.

Of the seventy-six towns under discussion, thirty-eight have but one railroad each. Of these, seven are on railroads which run north-south and five are on diagonal lines, while twenty-six are on east-west lines, which as a class are older than the other lines. The thirty-eight remaining towns of this group have east-west and either north-south or diagonal lines.

Of the seventy-six towns of the eastern group, only three, Pierre, Chamberlain and Yankton, are on the Missouri River. Vermilion formerly was on that stream, but the shifting river is now about two miles away. One of these towns, Olivet, is on the Dakota River, though several (Canton, Sioux Falls, Dell Rapids, and Flandreau are on the Sioux. Yankton Sioux Falls and Vermilion were the only river towns which were of significance before the coming of railroads. Yankton was then the capital of the Territory, and although it benefited greatly by the river in early days, it no longer does. It is not bridged, and therefore partially cuts off from the city nearly half the territory which might be expected exclusively to depend on it. Yankton has declined with the falling off almost to nil of navigation on the Missouri, and the building of a railroad on the opposite side of the river. The growth of Vermilion has been slow for similar reasons. Chiefly because of the expense and difficulties in bridging the Missouri River, several east-west railroads had their termini for many years on its east bank, with the result that towns grew up there. Chamberlain and Pierre are the larger towns whose growth was stimulated in this way. Running Water and Le Beau are small towns (less than 500) at the terminus of railroads, which indirectly owe their existence to the river.

Nearly all the other towns of this part of the state owe their location to railroads. A large proportion of them were laid out along the east-west lines, as most of the east-west roads were constructed before the main north-south road, the location of the railroads, and hence, in a way, of the towns, was influenced by (1) the presence of preglacial valleys across the relatively high Western Coteau and (2) favorable points for crossing the Dakota River. The main line of the Chicago, Milwaukee and St. Paul, heeding for the Black Hills, preempted the southern gap in the Coteau, between the Wessington Hills and the Bijou Hills. Entering Dakota at Canton, the railroad in 1880 was built across the Vermilion River Valley at its forks and across the Dakota River where the upper stream (Firesteel Creek) had prepared the way for a relatively easy crossing, by making a relatively easy grade from the river to the plain on the west. Elsewhere in the vicinity, and for some miles to the south, the Dakota River flows through a shallow gorges, which would have been difficult to cross. Mitchell was located on the plains north of this crossing, from which the line continues westward through the gap in the Coteau to the Missouri River at Chamberlain. The main east-west line of the Chicago and Northwestern Railroad entered Dakota in 1886 from the east near Brookings, swinging north to avoid the large lakes in Kingsbury County, and then continuing nearly west through the next gap to the north in the West Coteau and down the valley of Medicine Knoll Creek to the Missouri flood-plain. It followed up this plain to a point opposite the mouth of the Fresno River, where Pierre was founded. In 1907 it was continued westward to Rapid City in the Black Hills. Nearly midway between these two routes, which are about six miles apart east of the Missouri River, is the east-west line of the line is that of the Milwaukee and St. Paul, which entered Dakota near Flandreau and was extended west to the western Coteau at Wessington Springs. The location of a considerable length of this line is said to have been due to the relatively favorable crossing of the Dakota River by way of the small tributary...
valley of Silver Creek. In a similar way the other east-west lines, with their attendant towns, were influenced in their location, even in so nearly an area as eastern South Dakota, by physiographic features.

Near the points where each of the railroad lines crossed the Sioux and Dakota rivers, town sites were laid out, and between these points stations were located ten miles or so apart along the roads.

The north-south railroad lines are next in importance. The bottom of the Sioux Valley is fertile, and nearly level. In 1866, it had a considerable population. It was followed by the earliest north-south railroad line, completed to Sioux Falls in 1878, and to Flandreau in 1879. Prominent railroad towns in this valley are Elk Point, Canton, Sioux Falls, Flandreau, Brookings, and Watertown. The topography of the Dakota Valley favors railroad building as well as the fertility as does agriculture, and the second of the north-south lines was built, mostly in 1883, up the west side of the valley. It increased the importance of several towns already laid out on east-west lines, especially Mitchell, Woonsocket, Huron, Redfield, and Aberdeen, and it led to the establishment of many smaller towns. The territory between the Sioux and Dakota valleys needing railroads, lines were built (mostly in 1886) along the low intervening divide. The towns along these lines are not so large as those in the valleys. The more prominent are Centerville, Parker, Salem, Howard, Madison, Lake Preston, Bristol, and Britton.

Part of the broad divide between the Dakota and Missouri valleys is rugged, and no railroads have followed it entirely across the state. Among the towns in this region, most of them on east-west railroads, may be mentioned Tyndall, Platte, Stickney, Plankinton, Wessington Springs, Miller, Highbore, Clark, Gettysburg, Faulkton, Ipswich, and Roscoe.

The Towns of the Black Hills Region. The location of most of the towns in the Black Hills was determined by mines, or by passes into the more rugged sections. Custer, Keystone, Galena, Deadwood, and Lead are examples of the former class, and Edgemont, Hot Springs, Rapid City, Sturgis, Whitewood, and Spearfish of the latter. Thus the growth of Hot Springs was due largely to hot mineral springs. Deposits of gypsum also have been of importance here, as at Rapid City.

(3) Towns of the Great Plains Section. This part of the state had no towns until the coming of railroads. Once a year the ranchers drove stock to market towns in the Black Hills, or to the railroads near the Missouri River. In many cases these towns were scores of miles from the ranches. Supplies for months were sent by stage. The development of the railroads (1896 to 1910) changed conditions greatly, and now there are many small railroad towns in this part of the state. Six railroads have crossed this part of the region, four of them following the main divides, and the two others were inhabited and the divis were uncultivated, but now the divises are the more densely populated belts. Cross-line railroads have not been built, and several of these young towns are so nearly equal in size that it is quite certain which will attain leadership. Among the more prominent are Presher, Murdo, and Interior along the White River Divide; Presher, Murdo, and Interior along the White River Valley; Midland, Phillip, and Quinn in the Teton Valley; Eagle Butte and Faith on the Moreau-Cheyenne Divide; Timber Lake and Isabel on the Missouri and Divide; and McLaughlin, McIntosh, and Lemmon on the Grand-Canonville Divide.

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115 THE GEOGRAPHY OF SOUTH DAKOTA

(C) THE MORE IMPORTANT OCCUPATIONS

1. Agriculture

A large majority of the people in South Dakota are engaged in agriculture. In 1910 only 13.1% of the entire population of the state resided in cities and towns having a population of 2,500 or more, and in 1900 only 10.9%. At the taking of the census the 50 per cent of the dwellings were on the 77,644 farms of the state. There were only 5,526 persons engaged in manufacturing, and only 4,189 persons engaged in mining, quarrying, and well-drilling. These industries employed less than 5% of the 187,000 males of 16 years and over. The percentage engaged in commerce and transportation probably is larger than that, but the figure is not available. It appears likely, however, that more than 75% of the workers of South Dakota are engaged in agriculture and pastoral pursuits.

Farming and stock-raising are the leading occupations, largely because of geographic conditions. The wide extent of nearly level, fertile plains, grass-covered, and ready for the plow, and fairly well watered, encouraged agriculture. In contrast, the treelessness of most of the area determined that lumbering should be unimportant.

The lack of highly valuable deposits of coal or iron, or of other minerals outside the Black Hills, prevented mining from assuming the leading place. Manufacturing is handicapped greatly (1) through the want of cheap supplies of good fuel or of sufficient water power, (2) by the relatively sparse population, and (3) by the small local market.

Because South Dakota is near the center of a great continent, lacks effective natural highways, such as the Great Lakes, is on the border of the more densely populated region to the east, and is separated from the west by mountain barriers, commerce is not likely to attains a leading rank among the occupations of the people.

The leading types of agriculture (extensive farming of staple cereals and stock-raising) and the kinds of crops grown are responses to geographic conditions. The position of the state far from the chief markets for the produce, and in a vast area having similar climatic and soil conditions, small local markets, and without quick transportation to distant markets, discourages market gardening or the growing of fancy crops. The climate is unfavorable to horticulture in comparison with that of many other regions. The uncertainty of the rainfall, the scantly population, and the cheapness of land combine to discourage intensive agriculture. On the other hand, the climate, topographically, soil, and land conditions are all relatively favorable to grazing industry and to the growing of certain standard crops, notably wheat, oats, corn, and hay.

(a) Stock-raising. From the first settlement of the state, a major part of its area has been devoted to stock-raising. The nutritious native grasses, cured to hay during the dry autumns, and the light snowfall during most winters always will favor this industry. Formerly the presence of much unsettled land, and the ability of stock to travel many miles to market or to shipping points gave grazing a great advantage over farming. The farmer finding most unsettled stretches of country a menace because of prairie fires and locusts. The cost of the sod, their breeding grounds, reduces their abundance. Furthermore, the extension of the tillable area reduces the proportional damage done to any unit area.
of transporting crops long distances in many cases was prohibitive or greatly reduced the profit. Because of the variable and uncertain rainfall in most of the state, mixed farming, in which stock-raising formed a prominent part, has proved more profitable than either cereal farming or stock-raising alone. Consequently there continue to be great numbers of stock in South Dakota. The census of 1910 reported more than 1,535,000 cattle, nearly 670,000 horses, nearly 13,000 mules, more than 611,000 sheep, 2,390 goats, and about 1,910,000 hogs.\footnote{Census Supplement: loc. cit. p. 690.}

During many years the livestock sold each year has been second in value to the wheat crop.\footnote{Johnson, Willis E.: Dakota, a Republic of Friends, p. 164. (Pierre, 1911).}

Stock-raising was predominant in the area east of the Missouri River during the 1860\'s and 1870\'s before the region was served efficiently by railroads,\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} as Indian agencies and military posts formed excellent markets for beef\footnote{Ibid., p. 91.} not needed on the farms and in the towns of the area. The raising of stock was thus highly profitable. "Capital invested in stock usually brings a return of about 50% per annum."\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).}

"The want of capital is the chief thing that keeps homesteaders from going into stock-raising."\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).}

The "Herb-law," making cattle owners responsible for damage done to crops, whether fenced or not, was passed before 1883, and it greatly stimulated tillage.\footnote{Ibid., p. 91.} as fencing was expensive.\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} Tillage was encouraged still further by a series of wet years (1878-85), and by the extension of railroads. As the land of the eastern part of the area was appropriated by farmers during the early 1880\'s, stock-raising shifted westward. During the dry years of the early 1890\'s, when much land in the eastern section was abandoned, herds reappeared in this region, and since then stock-raising has remained important. According to the Census of 1910, the southeastern counties have more livestock per square mile than has any other part of the state (Fig. 32).

Cattle were introduced into the Black Hills region in 1875,\footnote{Johnson, Willis E.: Dakota, a Republic of Friends, p. 164. (Pierre, 1911).} shortly after the beginning of the gold rush, and by 1878, the year following the purchase of the region from the Indians, 10,000 cattle, many having been driven from Texas,\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} were reported from the area almost enclosed by the forks of the Cheyenne. Most of them were in Dakota.\footnote{Johnson, Willis E.: Dakota, a Republic of Friends, p. 164. (Pierre, 1911).} There was a very rapid development of grazing in western Dakota during the next few years, induced by the settling of eastern Dakota, Nebraska, and Kansas, and by the extension of railroads to the Missouri River at Pierre and Chamberlain and across Nebraska and the area now included in North Dakota. By 1883 there were 500,000 cattle in the Black Hills region.\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} During these next two years the industry spread to the Little Missouri region\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} and to the Badlands,\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} and according to the Territorial Census of 1885 there were 233,000 cattle, 63,000 sheep, and 10,000 horses in the western third of the area now in South Dakota. Sheep were introduced extensively into Dakota only after 1878. The woolclip of 1880 was nearly 157,000 pounds, while that of 1885 was 882,000 pounds.\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} The grazing industry received severe setbacks by the hard winter of 1886-87, when heavy snow and great cold caused the death of more than 50% of the stock,\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).} and by the dry years of the late 1880\'s and early 1890\'s. However, it was reported in 1899 that there were 225,000 adult cattle in the sections of South Dakota near the Black Hills, distributed as to ranges and the number of outfits as follows: Little Missouri Valley, three large and four small outfits, with 68,000 head of cattle; Missouri Valley, two large and two small outfits, with 59,000 head; Red River Badlands, five outfits, with 32,000 head; Bad River Valley, three outfits, and 24,000 head; Cheyenne Valley, six outfits, with 24,000 head; the Sandhill district, three outfits, and 10,000 head. During 1898, 1899, and 1900, cattle were shipped from Belle Fourche, and 110,000 cattle were shipped in 1902. For several years Belle Fourche claimed to be the greatest primary cattle shipping market in the world.\footnote{Gregory John: Conditions and Resources of Southern Dakota, p. 27. (Sioux City, 1872).}

In 1907, grazing continued to be by far the most important industry of the western half of the state, the Black Hills excepted. The chief ranges centered about the White River Valley, the Belle Fourche Valley, and the Little Missouri Valley. In each of these areas badlands or "breaks" afforded protection from winter storms, permanent streams supplied water, and pasture was available, especially on the terraces or "flats" along the streams. Many large "outfits" occupied the range country, and many cattle, mostly "Herefords," as well as many horses and sheep were raised.
The extension of the railroads across the state between 1905 and 1910, during which years nearly 1,000 miles of line were completed, attracted thousands of homesteaders, and their presence made impossible ranching on the enormous scale of earlier years, when tens of thousands of cattle were owned by one individual or company. In much of the western part of the state, however, grazing is the most uniformly profitable industry; and, though range stock is withdrawn on the arrival of homesteaders, animals are numerous in most regions. The large outfits with their picturesque cowboys have disappeared, but there were perhaps 75,000 more cattle in western South Dakota in 1910 than in 1899. The thirteenth census records nearly 400,000 cattle there; of this great increase in a region considered overstocked in 1899, it is not surprising when it is recalled that the range cattle then received almost no care, that because of lack of drinking water in certain seasons many otherwise excellent stretches of range were unoccupied, and that then only the territory within reach of water holes was stocked. With the settlement of the area, thousands of reservoirs have been constructed, the unoccupied tracts have diminished greatly, and supplies of hay have reduced winter losses. Wolves and coyotes also are less numerous than formerly.

Table 16—Statistical Data for South Dakota.
From U. S. Statistical Abstract and U. S. Census Reports.

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much as North Dakota. She produces more than all the New England States combined, with New York, North Dakota, New Jersey, Delaware, Montana, Utah, Washington, Oregon, California, Colorado and Wyoming.52

Although some crops have been grown in South Dakota from early days,52 there have been notable changes in agricultural practice. In pioneer days, wheat was the chief crop.54 It still is predominant in the northeastern quarter (Fig. 34). Much recently "broken" land is sown to flax, and during the early 1880's this was an important crop in the eastern half of the area, as it has been in the western half during the past decade (Fig. 35).

Fig. 33. The Yield of Corn in Bushels per square mile, Census of 1910.

Fig. 34. The Yield of Wheat in Bushels per Square Mile, Census of 1910.

Fig. 35. The Yield of Flax Seed in Bushels per Square Mile, Census of 1910.

A period of two-crop farming succeeded in which wheat was of chief importance, wheat and corn being rotated commonly in all but the northern counties, where wheat and oats, barley, or rye alternated. The dry years of the early 1890's encouraged still further diversification. Alfalfa and other forage crops, barley, oats, corn, flaxseed, potatoes, and fruits55 have increased greatly in importance and cultivation is more intensive.56 One result of this development has been an increase in the numbers of dairy cows and hogs, as well as of beef cattle.

The fluctuations in the acreages of some of the principal crops of South Dakota from 1879-1913 are shown in the next table. The acreage devoted to corn is more than three and a half times as great as in 1889, both the absolute and the relative gain of 1909 over 1899 being greater than during the preceding decade. The increase in the acreage

52Johnson: loc. cit., p. 83.
53Pole's Gazetteer of Minnesota and Dakota for 1882, p. 901 records that "Dakota exports wheat, corn, barley, flaxseed, flour, hogs, cattle, butter, eggs, wool and hides."
of oats has been great, but less regular. The acreage of wheat increased from 2,259,846 in 1889 to 3,984,659 in 1899, an increase of 76.3 per cent, but decreased during the last decade to 3,217,255, a decline of 19.3 per cent. The acreage of barley increased more than 1,000,000 acres during the period 1889 to 1900. The acreage of flaxseed increased during the same period.

Hay and forage have increased dramatically during the last two decades. In 1890 they had an acreage more than twice as great as in 1889.

Table 18.

<table>
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<tr>
<th>Crop Year</th>
<th>Corn</th>
<th>Oats</th>
<th>Wheat</th>
<th>Barley</th>
<th>Flaxseed</th>
<th>Hay &amp; Forage</th>
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<td>266,288</td>
<td>15,156</td>
<td>33,282</td>
<td>188,703</td>
</tr>
</tbody>
</table>

- Dakota Territory prior to 1889. This acreage does not include wild hay.

The following table shows for 1909 and 1909 the percentage which the farms reporting specified crops formed of all farms, the percentage of improved land devoted to these crops, and the percentage of increase or decrease in the acreage of each of the crops during the decade, together with the average yields and average values per acre for 1909.

Table 19.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percentage of Farms Reporting</th>
<th>Percentage of Land Devoted</th>
<th>Average of All Years</th>
<th>Average Yield</th>
<th>Average Value per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>63.5</td>
<td>65.8</td>
<td>12.9</td>
<td>70.3</td>
<td>27.3 Bu.</td>
</tr>
<tr>
<td>Oats</td>
<td>64.1</td>
<td>68.3</td>
<td>8.3</td>
<td>35.5</td>
<td>38.6 Bu.</td>
</tr>
<tr>
<td>Wheat</td>
<td>50.8</td>
<td>70.1</td>
<td>10.3</td>
<td>12.5</td>
<td>14.6 Bu.</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>17.5</td>
<td>17.5</td>
<td>4.3</td>
<td>32.5</td>
<td>14.6 Bu.</td>
</tr>
<tr>
<td>Barley</td>
<td>37.0</td>
<td>34.1</td>
<td>2.7</td>
<td>37.1</td>
<td>10.1 Bu.</td>
</tr>
<tr>
<td>Hay &amp; Forage</td>
<td>70.7</td>
<td>70.0</td>
<td>27.1</td>
<td>71.9</td>
<td>9.3 Bu.</td>
</tr>
<tr>
<td>Potatoes</td>
<td>57.2</td>
<td>58.9</td>
<td>21.7</td>
<td>50.6</td>
<td>1.7 Tons</td>
</tr>
</tbody>
</table>

Of every hundred farms, 71 report hay and forage; 84 report corn; 58, oats; 58, potatoes; 51, wheat; 37, barley; 19, flaxseed, and 18, cotton and flax. Except in the case of barley, the proportion of farmers reporting each of the specified crops for which complete data are given is smaller than it was a few years ago. The eight crops included in the above table cover about 77% of the improved land of the state. The most important relative increases in acreage related to barley, oats, flaxseed, and corn. Fruit growing for local markets is of some importance in parts of the Black Hills having a long frostless season. Clover and Timothy thrive at relatively high altitudes where much snow falls and are the chief forage crops there, as is alfalfa on irrigated land. Agriculture was commenced in 1876, the first season after the arrival of many prospectors in the Black Hills, in the valleys of Rapid and Spring creeks.

The close relationship between crop yields and precipitation has been discussed in the chapter on climate and the relationship between yields and soil in the chapter on the bio-geography.

Dry Farming. Where the rainfall is not always sufficient for the growing of crops by the methods used in moist regions, considerable quantities of wheat, flax, and other crops, are grown by the method called dry farming. Dry farming consists in preparing the soil so that almost all the moisture that falls is absorbed, and in hindering the subsequent evaporation of this moisture by a thin layer of dust on the surface, produced by repeated harrowing. Caked soil loses its water by evaporation much more rapidly than dust-covered soil. In the drier parts of South Dakota there are fifteen inches of rainfall a year on the average. Since cereals require at least nine inches for their development, it is obvious that from an area watered by rainfall and melting snow alone, very little can be allowed to escape if crops are to be grown. Under natural conditions nearly all of the fifteen inches that do not run off in streams (and much more than that amount, if it were available) would evaporate.

Differences in the yields from near-by fields seeded to the same crops in a dry year are due to (1) the nature of the soil (whether or not it can hold moisture), (2) the thoroughness of cultivation after heavy rains (the formation of the dust layer), or (3) the time of planting, the preparation of the land, and the method of planting.

Irrigation. In dry regions the soil in many places is very rich in the mineral elements of plant food, such as nitrates, phosphates, and potassium. But the surface of South Dakota is nearly level near the surface, instead of being leached out and washed away by the run-off as may occur in well-drained parts of wet regions. Therefore, when the water supply is sufficient, crop yields are likely to be large in dry regions. These bountiful yields and good markets for produce furnished by the mining population and the stock ranches are incentives to irrigation in parts of the state.

Most of the streams leaving the Black Hills were used early for irrigation, especially near Edgemont, Rapid City, and Spearfish. The first project, in 1909, was that at Belle Fourche, which was developed by the Federal government and completed in 1912. A tributary named Owl Creek, having a wide valley, was dammed and a large supply of water diverted from the Belle Fourche River is stored there. From this reservoir, 100,000 acres are irrigated. Other projects irrigated and favorably reported on by the government experts are in the Grand River Valley, in the Little Missouri Valley, and along the Missouri River. Lack of funds has prevented work on these projects to date.

Some of the private projects are (1) the irrigation of parts of Rapid City Valley (40,000 acres between Rapid City and the Cheyenne River), (2) "the Cheyenne project," involving parts of Stanley County, and (3) irrigation by pumping, (a) along the Missouri River by use of water power, and (b) along the Little Missouri Valley by power generated from the lignite deposits found in that part of the state.

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1 From the 13th Census Supplement for South Dakota, p. 625, (Washington, 1918); 1912 report by the Department of Agriculture, (Washington, 1914).
2 Thalens, loc. cit., p. 314.
and two planing mills in 1882. Almost all of the lumber is consumed in the Black Hills region, as the timbering of the mine shafts requires large quantities. Two million feet of lumber are used annually in timbering the Homestead mine. The Black Hills National Forest of almost 1,500,000 acres has been the scene of much good experimental work in lumbering and forest management by students of eastern schools of forestry and by government specialists. In the literature of American scientific forestry it holds almost as prominent a position as the Black Hills do in the literature of geology.

In the valleys of the eastern part of the state there are groves of hard woods and cottonwoods, and on the uplands there are many groves which have been set out. Although these trees are of great value as a protection of supply for posts and firewood, and as a protection from wind and sun, very little lumbering has been carried on recently due to the small size of the groves or of the trees.

Before the coming of the railroads many buildings were constructed of log, and sawmills and shingle mills were somewhat numerous. The first sawmill in the territory being erected at Sioux Falls in 1857. The first machinery in Lincoln County was a shingle cutter put in operation on the Sioux River in 1868. There were several steam sawmills in the Sioux and Missouri valleys by 1870. Most of the sawmills had sawmill attached, and lumber could be obtained at prices from $15.00 to $25.00 a thousand feet and shingles at $4.00 per thousand. The census of 1885 recorded thirty-three sawmills in the Territory of Dakota, while the census of 1910 reports but three custom mills in the state.

(4) Manufacturing

In South Dakota manufacturing has developed slowly, partly because of the proximity of the manufacturing centers at Sioux City, Iowa, and Minneapolis. For many years the manufacture of such products as flour and meal, lime, brooms, binder twine and butter has been carried on. The first grist mill in Dakota was located three miles east of Elk Point, in 1869. There was only one in Clay County before 1870, but several were built there that year, and several in Union County. The first flour mill in the western part of the state was erected at Deadwood in 1891. In 1882 there were several flour or feed mills run by water power in this area; one at Bigstone, run by Whetstone Creek; two at Canton, run by the Sioux; the third largest flour mill in the world at Sioux Falls; a grist mill at Olivet, driven by the Dakota River; a feed mill near Springfield, driven by Emanuel

(2) Mining and Quarrying

Mining and quarrying are very subordinate to agriculture both in the numbers of persons employed and in the value of the output. The minerals secured, the distribution of the miners, the nature of the undeveloped mineral resources, statistics of production, and other relevant matter are treated in chapter three. At this point certain supplementary matter is presented.

In 1909 more than 95% of the value of minerals produced (water excepted) came from “gold and silver deep mines,” which employed about 95% of the 4,169 persons engaged in this industry, and took 90% of the 16,400 primary horse power used. There were ten sandstone (including quartzite) quarries, four of granite, two of gypsum, two of limestone, one of mica, one of tin, and three placer gold dredges. The value in 1910 of the produce of the minor branches of the industry was $2,114,477, in contrast to $6,126,370 from the “gold and silver deep mines.”

(3) Lumbering

The Black Hills are nearly covered with western yellow or bull pine, and lumbering has been carried on there ever since the region was populated by white men. The first sawmill was brought to Custer and put in operation in February, 1876. Deadwood had two sawmills

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1910, 500 farms, 0.6% of the farms of the state, were irrigated. The irrigated area, 62,248 acres, was 4% of the improved land in farms. Less than half the area in irrigation enterprises and less than one-fourth of the acreage of projects being developed was irrigated in 1909. Of the 62,248 acres irrigated, 66% were in individual or partnership enterprises, 21.5% in co-operative enterprises, 10% in commercial enterprises, and less than 9% under the United States Reclamation Service. Since the Belle Fourche project was completed, the acreage under the Reclamation service alone exceeds greatly the total irrigated acreage of 1909. The total irrigated area of the state is now more than 59,000 acres. The sources of water used in 1909 were streams (75.4%), reservoirs (21.4%), wells (23.8%), springs (20.6%), and lakes (20.7%). The crops grown in order of value of product were alfalfa: “wheat, salt or wheat grass;” timothy and clover; oats; potatoes; wheat; orchard fruits; and corn.

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Drainage. When drained, wet lands are changed from breeding places of mosquitoes and disease to agricultural land of more than average value because in lowlands as in drylands, valuable salts and organic substances accumulate. As long as land is not requiring drainage could be obtained cheaply, drainage was practiced little. With the rapid rise in land values since 1900, there has been a great increase in drainage. Thousands of short, open ditches have been dug to drain “lake beds,” and a few large projects for the reclaiming of bottom lands have been carried out. Large areas in the flood-plain of the Missouri (between Vermillion and Yankton) Vermillion, Sioux, and Dakota have been drained. An increase in the length of the Vermillion River, produced by the shifting of the Missouri River in 1881, decreased the gradient and transporting efficiency of the former stream, and resulted in a higher water table and increased flooding of the lower part of the valley. The crooked stream has been replaced by a large, nearly straight ditch eleven miles in length, with the result that the bottom lands for a dozen miles have been drained, at an average cost of $25 per acre.

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LUMBERING

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Creek; and a flour mill and feed mill at Deadwood, run by Deadwood Creek. In 1883 a mill was erected at Rapid City and run by Rapid Creek. At the census of 1885 there were 85 flour and grist mills in Dakota, and in 1889 81 South Dakota towns had such mills. In 1910 there were 91 such mills in the state, producing 34.7% of the total value of manufactures for the state.

Dakota had twenty-six creameries, five broom factories, and sixteen breweries in 1887, and twenty-five South Dakota towns had creameries in 1889. In 1910 there were ninety-five creameries in the state producing 18% of the total of manufactures. This great increase in the number of creameries between 1889 and 1910 is a manifestation of the diversification of agricultural practices already mentioned.

Plants for making plaster of Paris, stucco, and pressed brick, and for preserving meat, have been put in operation more recently. Pork packing is being undertaken on a large scale. A plant costing a half million dollars was completed in Sioux Falls in 1911, and another costing a million dollars was completed there in 1913. Sioux Falls is the South Dakota city most favorably located in respect to the section of the state in which most corn and hogs are grown.

The census reported in 1909, 5,226 persons engaged in manufacturing, adding $6,324,000 in value to raw material worth $11,476,000. Both these figures show an increase of nearly 46% per cent over the corresponding figures for 1904, the latter an increase of more than 100% over those of 1899, due partly to the rapid rise in prices during that decade.

The following table (20) gives the more important statistics concerning manufacturing in South Dakota for 1904 and 1909.

---

<table>
<thead>
<tr>
<th>Industry</th>
<th>Value of Products</th>
<th>Value Added by Manufacture</th>
<th>Percent of Increase, 1904-1909</th>
<th>Percent of Distribution, 1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Industries</td>
<td>$6,346,000</td>
<td>$19,384,000</td>
<td>24.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Butter, cheese, and condensed milk</td>
<td>$1,868,000</td>
<td>$1,868,000</td>
<td>100.0%</td>
<td>29.1%</td>
</tr>
<tr>
<td>Bread and other bakery products</td>
<td>$1,650,000</td>
<td>$1,650,000</td>
<td>100.0%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Canning and conserving products</td>
<td>$1,000,000</td>
<td>$1,000,000</td>
<td>100.0%</td>
<td>15.7%</td>
</tr>
<tr>
<td>Carker and general shop construction</td>
<td>$600,000</td>
<td>$600,000</td>
<td>100.0%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Lumber and timber products</td>
<td>$400,000</td>
<td>$400,000</td>
<td>100.0%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Laundering and cleaning</td>
<td>$300,000</td>
<td>$300,000</td>
<td>100.0%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Artificial stone and machine-shop products</td>
<td>$200,000</td>
<td>$200,000</td>
<td>100.0%</td>
<td>3.2%</td>
</tr>
<tr>
<td>All other industries</td>
<td>$300,000</td>
<td>$300,000</td>
<td>100.0%</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

---

26Talbot: loc. cit., p. 437.
Nearly all the manufacturing done in South Dakota represents the attempt to supply local demands or to prepare the raw materials produced in the region for market elsewhere. The chief industries involve local agricultural products, the preceding table showing that about 51% of the total value of manufactured products is furnished by the milling, baking, and dairy industries, to which should be added much of the 11.2% acceded to “other industries,” the most important of which is pork packing.

(5) Commerce

Commerce is favored by an excess of some commodity or commodities in demand and elsewhere, and facilities by which the surplus profitably may be transported to and sold in the areas in which it is needed. Similarly, commerce is favored in any region where the population, desiring various articles not supplied in sufficient abundance in the locality, has the means and opportunity to import. In most cases such means are secured by the sale of other commodities of which an excess is produced. In many new areas there is importing before there is exporting, the imported goods being paid for out of wealth produced elsewhere and sent (loaned) to the area or bought by the new settlers. In years of short crops, importing is likely to decrease because of the reduced purchasing power of the population. However, in many instances imports are bought on credit and paid for after a favorable crop year.

South Dakota is a region of specialized production; a few commodities are produced in amounts far in excess of local demand, while many articles, including the usual necessities, are produced only in small quantities or not at all. The first factors mentioned above as favoring commerce therefore are operative. Transportation to and from the state is chiefly by railroads, there being very little transportation by water, none within the state’s boundaries, and little (for any purpose) by roads. There are (1915) nearly 4,000 miles of railroad in the state; west of the Missouri River there are about 1,500 miles. In the eastern, more densely populated half of the state, except for portions of the Crook and Tripp counties, there are few areas which are more than fifteen miles from a railroad station. West of the Missouri, the only areas farther than thirty-five miles from a railroad station are in southwestern Perkins County and southern Harding County.

The building of railroads has been facilitated in many of the state by the topography, and by certain features of the climate. The slight precipitation is an advantage, but the persistent and often high wind, the great range in temperature with the consequent large expansion and contraction of rails and other metal objects, the lack of fuel and in some places of suitable water for the engines, are handicaps to railroad operation. Another and serious problem is the great fluctuation in the volume of produce to be handled. The amount of grain exported from the state served by a particular section of the railroad varies greatly from year to year and largely due to fluctuations in rainfall, while the “up-keep” cost of the railroad is almost as high in a year of small traffic as in one of large and profitable business.

Various phases of railroad building have been considered in South Dakota, due chiefly to the relatively small population and to lack of local capital, but in part to the competition of fuel supplies. The only interurban line is that between Deadwood and Lead (three miles apart); it is operated by hydro-electric power.

Water transportation at present is of significance chiefly to the farmers near the Missouri River in northeastern Gregory and northeastern Charles Mix counties. There grain is shipped by river steamers to the railroad at Chamberlain.

Wagon roads are numerous and usually of excellent quality, owing to the long season of slight precipitation and the topography, nearly level over large areas. The absence in much of the state of rock outcrops, sandy areas and trees also contribute to the good quality of roads. Chiefly for these reasons little work has been done on the roads. In most sections improvement has been limited to a small amount of grading to increase the run-off and accelerate drying after rains, and to the construction of culverts in the shallow depressions and of bridges across the few streams. In the western part of the state many of the less frequently traveled roads are little more than trails and lack bridges. The graveling or sanding of roads is discouraged in most parts of the state by insufficient local supplies of these materials and by the unsatisfactory character of the dirt roads during most of the year.

As in the early years of settlement, the leading exports are agricultural commodities and gold. The chief articles are wheat, flaxseed, barley, corn, oats, cattle, hogs, sheep, horses, poultry, eggs, butter, flour, packed meat, wool, and gold. The more important articles of import are manufactured goods, such as farm machinery, vehicles, wearing apparel, and fencing materials.

II. HISTORICAL GEOGRAPHY OR THE EVOLUTION OF PRESENT CONDITIONS

(A) Introductory: The Period Before General Settlement

More than a century and a half elapsed between the coming to South Dakota of its first whites and the establishment of permanent settlement in 1859; moreover, settlement did not become extensive until after 1877. The causes of settlement may be discussed under three heads, (1) Exploration, (2) The Fur Trade, and (3) River Commerce, as these activities were the chief ones of that period. The discussion of these activities will not be limited to the period before settlement, however, but will be continued to recent years.

1. THE GEOGRAPHY OF EXPLORATION

Situated in the interior of the continent and in the general latitude of the Great Lakes, and possessing fur-bearing animals, it was natural that the first white visitors to the South Dakota region should have been French fur traders. These quaint but practical men went from the French posts on the Great Lakesgressively farther and farther as the fur-bearing animals nearer to the posts became depleted by the reckless methods practiced. The first white man to visit what now is South Dakota probably was Le Sueur in 1738.22 It is certain that French traders regularly visited the Sioux Valley by 1700.23 By 1743 they had advanced as far west as the Missouri, and planted a post near the site of Pierre claiming the soil for the king of France.24 As early as 1755,25 traders of the Hudson’s Bay Company established a post on the Red River and down the Sioux and established a post near the site of

EBK Point close to the junction of the Sioux and Missouri valleys. They were not able, however, to maintain this remote post in the enemy's territory.

The fur trade necessitated wide wanderings, the trader often visiting many Indian villages, or accompanying bands of Indians on their hunting and trapping. When the first scientific explorer reached the region in 1803, fur traders and trappers had become more or less familiar with the Missouri River, several of its tributaries, and even with the Black Hills. Few of the traders had the inclination or ability to write or describe the early explorations and findings. The earliest well known account concerning this area records the achievements of scientific explorers.

Crosed by the Missouri, the longest stream of the northern Great Plains, it was natural that this area should have been visited in the early days of water travel by parties en route for the Pacific Coast. The Lewis and Clark party (1804-06) was the first well known one to follow this route. Like many other and less well known parties, it made only brief stops at points within the area of South Dakota, but it named various physical features and perpetuated the earlier names of others, and reports of the expedition contain interesting descriptions of Indians, the character and abundance of game, and other matters. The first party to leave the river and travel across country was the Hunt expedition, en route in 1810 to Astoria near the mouth of the Columbia. This party crossed what are now Corson, Perkins and Harding counties.

Such overland travel was facilitated in this region by the topography, the sparsity or absence of trees and brush, and the character of the herbaceous vegetation. Because of the abundance of nutritious grasses and naturally cured hay, parties were not hindered by lack of forage making long trips at any season.

The Dakota drains into Hudson Bay, and was under British influence until visited in 1820 by Major Longe's expedition, which compelled the removal of English flags and substitute American for British influence.

Dr. Nicollet, delegated by the Federal government to examine the geology and resources of the Territory of Iowa, visited in 1833-39 the eastern part of the area now known as South Dakota, then a part of Iowa, and mapped and named many of the lakes. His glowing description of the Sioux and of the surrounding area, calling to the attention of land speculators, led in 1858 to the first attempt to secure possession of the South Dakota area. The geology and topography of the area, however, were not fully explored until after the cession of the Black Hills and the Missouri River to the United States in 1868.

Shortly after the discovery of gold in California, there were urgent demands for roads, and if possible railroads, to bind the Far West with the East. During the 1860's much exploration was carried on at the request of the Government, with the view to finding practicable routes for such a railroad. The first widespread exploration in the South Dakota region was done in 1855-57 under the direction of General Warren by H. V. Hayden, subsequently director of the U. S. Geological Survey. During the fall of 1855, the geological formations of the area and studied certain types of Hills. Although he did not penetrate the Black Hills, he obtained a general idea of their structure. In part because of the Black Hills barrier, it soon was recognized that there would be need of a transcontinental railroad south of the South Dakota region. For years, this area was neglected, while more practical routes to the south and north were investigated.

The next exploration in this area resulted from persistent rumors of the presence in the Black Hills of gold in paying quantities. Although the Indians, in 1868, had been promised temporary possession of this area, an expedition under General Custer was sent in 1874 from Fort Abraham Lincoln, near the site of Bismarck, to explore and claim the Black Hills, preliminary to their purchase from the Indians, should they prove to be of great value to the whites. The expedition discovered gold, but the scientific members were not convinced of its abundance. After a more thorough examination of the area during the following summer the presence of hundreds of prospectors and much gold was announced. A great gold rush followed.

The underground water supply was one of the motives back of the later, and more detailed exploration of the state. Because of the character of the structure of the underlying rocks, artesian waters are readily accessible in many parts of South Dakota, and in many places the soil conditions, such waters are valuable. Therefore, the United States Geological Survey undertook the study of this resource, and assigned two geologists, Prof. J. E. Todd (already somewhat familiar with the controversial work on the origin of the Missouri River) to the eastern half, and N. H. Darton to the Black Hills Region. In order to facilitate work, many topographic maps were made. The geological folio, water-supply papers and professional papers have proved of great value to well drillers, farmers and others, and
The Geography of South Dakota

"Darton's "Geology and Water Resources of South Dakota" contains an excellent summary of these subjects.

2. The Geography of the Fur Trade

As noted in the previous section, the fur trade was established early in this region. It was of special importance between 1808 and 1837, although nearly destroyed by the war of 1812-14. Before 1808 bison were so numerous east and south of the South Dakota area that the "territory of the Cheyennes" was chiefly of value for its grass, not its inhabitants. Moreover, their proximity to large Indian tribes made them "the presence of a fine bottom a mile wide and six miles long." The last doubtless was a minor influence, since there are many similar bottoms elsewhere.

The extermination of fur-bearing animals in most parts of this region probably came more promptly than in other areas because of certain geographic conditions. In a region having frequent unfavorable seasons such as occur in the steppe, native mammals are less prolific due to the effects of climate and less severe climatic conditions. Furthermore, the mammoth population of such a steppe region is less numerous than that of other areas. Even if the animals originally were as numerous and as prolific in the South Dakota region as elsewhere they doubtless would have been exterminated much more rapidly than in certain other sections. In a sandy region of slight relief, large animals may be seen from a distance, as can streams, ponds, and other places favorable to semi-aquatic fur-bearing species, and thus the extermination of such animals is facilitated.

The American Fur Company sold its stock to the government the most important post, Fort Pierre, which became the first military post of the region. The price paid, $45,000 suggests the size of the post and the value of the fur trade in establishing it.

The slaughtering of bison for their skins continued to have some importance even after the early 1870's, but by 1874 so few remained that the Custer Expedition saw none between the sites of Bismarck, the present-day Black Hills, although it was about this time that the government decided to close Fort Randall.

Footnotes

1. The Missouri River Fur Company was the first important company in this region. It was organized in St. Louis in 1807 and erected two large posts along the site of Ft. Pierre. Fort Pierre, near the mouth of the river of that name and near the site of present-day Pierre, was established by Fort Tecumsch built by the Columbia Fur Company. In 1828 the American Fur Company and the Cheyenne River Company became the principal fur trade companies. Two other fur companies "the Northwestern" and the "Rocky Mountain" had engaged in this trade of this region. (King's Handbook of the United States, p. 739, n. 1894.)

sidered to be the object of their rapidly diminishing range. The disappearance of the bison was hastened greatly by the introduction in the middle 1860’s of breach-loading rifles.

The fur trade as a leading industry had disappeared from this area before the establishment of permanent agricultural settlement and therefore influenced settlement little. All the posts were abandoned decades before towns were founded, although on the sites of some of Pierre, Moundeleau and Vermillion.

Some of the smaller fur-bearing animals, especially the muskrat, mink, and skunk, increased in numbers after the decline of the fur trade, and their furs helped many pioneer farmers to become established.

3. RIVER COMMERCE

The Missouri always has been commercially the most important waterway of the area. Steamers never ventured on any other South Dakota river, although there was a steamer on Big Stone Lake in 1881, as there is today. Each of the other large streams doubtless floated the canoes of fur traders, as they bear the few row boats and launches of today. However, no record of their use for floating logs or loaded or unloaded rafts or boats has come to light.

(a) Before the Coming of the Steamboat, the navigation of the Missouri does not appear to have been extensive, and it was associated chiefly with fur trade. The exploring parties which used the river as a highway in early days accompanied a fleet of fur-trading boats. There is record, however, that shortly before 1870 a quantity of logs, cut from extensive groves a few miles up river from Yankton, were floated down to a sawmill at that place.

(b) The Navigation. The first steamboat, "The Yellowstone," entered the confines of the present state of South Dakota in 1831. It was sent up by the American Fur Company. The steamer was named Fort Pierre in honor of Pierre Chouteau, a distinguished passenger. The following season this steamer ascended to Fort Union at the mouth of the Missouri River.

Henceforth, the fur trade was associated chiefly with steamboats. Many of the furs obtained before 1865 in the Northern Plains and Rocky Mountains found their way to market down its channel. The total value of the fur trade of the Missouri River by boat grew from beyond the limits of South Dakota. After analyzing the significance of steamboats in the development of the area, it was evident that steamboat navigation was of great importance in the Indian Wars and the Indian culture.

1862, when gold was discovered in what is now Idaho and Montana, there was a rush of prospectors, many of whom ascended the Missouri River and crossed southern Dakota, thereby influenced its development. Steamboats that ascended the upper Missouri in the early 1860’s. In 1860, 1862, 13; in 1863, 18; in 1864, 40. All the posts were abandoned decades before towns were founded, although on the sites of some of Pierre, Moundeleau and Vermillion.

Some of the smaller fur-bearing animals, especially the muskrat, mink, and skunk, increased in numbers after the decline of the fur trade, and their furs helped many pioneer farmers to become established.

3. RIVER COMMERCE

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Although the steamers carried but little produce down-river from the Dakota area, they brought considerable quantities of supplies from the east. The first frame building at Yankton is said to have been built in 1837, when the steamboat traffic was at its peak.\(^{115}\) In 1870, after Sioux City had been reached by railroads, there was a steamer plying regularly between that place and Yankton which furnished "the cheapest and most expeditious means of transporting freight to Yankton."\(^{115}\) With its help, average freight charges on boxed goods from Chicago to Yankton were only two dollars per hundred pounds in 1870.\(^{116}\) Thus steamboat traffic had some influence on the agricultural development of the area under consideration. Steamers also influenced the development of the smaller towns, especially Yankton. The traffic on the Missouri River, which was for years an important factor in Yankton's prosperity, as at one time as many as forty steamers did business at Yankton, at this time [1883] is very small.\(^{117}\)

Reasons for the Slight Development of River Commerce. Steamboat traffic on the Missouri River had little influence on the industrial development of South Dakota, partly because of certain characteristics of the river. It is sluggish, swift, crooked, shifting, subject to marked fluctuations in volume and often very shallow at many points, obstructed by many sandbars, and frozen over for a considerable portion of the year. The average velocity of its current has been estimated at three miles an hour, and this is greatly increased during the flood season.\(^{118}\) In contrasted portions of the river, frequently reaching five or six miles an hour, and forcing the powerful steamers to use the towing lines.\(^{118}\) As to fluctuations in volume, it is an established fact that river steamers of three hundred tons burden,\(^{119}\) having a draft of about four feet, can, when loaded,\(^{120}\) usually navigate the upper Missouri during the open season to the mouth of the Yellowstone. In the fall of 1862 the water was so low that an ordinary steamer could not reach Yankton, and had to unload its cargo five miles below, near the mouth of the Dakota River.\(^{121}\) At other times the bottoms near Yankton and Sioux City are flooded to a width of ten miles in places, as in 1862,\(^{122}\) 1881,\(^{123}\) and in 1907, and lesser floods are expected each year. The magnitude and rapidity of these changes of channel are remarkable: "In many cases there is a shifting of two or three hundred yards into the bottom lands."\(^{124}\) The navigation of this section of the river usually is prevented for more than four months annually by ice.\(^{125}\)

Therefore the steamboats could not successfully compete with the railroads, reasons which may be summarized as follows:
1. While the railroads can operate all the year, the river is closed by ice for a third of the year, when, therefore, the railroads have a monopoly.
2. As slow as was early rail transportation, it was far more rapid than that furnished by boats on the Missouri, which often could make but small progress against the current, and were in constant danger of running aground on bars. Because of the frequency of such occurrences boats would not approximately maintain a schedule.
3. The cost of the river at many points made necessary boats of small capacity, while the strength of the current required a relatively powerful engine with corresponding fuel supply. This inflexibility is in contrast to trains of lighter engines to meet the needs.
4. The landward charges on river navigation were much greater than those to which rail transportation is subject. The muddy water, of necessity used by the boats, caused many boilers to explode; snags were numerous and severely damaged many boats; in running with the current, the boats frequently became grounded on bars as to be removable only at so great an expense that in many cases they were abandoned until a rise in the river, or permanently.
5. The heavy expenses resulting in part from the high wages paid by who must be highly skilled, who, at the peak of demand, were in short supply, and charged by insurance companies, were severe handicaps to river commerce.\(^{126}\) The ever-shifting channel, together with banks of silt, made the problem of wharfage a serious one in most places. The approach to the docking place of the boats was, in many cases, made very difficult by bayous, sand, "blow-outs," "gumbo," or steep slopes. The approach to railroad depots in nearly every case is enormous easier.\(^{127}\)

For the foregoing reasons, steamboats now have little significance on the Missouri. In 1906 there were only ten steamboats on the Missouri River above Sioux City, and most of these were above Bismarck.\(^{128}\) The only steamboat traffic of moment in South Dakota is the taking of grain from various points in the northern part of Charles Mix and Gregory counties by the railroad at Chamberlain. In the last decades in possessing a fairly stable water front, the best for three or four hundred miles.\(^{128}\)

(B) THE SETTLEMENT OF THE STATE

1. Causes for the Late Settlement of this Area

The first attempt at permanent settlement was made in 1855 near the falls of the Sioux. From 1857 to 1862 many homes were established in the Sioux Valley, but all were abandoned between 1863 and 1865 on account of the Indian scare and a permanent settlement was not established until July, 1859, at Yankton. The population of Southern Dakota probably did not exceed 2,000 in 1865 or 12,000 in 1870, by which date Iowa had more than a million people (1,115,000), and in 1878 it probably was less than 60,000. The causes for the delayed settlement of this area are in part geographic as (1) As long as lands more desirable in respect to location, climate, or resources were available, there was little demand for lands in the area of South Dakota. (2) The government followed the policy of not attempting to secure title to Indian lands until the demand for them was urgent. As a result, the Indians claimed all of what now is South Dakota until 1851 when a small strip east of the Sioux River was ceded. The next tract obtained from the Indians, consisting of much of eastern South Dakota, was declared open to settlement in July, 1859. The next large tract included the Black Hills, which was opened in 1877; the next was opened in 1889 (Fig. 35.) Until the Federal government obtained title to the land, it attempted, with a good deal of success, to keep would-be-settlers out. (3) Until the railroad was fairly dense, transportation to distant markets was very expensive.


\(^{115}\) Holley, F. C.: Our Heritage from the Dakotas, p. 84. (Chicago, 1890).

\(^{116}\) Foster: loc. cit., p. 84.

\(^{117}\) ibid., p. 87.


\(^{119}\) "Steamboats" loc. cit., p. 78.

\(^{120}\) McClure: loc. cit., p. 78.

\(^{121}\) Loc. cit., p. 130. Many acres of crops were destroyed by this flood.

\(^{122}\) ibid., p. 130. The towns of Yankton and Vermillion were severely damaged, the property loss being set at $50,000 and $144,000 respectively. Ten persons lost their lives.

\(^{123}\) ibid., p. 132.

\(^{124}\) ibid., p. 132.

\(^{125}\) ibid., p. 132.

\(^{126}\) ibid., p. 132.

\(^{127}\) ibid., p. 132.

\(^{128}\) ibid., p. 132.
from most of the areas, there being only one stream navigable by steamboats and that, for various reasons noted, quite unsatisfactory. (4) Droughts and the visitations of devastating hordes of grasshoppers, gave the region a bad reputation in some quarters and at some periods. (5) The Kansas-Nebraska bill accelerated the settlement of those areas, especially Kansas, and tended to retard the settlement of other sections of the frontier.129

(2) THE SETTLEMENT BEFORE 1876

In 1856, the white population of the area now included in South Dakota appears to have consisted chiefly of a few traders and trappers, most of them of French extraction,130 of whom a majority had Indian wives.131 There also were some soldiers, and the steamers on the Missouri River carried a few transients. The first white woman to visit this area, the wife of a steamboat captain, came in 1847.132

In 1851 the Santee Sioux Indians, by the Treaty of Traverse de Sioux,133 relinquished their lands situated to the east of the Big Sioux River (Fig. 56) and settlement was made legal in a small area, near Sioux Falls, but within the present confines of South Dakota. In 1856 a party from Dubuque, Iowa, attempted to found a settlement at the falls of the Sioux, but was driven away by Indians. It returned the following summer. Early in 1857 the government erected Fort Randall on the Missouri River (in what is now Gregory County) and undertook to keep the Indians out of deeded territory and to prevent settlers from occupying lands still in the reservation.134

(a) The Beginnings of Settlement. In May, 1857, a party of land speculators from St. Paul, Minnesota, laid out four towns in the Big Sioux Valley.135 Two of them (Sioux Falls and Flandreau) still exist, although they were abandoned from 1862 to 1865 because of the fear of Indians, while Medary was burned and permanently deserted in July, 1856.136 as was Eminence. The falls as the Eminence, enthusiastically described by Nicollet, determined the location of the town of Sioux Falls,137 while the Big Bend of the Sioux River and a trading post located there in 1822 determined the location of Flandreau.138

During the 1868 there was considerable immigration to the Sioux Falls region, the first woman settler coming in the summer and the first family with children in the fall.139 That year the Yankton Sioux Indians sold for $1,600,000140 most of the tract between the Sioux and Missouri rivers (Fig. 36). On July 10th, 1869, the Indians were removed from this area and the reservation was declared open. Some hundreds of prospective settlers, who had encamped on the Nebraska side of the Missouri River awaiting the opening, immediately crossed over and within the next few weeks the towns of Yankton, Meckling, and Vermilion were laid out. Elk Point was founded shortly after.141 These towns were all near the Missouri River, the chief highway at that time: Yank-

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129 Hale, E. E.: Kansas & Nebraska, p. 224, (Boston, 1854).
130 ibid., p. 218.
134 ibid., loc. cit., p. 96.
135 ibid., loc. cit., p. 218.
137 ibid., loc. cit., p. 96.
138 ibid., loc. cit., p. 219.
139 ibid., loc. cit., pp. 8, 46.
ton near the mouth of the Dakota River on a low terrace being eroded by the Missouri River and hence affording fairly good wharflage; McCooking near the river in a large area of unforested plain; Vermillion and Yankton; Vermillion at the foot of the bluffs at the mouth of the Vermillion River; and Elk Point on the flood plain at the junction of the Sioux and Missouri valleys, and not far from those streams. During 1859, 1860 and 1861 there were good crops and rather rapid settlement. As a result, there was considerable agitation for territorial government, this area having been left without government when Minnesota was admitted in 1858.

Late in 1861 Dakota Territory was created by act of Congress, and in 1862 Yankton was selected by the first governor as the capital. A census taken in June, 1862, just after the organization of the territory, revealed a population of 4,492,142 distributed as follows: Sioux Falls, 40; Clay and Union counties, 696; Yankton County, 287; Bon Homme County, 183;144 and the balance chiefly in the Red River Valley in what is now North Dakota.

Four counties were organized in 1862, Union, Clay, Yankton, and Bonhomme, all on the eastern border of the Territory. Two additional counties were organized before 1871 in the Sioux Valley: Lincoln County (1867), just north of Union and Clay counties, and Minnehaha County (1865), containing Sioux Falls, just north of Lincoln County.

In 1862 Congress passed the Homestead Act. This statute, later of great significance in the settlement of the state, had little immediate effect because of the competition of lands farther east, the lack of transportation facilities between this area and the settled portions to the east, and especially the fear of Indian uprisings.

(b) Hard Times. In August, 1862, two citizens were murdered by Indians near Sioux Falls.146 Closely following massacres in Iowa and Minnesota, several hundred white men were killed and 147 produced a panic among the frontier settlers of Dakota. "So many returned to the Eastern states, that the area was almost depopulated." More than three-fourths of the settlers fled, according to one writer, and only three hundred remained in the area.148 The Sioux Valley was entirely deserted from September, 1862, until May, 1865, when Fort Dakota was erected at Sioux Falls. It was kept well manned for four years.149 It was not until 1866 that farmers returned to the Valley.150 In Bon Homme, the westernmost county, the settlements began in 1869, and comprising 200 persons in September, 1862, were deserted; eight years later the population of the county was only 500. The panic stricken settlers who did not leave the territory gathered in a stockade at Yankton.151 Experiencing no more trouble from the Indians that fall or winter, a few returned to Vermillion, Elk Point, or Jefferson and built stockades at those points.152 In the spring and summer of 1863 more settlers were murdered in Dakota than before 1860.153 In 1864 the Indians continued espe-

146Foster: loc. cit., p. 10.
147Armstrong: loc. cit., p. 22.
148Andreas: loc. cit., p. 96.
150Andreas: loc. cit., p. 102.
153Armstrong: Early Empire Builders, loc. cit., p. 86.
155Hist. of Minnehaha County, p. 31.
156Huber: loc. cit., p. 67; Foster: loc. cit., p. 76.
159Foster: loc. cit., p. 17.
161Blackburn: Hist. of Minnehaha County, p. 31.
162Chicago was connected by rail with the Atlantic Coast in 1853. The Mississippi River west of Chicago was reached by 1855. Sioux City, was connected by rail with Chicago in 1868 by a line up the Missouri Valley from Council Bluffs, and in 1871 by a line from Yankton, Iowa, across the Missouri. Sioux City became the terminus of the railroad because it was favorably located on the outside of the great bend of the Mississippi River.
Bohemian colony was organized and several hundred settlers came. Large groups of Norwegians came during the same year. It is said that 10,000 of them left Sioux City for Dakota on June 3, 1869. The New York Colony was organized in Syracuse, New York, in 1863, principally through the efforts of Jas. S. Foster and Chas. Van Etts. Mr. Foster was sent west in August, 1863, and after visiting Iowa, Dakota, Nebraska, Kansas, and Missouri, he returned and reported in favor of Dakota. A special train was chartered to Marshaltown, Iowa, the terminus of the line and the railroad station nearest to Dakota. Adult members of the association were furnished tickets for the trip for $15.00, the freight was carried the entire distance for $2.95 per hundred pounds. Of the one hundred families which started from New York, forty settled in Iowa. Many of the sixty families which settled in Dakota became disheartened by the drought and grasshoppers of the first summer and left. Six years later, in 1870, only thirty families remained. They were distributed along the Missouri Valley, mostly near Yankton.

In 1873, a colony of Russian Mennonites settled in Bon Homme County. Groups of acquainted families had made “colony settlements” at earlier dates. For instance, a “colony” of Norwegians from Mankato, Minnesota, settled in Bon Homme County in 1867 and more than one hundred families of Scotch from Canada settled near Scotland in the same county during 1872-74.

The influx of settlers was promoted in this period not only by land agents, colony organizers, and railroads, but by local improvements in transportation facilities. Ferries had been established at various points. One agreed the Dakota River on the route between Sioux City and Fort Randall was installed for the special benefit of settlers of several counties, including Union, Clay, and Yankton, also kept ferries on the larger streams along the route between Sioux City and Yankton. These streams were bridged by government appropriation in 1868, a notable improvement. Shortly after the arrival of the railroad in Sioux City, a daily stage to Yankton was established, and in the same season Sioux Falls and Yankton were united by a mail stage.

Transportation was facilitated somewhat by three government roads. In 1865 Congress had appropriated $85,000 for the opening of three wagon roads through Dakota Territory to the distant mines in the Rockies. One went along the Missouri Valley from Sioux City to the Mouth of the Cheyenne River; another was built up the Cheyenne to its forks; a third, the Nobles road, followed approximately the southern boundaries of Brooking and Kingsbury counties to what now is the northwestern corner of Sandborn County, and thence southwestward to the big bend of the Missouri River. None of these roads reached the Rocky Mountains.

In 1870 that part of Dakota Territory now in South Dakota had a population of 11,778. Before the beginning of the Great Boom (1878-86) only two small parts of the area had a population of two or more per square mile. The southeastern corner (the lower Missouri and the lower Sioux valleys) had this density after 1869, and the Black Hills after 1876. The population in the former section was found chiefly on the flood-plain, with a large majority in the Missouri Valley. This section was the chief source of the Missourian influence of the Missorians. The relative proximity to more densely populated areas in the east and south was also of importance. Between 1868 and 1872, when a railroad was extended into Dakota, Sioux City, Iowa, served as a market for such produce as was shipped eastward out of the region, and as the depot from which imports were received. Sioux City had a population of 4,000 in 1870. The population of the Dakota counties in 1870 reflects these influences. Union County, in the southeastern corner of the Territory and in part within four miles of Sioux City, had a population of 3,507; Lincoln, the county next to the north and more distant from both railroad and navigable river, had a population of 712; while Minnehaha, the county next to the north and on the frontier of settlement, had only 355. Clay County, to the west of Union, on the Missouri River, had a population of 2,621; the next county, containing the capital, had 2,097; while Bon Homme County, the next up the valley and on that frontier, had only 400.

The gold of the Black Hills and Its Influence on Settlement

The presence of gold in the Black Hills was rumored more than three decades before its discovery in 1874. Gold was discovered in 1854 by a party all but one of whom were killed by the Indians. The latter was the first to tell many a tale of the fatal day, but had never been heard of thereafter. Nuggets of gold said to have been taken from this party were given to traders and to Father DeSmart at Napoleon, and, town traditions support the legend on the tablet. Several publications issued about 1870 about the beauty of the Black Hills, but the discovery of the Black Hills as one of the inducements to settle in Dakota. Even before the existence of gold in the Black Hills was established with certainty these reports had some influence on settlement. In 1872 a private expedition was prevented by a military force from exploring the hills. and settled in the eastern half of the territory.

The expedition of 1874 under General Custer, which discovered gold, was the first to give a written account of the interior of the Black Hills. The Black Hills region belonged to the Indians until Feb. 28, 1877, although they are said never to have frequented the Hills proper, and until nearly that date they made many efforts to keep white citizens out. Until November, 1875, the United States army also endeavored to prevent trespassing on this Indian reservation. The goods of many offenders were burned, and the leaders of a number of expeditions were imprisoned. However, the lure of gold was so powerful that in spite of military opposition, Indian resistance, and many natural hardships, there were many who attempted to acquire wealth in the supposed marvellously rich gold-field guarded so zealously. The first party of prospectors that reached the vicinity of the place where

170 Foster: loc. cit., p. 194.
171 Talbot, A. D.: The Black Hills, p. 10. (St. Louis, 1899).
173 Smith: loc. cit., p. 146.
175 Foster: loc. cit., p. 58.
177 Foster: loc. cit., p. 25.
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In the region both reached significant proportions before the area was purchased from the Indians.201 The more favorably located farmers in the eastern part of the Territory also had several years to probe for this population, and the Black Hills during the period 1880-85. From 1876 until 1880, in which year the Chamberlain, Pierre and Dickinson (North Dakota)202 were reached by rail, the chief freight and stage lines had their railroad terminus at Cheyenne,203 or at Bismarck, but from 1880 until 1885, when a railroad approached the Hills from the south, Pierre was the most important shipping point thence. In 1883 upwards of 26,000,000 pounds of freight and 5,000 passengers were carried between Pierre and the Black Hills, by the two chief transportation companies204 by means of twenty-four four-horse coaches (run ten per week each way), 1,400 wagons, more than 3,000 oxen, 850 mules, and 400 horses.205 The total amount of freight received in the Black Hills after 1877 is said to have been at least forty million pounds a year.206 A large part of the livestock used in transporting this freight was reared near-by, and the companies secured many other things from the agriculturists of the region. In addition to the transportation done by regular companies, goods were carried to the Black Hills from Pierre by "farmer outlaws." During the winter considerable sums were earned in this way by many farmers of Hughes and neighboring counties.

Another way in which the gold of the Black Hills influenced the settlement of neighboring areas was by attracting thousands of young men, many of whom, after a stay in the mining camps or towns, went either to farm or entered business in one or another of the towns seen on the way to the Hills. Indeed, a large majority of the "old timers" in the western part of the state came to the region during the gold rush. During recent years many foreigners, brought from eastern countries, or the Homesteads in the Black Hills, have established agricultural settlements near the Hills. There are silver mines in the northern part of the county which kept the mines in the Black Hills. Many persons who set out for the Black Hills during the excitement over the discoveries of gold were attracted by opportunities for farming or business in the eastern part of the state, and remained there instead of making the costly trip to the gold-field.

The presence of gold, the excitement its discovery created, the numerous reports of the Indians, and especially the exciting times in the mining camps, particularly Deadwood, were described in numerous newspapers, magazines, pamphlets and books,207 as well as by word

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144-gold was first found, arrived from Sioux City, December 24, 1874, after a seventy-eight day journey.20" At present the trip can be made by train in little more than fourteen hours. Two members of this first party returned to civilization with some gold late in February, 1875, and spread the "gold fever."219

During the summer of 1875 there was a considerable influx of prospectors to the government had the area re-examined by scientists, enough gold and other minerals were found20 to warrant the purchase of this area from the Indians, but they refused to consider its sale until all the prospectors had left. General Crook, in charge of the troops engaged in attempting to keep out intruders, invited the prospectors to assemble, and after explaining to them the demands of the Indians, persuaded nearly all of them to leave the region for the time being.298 When the conference with the Indians proved unsuccessful, almost all official hindrance ceased, and soon there was a rush of settlers. Eleven thousand persons arrived between November, 1875, and March 1st, 1876.209 Most of the new arrivals flocked to Custer, laid out near the original discovery, which became a city of at least 6,000 persons and 1,400 buildings by the latter date.210

The scarcity of water, the insufficiency of water for washing the gravel, the appropriation of more promising localities in the southern Hills, and the partial exhaustion of the placers there, encouraged wide-spread prospecting with the result that gold was discovered elsewhere. In June, 1876, Deadwood Gulch, seventy-five miles north of Custer, was found by prospectors, and there was a rush to that locality.211 Custer was almost deserted, and remained an insignificant place for nearly a decade. 212 Deadwood, in the valley of that name, quickly became a city of importance, acquiring a population of about 10,000 in 1877. After the lease of large bodies of ore in the locality, it took on a more permanent character. Other cities grew up near various deep-mines; Lead, by far the largest city in the Black Hills, is an example.

The settlement of other parts of the area under consideration was affected in various ways by the presence of gold in the Black Hills. This was true after 1878 as well as before, and the following discussion is not limited to the earlier years. (1) The most direct effect of the gold was that the miners, the speculators, and most of the people supported directly by them, furnished a market for various commodities. In response to the high prices210 which then prevailed in the mining towns, which were supported by railroads by many miles by poor trails infested with robbers and Indians, farming and stock rais-

298Ibid., pp. 20-26. An account of this trip by the author, one of the members of the party, is as follows: "Ibid., p. 88.
299Rosen, P.: Pahaska or the Black Hills, pp. 597-611, is a reprint of the report rendered the governor by Jenny, the leader of the party.
300Tallent: loc. cit., p. 132.
302United States mail service to the Black Hills was not established until after the area was ceded by the Indians. Many of the letters carried in the preceding year a celebrated "pony post" between the Hills and Cheyenne, carried letters and packages each. (Tallent: loc. cit., p. 134-6; Holley: loc. cit., p. 100.)
304For a very readable account of a trip from Pierre to Deadwood in 1885 see Maudet-Grancy: Colonels and Cowboys, (London, 1886). The fare charged was $4.50 for one, and it cost 10 cents per pound for baggage (p. 36. Andreas: loc. cit., p. 124.
305Rosen: loc. cit., p. 117.
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307Ibid., p. 135.
309The Black Hills, (St. Louis, 1895), gives excellent descriptions of events in the early days of this region as experienced by the author of this book. Appendix containing a list of those who helped in the history of the Black Hills. (St. Louis, 1895) will be the best account with county histories, will be found in that compendium of historical lore on Dakota, Andreas, A. T.: Historical Atlas of Dakota, (Chicago, 1884). Sig.—10.
of mouth. These descriptions advertised this region widely, making Dakota a familiar name throughout the country and paving the way for the Great Dakota Boom which followed.

(4) The opening of deep gold mines and the development of other mineral resources which gave promise of furnishing permanent employment for many workers with consequent great and persistent demand for commerce, led railroad companies to contemplate the extension of their lines to this region. It was on a tour of inspection of proposed routes to the Black Hills that the president of the Chicago and Northwestern Railway became so impressed with the great possibilities of the area east of the Missouri River that he resolved to try an experiment in railroad building. He believed that if railroads were built in the Dakotas, homesteaders would flock in by the thousands, deal of traffic, and so make the railroad investment profitable. This plan received the approval of the directors of the company, and also was adopted promptly by its great rival, the Chicago, Milwaukee and St. Paul Railroad Company. As a result, the Great Dakota Boom was made possible.309

4. The Great Dakota Boom

During the period 1879-1886 much of the territory of Dakota was settled. What a few years before had been an almost uninhabited expanse of prairie, became a fairly populous farming region, soon to be admitted as a state. Probably more people moved into the region to make farm homes during any two years of the late 1880's than in the twenty years which followed its collapse. The increase in population of 1907 over 1887 (perhaps 60,000) is less than the increase by birth during this period, supplemented by a relatively small immigration, mainly to cities and towns.

Because of the importance of this boom in the settlement of the state, it is desirable to consider in some detail the influences, especially the geographical which operated, extending and maintaining it. Of primary significance was the fact that for several years the rainfall came at such times and in such amounts as to permit abundant yields. During several consecutive seasons abnormally heavy yields were secured in spite of careless preparation of the ground, the use of seed poorly adapted to the area, and lack of knowledge (or disregard of it) as to when and how to plant, what crops to sow, and how to care for them. Had the years 1879-86 been as dry as the eight years which preceded it, there is every reason to believe, no such boom could have taken place, and had they been as dry as the period 1885-96, most attempts at settlement would have failed. (See chapter V, Climate, p. 50.)

A climatic factor of less, though considerable, importance in producing the boom was the "hard winter" of 1889-91 in the Northwest. The October blizzard, and the very heavy snowfall which accumulated during the winter, were unfavorable to the influx in some respects, since they brought hardships to many unprepared homesteaders and tended to give the area a bad reputation so far as its winters were concerned. In other respects this exceptional winter promoted settlement. The ground still was unfrozen when the first snow came, and because of the depth of the snow (averaging more than ten feet, it is claimed)310 it remained so until early in the spring, on which much of the prairie contained more or less water. Many

of them contained water for several years thereafter. As a result of this unique snow-fall, the water-table was higher for years, and some claim that this influenced crops for several seasons, and there was a progressive decrease in yields during several years after 1881.311 Certain it is that this snow, by creating thousands of ponds and lakes, suggested a humid climate, a condition highly attractive to prospective settlers.

Aside from the relative abundant precipitation of this period, the extension of railroads throughout most of the area was of great importance in starting and maintaining the boom. Without good transportation facilities, or the expectation of their being provided soon, the boom could not have taken place. Even though wheat, corn, and other crops of similar bulk and value yielded exceptionally well, farming would not be profitable if the produce has to be hauled many miles to market. Development is discouraged also where necessary articles are very costly. Because of the lack of timber in much of this region, materials for buildings and fences, and other bulky and heavy articles, cost so much after being wagoned long distances, that most improvements were discouraged. Only with the help of much fencing and many buildings can a region support a fairly dense human population by rearing stock that can be driven long distances to market.

Before the boom, the area now included in South Dakota was served very inadequately both by railroads and by river transportation. In 1873 the railroad reached Yankton, the capital, by way of the Missouri Valley, and the same year one was built as far west as Lake Kampeska, near the site of Watertown. There were no settlers in the larger region, and the line was extended to this, the westernmost point on the Sioux River, primarily to secure the building company the largest possible grant of land, as Congress had granted large tracts based on the mileage for a line to be built across Minnesota to the Sioux River.312 In 1874 a prairie fire destroyed the bridges and culverts along the railroad, and was part of this line, and that section was useless until these structures were replaced in 1879.313 Sioux Falls, the second largest city of southern Dakota, had no railroad nearer than Worthington, Minnesota, sixty-eight miles distant,314 until late in 1878. Then a line was built up the Sioux Valley, connecting Sioux Falls with Sioux City and the East.315

There were several results of the insufficiency of markets, due chiefly to the few transportation facilities. Most of the few pioneers found in the area not served by the Yankton-Sioux City line (and many of those in that region before that line was built), had to travel long distances, and bought and sold by mail. Many of their buildings were made chiefly of their own supplies, in many cases, consisting of poles and sod. In case a grove of large trees was near, as was the condition along most of the Missouri Valley, logs were used in building. On the prairie "buffalo chips," bricks or crude shingles were available, and even ear corn at times, were burned for fuel. Little fencing was done, and that chiefly with local materials.

311Holley, F.: Our Heritage from the Dakotas, p. 39. (Chicago, 1890).
312Andreas: loc. cit. p. 160.
materials. Only a small portion of the land was tilled, and wild game and fruits contributed largely to the larder of the settler. The money received from the sale of furs secured in winter appreciably increased the income, but until railroads came a large proportion of the homesteaders depended on earnings secured in other regions.

In view of the hardships arising from the lack of cheap, expedite, and reliable transportation, the following quotations appear not to involve much exaggeration: "The whistle of the locomotive would be the sweeter music to the resident of the broad prairies could hear, and the mere rumor that a party of railroad surveyors had been seen in a particular locality, was enough to fill the heart of every settler with joy and cause visions of town-site and county-seat speculations to color with all the alluring hues of the rainbow, his dreams at night." Possible some of the remote pioneers thought "every obstacle would flee as if by magic at the sound of the locomotive." 

The great importance of the railroad to the settlement of this area is emphasized in the following quotations: "As a direct consequence of progress in railroad construction the increase of the territory in population and wealth has been phenomenal in the history of the county." "The greatest factor in the upbuilding of Dakota, next to her vast expanse of productive lands, has been the railroad." Gradually the fine agricultural lands and immense stock ranges would, no doubt, have been occupied; but without the railroad it would have required a century to accomplish what has been done in five years under its powerful influence.

The railroad companies supplied more than transportation facilities. They issued descriptive pamphlets to the new-comer, containing suggestions of value, and in many cases the railroad company "was explorer, carrier, provider, thinker, heart, soul, and intellect." A third potent factor in the rapid settlement of Dakota during this period was the earlier occupation of much of the more desirable land elsewhere, especially to the east. By 1879 there was available in the eastern states little free land as desirable for farming as eastern Dakota. The fertility of the soil of this area has been largely by "bumper crops," the topography in most places was more even than in most other sections, and, of great significance in creating an agricultural, the land was ready for the plow, it not being necessary to clear it from trees, stumps, brush or stones as in most of the occupied areas to the east.

A fourth factor, not entirely geographic, was the clean, nearly level fields of the prairies of Dakota had distinct advantages over the rugged, stony, or stumpy areas so widespread to the east, in the use of most large farm machinery. The small but improved grain separator recently had made large-scale farming possible in regions like Dakota.

In addition to the four factors, chiefly geographic, discussed above, at least two other, non-geographic, were in competition with the great influx at this time, and they may be remembered briefly. (1) As considerable capital was required for constructing railroads and buildings, breaking sod, and caring for crops, it was of im-
of 1881 the Chicago, Milwaukee and St. Paul Company had 680 miles in operation in this area and the Chicago and Northwestern 445 miles. During 1882 there seems to have been relatively little building. Madison was reached by the Southern Minnesota division of the Chicago, Milwaukee and St. Paul, and Redfield also received a railroad from the east. During 1883 the line up the Dakota Valley from Yankton to Aberdeen was completed and the east-west line to Madison was extended beyond Howard. Before June 30th, 1884, this line was extended to Woonsocket. Probably there were other extensions during this year. During the year ending June 30th, 1885, 145 miles of line were completed in Dakota and the total mileage of the two more important southern Dakota companies was brought to 755 for the Chicago, Milwaukee and St. Paul and 574 for the Chicago and Northwestern. During the next year, 679 miles were completed; in the succeeding year, 716; while during the next fiscal year only 114 miles were built. During the calendar year 1886 more than 4,000 miles were completed in Dakota. A considerable part of this was on the divide between the Sioux and Dakota rivers, but extensive sections were on the western Coteau, and some in the Black Hills. There was little railroad building in southern Dakota between 1888 and 1905. In 1890 the mileage was 2,610; in 1905, only 3,067. As reflected in the following table of land entries and as shown by other data summarized in Table 21, active settlement did not take place in some sections until one, two, or three years after the coming of railroads. This was conspicuously the case west of the Dakota Valley. In many counties the establishment of train service coincided with widespread settlement. During the height of the boom (1882-85), railroads were not built fast enough to serve the rapidly increasing population and much land that had completed lines was filed on. Some such land was not served effectively by railroads for several years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Miles Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1884</td>
<td>755</td>
</tr>
<tr>
<td>1885</td>
<td>679</td>
</tr>
<tr>
<td>1886</td>
<td>716</td>
</tr>
<tr>
<td>1888</td>
<td>114</td>
</tr>
</tbody>
</table>

The increase in land claims in the last year indicated in the above table was due to the opening during that year of the Sioux reservation comprising the area now in Lynx and Stanley counties.

The magnitude of the Dakota Boom is indicated strikingly by the fact that in 1882, 306,000 acres were filed, and in 1883, 2,520,000 acres. The figures for 1875 to 1887 are from McClure; loc. cit., pp. 245. (Aberdeen, 1887).
following comparisons: During the first five years of the territorial government (1862-67) only 100,000 acres were filed on, and before August 1, 1870, less than 500,000 acres had been taken. Nearly two-fifths of the entire acreage filed on in the United States in the year ending June 30, 1883, was in Dakota, where nearly two-fifths of the whole territory (2.7 million acres) was filed on, as in Minnesota, Nebraska, and Kansas combined. During the decade ending June 30, 1889, nearly forty-two million acres, or nearly half the area of Dakota, was filed on. Probably more than three-fourths of this immense area was in southern Dakota, which then had about two-thirds of the population of Dakota. By 1887 no free land remained in twenty-two counties of southern Dakota and nine others had an average of only 2,500 acres each, most of which was then under water.

The growth in population during this period shows most clearly the magnitude of the immigration. Fairly reliable data are obtainable only for 1880 and 1885, in which years a federal and territorial census, respectively, was taken. The following table 23 indicates the population by counties for these years, together with the increase of 1885 over 1880.

<table>
<thead>
<tr>
<th>County</th>
<th>1880</th>
<th>1885</th>
<th>Increase 1880</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurora</td>
<td>6,900</td>
<td>9,881</td>
<td>2,981</td>
</tr>
<tr>
<td>Beadle</td>
<td>10,318</td>
<td>13,500</td>
<td>3,182</td>
</tr>
<tr>
<td>BonHomme</td>
<td>7,439</td>
<td>6,446</td>
<td>1,993</td>
</tr>
<tr>
<td>Brookings</td>
<td>5,250</td>
<td>4,866</td>
<td>384</td>
</tr>
<tr>
<td>Brown</td>
<td>16,221</td>
<td>14,330</td>
<td>1,091</td>
</tr>
<tr>
<td>Brule</td>
<td>7,648</td>
<td>6,875</td>
<td>773</td>
</tr>
<tr>
<td>Butte</td>
<td>6,482</td>
<td>1,981</td>
<td>1,981</td>
</tr>
<tr>
<td>Campbell</td>
<td>1,219</td>
<td>510</td>
<td>709</td>
</tr>
<tr>
<td>Charles</td>
<td>4,020</td>
<td>3,015</td>
<td>1,981</td>
</tr>
<tr>
<td>Clark</td>
<td>4,832</td>
<td>3,114</td>
<td>1,718</td>
</tr>
<tr>
<td>Clay</td>
<td>6,830</td>
<td>5,707</td>
<td>1,093</td>
</tr>
<tr>
<td>Codington</td>
<td>5,648</td>
<td>5,186</td>
<td>462</td>
</tr>
<tr>
<td>Custer</td>
<td>1,392</td>
<td>950</td>
<td>442</td>
</tr>
<tr>
<td>Davison</td>
<td>5,946</td>
<td>5,100</td>
<td>846</td>
</tr>
<tr>
<td>Day</td>
<td>5,601</td>
<td>5,040</td>
<td>561</td>
</tr>
<tr>
<td>Deuel</td>
<td>4,053</td>
<td>2,303</td>
<td>1,750</td>
</tr>
<tr>
<td>Dougherty</td>
<td>2,801</td>
<td>1,362</td>
<td>1,439</td>
</tr>
<tr>
<td>Edmunds</td>
<td>2,422</td>
<td>2,422</td>
<td>0</td>
</tr>
<tr>
<td>Etta</td>
<td>60</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Fall River</td>
<td>472</td>
<td>472</td>
<td>0</td>
</tr>
<tr>
<td>Faulk</td>
<td>3,120</td>
<td>3,116</td>
<td>0</td>
</tr>
<tr>
<td>Grant</td>
<td>6,782</td>
<td>6,783</td>
<td>0</td>
</tr>
<tr>
<td>Hamlin</td>
<td>3,757</td>
<td>3,084</td>
<td>673</td>
</tr>
<tr>
<td>Hand</td>
<td>7,057</td>
<td>6,904</td>
<td>153</td>
</tr>
<tr>
<td>Hanson</td>
<td>3,032</td>
<td>2,632</td>
<td>400</td>
</tr>
<tr>
<td>Harding</td>
<td>5,745</td>
<td>3,656</td>
<td>2,089</td>
</tr>
<tr>
<td>Hughes</td>
<td>5,066</td>
<td>3,084</td>
<td>1,982</td>
</tr>
<tr>
<td>Hutchinson</td>
<td>5,573</td>
<td>3,433</td>
<td>2,140</td>
</tr>
<tr>
<td>Hyde</td>
<td>2,178</td>
<td>2,178</td>
<td>0</td>
</tr>
<tr>
<td>Jerauld</td>
<td>3,458</td>
<td>3,458</td>
<td>0</td>
</tr>
<tr>
<td>Kingsbury</td>
<td>7,345</td>
<td>7,345</td>
<td>0</td>
</tr>
<tr>
<td>Lake</td>
<td>5,432</td>
<td>5,467</td>
<td>35</td>
</tr>
<tr>
<td>Lawrence</td>
<td>10,336</td>
<td>10,245</td>
<td>91</td>
</tr>
<tr>
<td>Lincoln</td>
<td>5,186</td>
<td>5,098</td>
<td>88</td>
</tr>
<tr>
<td>McCook</td>
<td>5,641</td>
<td>5,183</td>
<td>458</td>
</tr>
<tr>
<td>McPherson</td>
<td>5,208</td>
<td>5,183</td>
<td>25</td>
</tr>
<tr>
<td>Marshall</td>
<td>2,167</td>
<td>2,167</td>
<td>0</td>
</tr>
<tr>
<td>Miner</td>
<td>1,098</td>
<td>1,098</td>
<td>0</td>
</tr>
<tr>
<td>Minnehaha</td>
<td>13,567</td>
<td>6,351</td>
<td>7,216</td>
</tr>
<tr>
<td>Moody</td>
<td>1,259</td>
<td>1,259</td>
<td>0</td>
</tr>
<tr>
<td>Pennington</td>
<td>1,382</td>
<td>1,382</td>
<td>0</td>
</tr>
<tr>
<td>Potter</td>
<td>2,324</td>
<td>2,324</td>
<td>0</td>
</tr>
<tr>
<td>Potter</td>
<td>2,324</td>
<td>2,324</td>
<td>0</td>
</tr>
<tr>
<td>Potter</td>
<td>2,324</td>
<td>2,324</td>
<td>0</td>
</tr>
</tbody>
</table>

The total population of the area now in South Dakota, according to the census of 1880, was 93,283, including 16,487 in the Black Hills. In 1885 it was 263,411, of whom only 14,342 were in the Black Hills. The increase in the eastern part of the area (the rest is in Indian reservations) therefore was 166,728 in five years. In 1890, 288,809 persons were recorded in the state, of which number 32,559 were in the Black Hills region. The enumeration for 1880 was made after the great influx was well started, while that for 1890 was taken after there had been a great exodus due to two or more crop failures and to many disappointments on the part of town builders and speculators. Therefore it is impossible to give accurately the total influx to the country during the boom in question. An approximate statement is possible: The population by the ninth census (1870) was less than 12,000. The number was estimated to have doubled by the winter of 1872. In 1875 the Territory of Dakota was estimated to have 50,000 people, of whom nearly 35,000 probably were in the Black Hills. The increase between the 72 and 78 was slow, except in the Black Hills, and it is likely that the eastern part of the region had less than 50,000 when the boom started in 1878. The rapid influx continued for some time after the census enumeration of 1875. It was estimated that the increase for 1880 was over 85,000, and for the first half of 1887 about 45,000. Assuming that the increase for the last seven months of 1887 was at a corresponding rate, the population of the area would have been more than 440,000 in June, 1887— an increase of more than 75% in about nine years.

Striking as the influx to Dakota during this period is when considered in its larger aspects, as above, it may be illustrated even more truly by the legislation of smaller units. Beadle county, which had only thirty-seven acres in farms, in 1885, it had 135,384. Huron was platted by the railroad company in May, 1880. The first train arrived June 25. The population in the spring of 1884 was estimated at 300. The improvements made during 1882 cost $40,000. Brown county in 1880 had only 468 acres in farms; by 1885 it had 242,454, and a population of more than 12,000. Early in 1880 it had contained fewer than 100 persons. Previous to June, 1881, the site of Aberdeen was a wilderness, but the first railroad train arrived July 6, of that year, and in June, 1882, it had a population of 500. Blunt was first settled in the fall of 1882. In December 1882 it boasted a popu-

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*Armstrong, M. K.: Early Empire Builders, p. 47. (St. Paul, 1894).*
*Batchelder, Sec. Hist. of Dak., p. 46. (Yankton, 1870).*
*Andreas: loc. cit., p. 98.*
*McClure: loc. cit.*
lation of nearly a thousand, occupying 300 well-made buildings. In May, June and July, 1883, real estate transactions amounted to $150,000 and business prosperity advanced 599% in value. Mitchell dates from May, 1884. It opened for business in September, 1884, and in 1885 it was a United States Land office in October. It was incorporated in 1883 and had a population of 1200 in 1882. With the building of the second railroad, it had a wonderful growth in 1882-83, during which time flour mills, feed mills, an elevators, sandy, machine shop, and brick yards were established.243 Woonsneck was platted in September, 1883. Two months later it had 550 persons, and seven months later it had more than 800.251 "The site of Redfield prior to July, 1882, was an unbroken wilderness and an Indian camping ground. It was reported to have 1250 inhabitants.255 Brookings, first settled in 1878, but not as a town by the census of 1880, had a population of 800 in 1882.254

In 1878 the largest place in the area now forming eastern South Dakota was Yankton, the capital. It had a population of 737 by the census of 1870 and perhaps much fewer than a thousand people in 1878. Sioux Falls, the second center, was then a village of 600 or 700 people.255 Vermilion was third in rank. So great was the influx after 1875 that by 1880 four places, Watertown, Canton, Elk Point, and Vermilion, had a population of more than 500 but less than 750 each, while two, Sioux Falls and Yankton, had 2164 and 3431 respectively. Sixteen other towns are recorded by the census of 1880, but Aberdeen Brookings, Pierre, Redfield, Milbank, Webster, St. Simon, Chamberlain, and other towns of present prominence had not yet been founded, while Mitchell had a population of only 320, Huron of 184, and Madison of 29.256 These towns named above were significant; they are still are. When the boom began, few people foresaw which of the scores of towns platted were to become important cities, and which were to remain mere way-stations or county trading posts. Ambitious men of ability settled in equal numbers in each of many villages and each envied to make his town the chief one of the section. The rivalry between various towns therefore became very strong and resulted in many incidents that were ludicrous and many disappointments that were pathetic.257 With few exceptions each town tried to become county seat. In several counties violent possession was taken of the county records.258 A few examples of keen rivalry follow: In Sambom county, Letcher contested with Forestburg (centrally located) for the county seat. When Wessington Springs (in the north) was laid out in 1874, it was not entered by a railroad and as a result slowly declined and finally lost the county seat. In Tripp county, Lamor, with a population of more than one thousand in 1890, the county seat, was on the direct line of a projected railroad, completed within a few miles. When the line was extended in 1911, a curve was made to avoid Lamor, and a railroad town named Winner was laid out little more than a mile away. Lamor was deserted, its buildings became moved, and it received but a small portion of 1500 almost immediately. There have been many other instances of railroad favoritism in Dakota, especially before the Board of Railroad Commissioners began its work in 1884.259

For the foregoing reasons, and others, there was great uncertainty about the future of towns during this boom period. This is illustrated by contemporaneous gazetteers. In one of them,261 Huron, which in three or four years became, as it still is, one of the more important cities of the state, received only mention, two and a half lines being given to it. In the same volume thirty lines were given to a discussion of Jamestown in Yankton county, a town which soon disappeared. Scores of other towns which disappeared within a few years, received extended notice.

The boom times were brought to an end chiefly by crop failures. In 1886 "Dakota suffered in common with the rest of the country from business depression and from drought which injured the small grains, producing a shortage of at least a third in wheat and oats. The drought was local, some localities having splendid crops and others almost total failures of small grain."262 A weather bureau estimate places the shortage of crops at 50%.263 In 1887 there was a severe and widespread drought. In many counties little harvesting was done.264 In 1888 droughts were local only, and the average crop was not much below reasonable expectations,265 but "the terrible drought of 1889 produced widespread destitution."266 Other factors helped end the boom. The free land east of the Missouri River was nearly all taken by the summer of 1887. This region was fairly well supplied with railroads at that date, and few lines were built, with the result that towns which had looked for a railroad or for local government were less and less satisfactory, and loans were harder to secure. The difficulties became greater after each drought. While the exodus from Dakota which followed the collapse of the boom was produced primarily by the drought, it was increased by disappointments in business and land speculation. Furthermore, thousands left who had come to the region chiefly to secure land while it could be obtained for $1.25 an acre. Several were left with the intention of making it their permanent home. After receiving title to their claims, many did not need even a moderate drought to induce them to leave.

5. The Admission of South Dakota to Statehood

An urgent demand for statehood resulted from the great influx of 1870-86, and after vexations delay, South Dakota was admitted in 1889. The movement for statehood began during the first boom (1869-74). A memorial to Congress was presented for a dividing line on the government and for the admission of the southern part as a state was passed unanimously by the Legislature Jan. 12, 1871.267 A similar memorial was passed with but four dissenting votes on Dec. 31, 1872. The memorial again was passed with but one dissenting vote Dec. 19, 1873. See Annual Reports of this board, especially page 9 of the 1st. Polk's Gazetteer for 1881, page 259, for the city of Detroit, 1881. Governor's Report to the Sec. of Interior for 1888. Snell, loc. cit. p. 28. Ibid, p. 28. Hagerott, loc. cit. p. 38.
the people of northern and southern Dakota. South Dakota was chiefly occupied by homesteaders who brought with them the conservative notions of the small farmer about public and private economy, morality and education. On the other hand, North Dakota was controlled chiefly by bonanza farmers, captains of industry, whose traditions were entirely at variance with those of the homesteaders of South Dakota and later of western North Dakota.

Rogue farmers were secured much more readily and promptly by wealthy men in northern Dakota than in southern, as in the former there were large tracts of railroad lands given by the government to subsidize the building of the Northern Pacific Railroad. There were no such lands in southern Dakota. The Red River Valley occupied early by bonanza wheat farmers, has its southern end near the 46th parallel possibly was an influence, as was the fact that this parallel divides Dakota nearly equally. Aside from the seven standard parallel four miles to the south, no other division line appears to have been suggested officially.

6. Dry Years and Their Effects

As noted in Chapter V (climate), local droughts are to be expected somewhere in South Dakota every year, and widespread droughts are likely to occur at not infrequent intervals. Some of the influences were the severe droughts of 1864, 1874, 1886, 1887, and 1889 have been noted. The longest and most widespread drought in the history of the area commenced in 1889, and lasted in most sections until 1893. Rainfall was distinctly below normal in that part of South Dakota nearly every year of that period, and in several years there was an almost total failure of crops in many counties.

A discussion of the amount and distribution of the precipitation and the effect of years of drought is contained in Chapter V (p. 160). The droughts bringing the Great Boom to a close and in producing an exodus of population also has been mentioned. The exodus continued for several years. It was increased by the panic of 1893, produced in part by widespread drought in the Great Plains and in the Prairie Plains during that and the preceding years. Many counties of South Dakota, most of them west of the Dakota River, decreased greatly in population; and in 1897 many probably had less than half as many people as they had a decade before.

The exodus produced by the droughts was selective in character. The less patient and those readiest to start again elsewhere usually left soonest. The proportion of foreigners in South Dakota creased conspicuously, while that of Americans born in certain states, especially New England and New York, decreased greatly. Many native Americans, being more or less familiar with other parts of the country and having friends and relatives in other regions, soon discovered greater opportunities elsewhere. As a class they probably were more likely than recent immigrants to have the funds with which to move. Others lacked the perseverance to await favorable seasons, or the patience to sow a second or a third crop when the preceding one or two had failed. But a few of them, being accustomed to some degree of prosperity, were unwilling to subsist on the meager diet and endure the other hardships imposed by dry years and partial crops. Most of the foreigners in Dakota had come from northern Europe, and many of them, accustomed to poverty and meager crops resulting from infertile soils, tiny fields, or adverse climate. Some of the immigrants found conditions in Dakota even during the
served by farmers. Some of this land presently was used by stock
rangers. In the eastern part of the state, especially on the western
Coteau, areas relatively remote from railroads were deserted by farmers
soonest and most completely, other things being equal. Many farms
having relatively poor soils also were abandoned promptly.
Farming methods were changed. Varieties of plants better suited
to the climate were grown, and more care was given to the preparation
of the soil. The system of using custom of hiring men to plant
seed which had been scattered broadcast was replaced generally by the
practice of plowing or double-discing the land and planting by drill.
The rotation and diversification of crops received greater attention.
Mixed farming replaced 'pure' or 'straight' farming on many farms;
livestock were introduced on most farms; and dairying became much more
important than formerly. Other changes are noted in the section on
agriculture (p. 115.)

Land values decreased greatly as a result of the years of drought.
In 1870 unimproved land in the Missouri Valley was worth from $3
to $5 per acre if without trees; if heavily wooded, it was worth $15
to $40. Improved land without timber was worth $8 to $25 per acre.295
In 1872 land near Vermillion, a railroad town, sold regularly at $15
to $30 per acre, while ten miles north land was sold for $3 to $10.296
The construction of the railroad from Sioux City to Yankton is said to
have 'doubled the value of all the land of southern Dakota.'297 In
1852 land near Sioux Falls was sold for $5 to $15 or more per acre;
near Huron, $6 to $20; near Elk Point, $4 to $25 or more; and near
Canton, $4 to $12.298 During the height of the Boom, 1853 to 1855
inclusive, little or no land to which title could be given could be
had for less than $25 per acre; and the highest price paid was $140
per acre. The valuation of land was increased about 400 per cent
twice that, a price justified by the crops obtained. During the hard
times of the early 1890's, when prices of crops were low and yields
were small, land values fell to such an extent that $10 an acre was
counted a good price in most counties, and tens of thousands of
acres of farms could have been bought for less than half that.
Indeed, much land was sold for taxes.

The droughts made it more difficult to secure water for household
use, and most shallow wells failed, and many of the farmers who were
financially able undertook the drilling of deep wells. Irrigation also
was much considered during that period. The feasibility of diverting
waters from the Missouri River in North Dakota to irrigate farms297
were nearly level parts of the Dakota Valley was much discussed. Topograh-
ical relations favored the plan, but the volume of water carried
by the Missouri is so uncertain that it was abandoned. There was
much talk of drilling many large artesian wells in order to irrigate
with ground waters. The Federal Government called for a report on
this subject298 and drilled several wells, most of them in Indian reser-
vations, but no widespread system of irrigation was adopted.

6. Wet Years and the Return of Good Times

Commencing about 1895, the rainfall increased, and of much more
importance to agriculture, a larger proportion of it came when needed
by plants. Finally, in 1898, a series of "wet years" commenced, and
fairly satisfactory conditions continued in most of the state until
1910. As a result, these were years of bountiful yields and of great

294Butcher, Sec. The Hist. of Dak., p. 45., (Yankton, 1870.
295Brennan, John: Conditions and Resources of Southern Dak., p. 22.
296Sioux City, 1872-23.
297B.Bid., p. 25.
299B.Bid., p. 56.
300B.Bid., p. 56.
301B.Bid., p. 25.
302This is true also of New York and Ohio that we have taken the models of
our laws, while the basis of our local institutions and usages of government
is essentially that of New England." (Smith and Young, Civil Govern-
ment of S. D., p. 62, New York, 1866)
304Tbid., pp. 100, 141.
307Brennan, John: Conditions and Resources of Southern Dak., p. 10.
308B.Bid., p. 4.
310Culver, G. E.: The Practicality of Irrigating with Artesian Waters
in the Dakotas, (Washington, 1893).
prosperity. Bank deposits in South Dakota increased 600% between 1900 and 1910. Land values increased greatly. The aggregate value of all farm lands increased 377% between 1900 and 1910. The total increase between 1895 and 1910 was at least 500%; many farms increased in value more than 1,000% in the fifteen years. The increase in population between 1895 and 1910 was 252,913, more than 75%. A large proportion of this increase was west of the Dakota Valley, and more of the Missouri Valley on which area the increase in population between 1903 and 1910 was perhaps 400%. Twelve counties were organized in the latter region as a result of this influx, and nearly all the government land available was taken up. The eagerness of many people to secure some of these lands is reflected in the following statements: In 1904 a part of the Rosebud Indian Reservation was open to settlement; 106,000 persons applied for the right to homestead land, none of which was free, and most of which cost $2.50 or more an acre. In 1907 a small part of the Brule Reservation was opened, and 4,350 persons registered for some one of the 343 homesteads available. In 1909 most of the Cheyenne and Standing Rock Reservations were opened, and there were 80,142 entries for 19,000 homesteads.

7. Recent Years

The years 1910, 1911, and, in many sections, 1912 as well, were exceptionally dry, as dry as any three consecutive years in the early 1890’s. In 1910 the average rainfall of the state was only two-thirds the normal at many points; although the total amount in 1911 was greater, a considerable share came in the autumn when it was a handicap, as it interfered with harvest. In 1915 fairly satisfactory crops were obtained in many sections, but yields were well below the average. The weather conditions of these years are discussed further in Chapter V.

The effects of these dry years in the western part of the state were somewhat similar to those produced by the dry years which terminated and followed the Great Boom. There was a considerable exodus from this section, and land values fell in some cases to $6.00 an acre. Little land was abandoned, however. The farmers that remained acquired larger holdings, by lease or purchase, and by raising more livestock, practicing “dry farming,” and cultivating alfalfa, continued to utilize most of the land. In the eastern part of the state, the effects were far less pronounced. There most farmers practiced mixed farming, pay much more attention to the selection of suitable varieties of plants, and employ methods of tillage better suited to local conditions. Many have artesian wells which afford a constant supply of water for their stock even in the driest years. In each of these particulars, conditions there have improved greatly since 1887, and the occasional drought is far less disastrous than formerly. In the southeastern quarter of the state, land values have continued to rise, stimulated perhaps by the contrast between this section and areas less fortunate in respect to rainfall. Many farms in this quarter have sold recently for more than $175 per acre, and some for more than $200.00 per acre.

Conditions during recent years are treated more in detail in the first third of this chapter, under “Present Conditions.”

SUMMARY OF SETTLEMENT

Most of the settlement of this area took place during three boom periods, the second of “Great Dakota Boom” being the one during which the population increased slowly or not at

all. Each of the booms was due to railroad extension and a series of wet years; each was terminated by poor crops, due in most cases to droughts.

The first boom began in 1868, and developed rapidly in 1870. In the former year, Sioux City, Iowa, was reached by railroads, and in the latter year, several lines were approached and fifteen projected lines which were to serve Dakota were much talked of. However, railroad building was stopped by the panic of 1873, before southern Dakota had many miles of railroad, and the boom was terminated by the ravages of grasshoppers. From 1873 to 1875, the crop of 1874 being nearly destroyed by them. Thousands of persons were reduced to the verge of starvation.

The Great Dakota Boom was inaugurated in 1879, after two years of grasshopper activity in the western states. The presence of a large mining population in the Black Hills was an incentive for railroad extension in that direction, and the appropriation of nearly all the land in Iowa was another. During this boom nearly 3,500 miles of railroad were built in the area now included in eastern South Dakota, and a flood of settlers occupied most of the eastern half of the state, and parts of the western half. The Sioux Reservation delayed until 1889 the occupation of a large section west of the Missouri River. The population of southern Dakota increased from perhaps 60,000 in 1873 to more than 350,000 in 1886. When all the better land available had been filed on, the further influx of settlers was stopped by severe droughts in 1886 and 1887. The widespread droughts of 1886 and 1887 impoverished this area, as from other sections of the Great Plains and nearby depopulated certain counties, especially those west of the longitude of the Dakota River.

The third boom commenced in the eastern part of the state about 1893, as a result of fairly good crops for two or three years. During the decade 1890-1910 farm land values increased 277%, and the population of the state increased 45%. All the more desirable land of this section was occupied by 1900; however, the land was occupied, and a strong demand developed for railroad extension and for the opening of the Indian reservations west of the Missouri River. This was due in part to the fact that settlers had reported good harvests for several years.
even in the drier parts of the state. Finally the Missouri River was
bridged at Pierre and Chamberlain in 1907, and at Mobridge in 1909.
Between 1906 and 1910, inclusive, several hundred miles of line were
built west of that river, and by 1911 nearly all the government land
of much agricultural value, and open to entry, had been filed on.
During the decade 1900-1910 the total population of the area west
of the Missouri River, Lawrence County in the Black Hills excepted,
increased nearly 440%, from 27,343 to 115,973. Most of this in-
crease occurred in the last third of the decade.
Several dry years, of which 1910 was the first and the most severe,
have caused many homesteaders to leave soon after receiving patents
for their claims, decreasing greatly the population of many western
counties.
Geographic conditions, especially climate, have been powerful in-
fluences in this area. The native flora, fauna, and the settlement
and development of the area clearly reflect these conditions; and the activities
of the people are chiefly in response to geographic conditions. From
a geographic viewpoint, the area seems destined to remain predominantly
agricultural, and much of the western half, at least, of the type in
which stock raising is prominent.


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Fig. 38. Average Length of the Crop Growing Season, in Days.
Fig. 39. The Largest Lignite Mine in the State, Near Strool, Perkins Co.

Fig. 40. Range Horses at Water Hole, Fall River Co.

Fig. 41. The City of Pierre from Across the Missouri River.

Fig. 42. A View of Rapid City showing the foothills in which the Dakota sandstone, of artesian well significance, outcrops.
Fig. 42. The Missouri River Near Vermillion, S. D.

Fig. 43. Lead, S. D., the largest city of the Black Hills and the site of the Homestake Mine.

Fig. 44. Pierre, Showing the Capitol in the Distance.

Fig. 45. Pierre, Showing the Capitol in the Distance.

Fig. 46. Aberdeen, looking north from the Citizens Bank Building.
Fig. 47. A farm home near Aberdeen, and a part of an oat field which yielded 70 bushels per acre.—Courtesy C. M. & St. P. R. R. Co.

Fig. 48. A wheat field near McIntosh, in the northwestern quarter of the state.—Courtesy C. M. & St. P. R. R. Co.

Fig. 49. A general view in eastern South Dakota (Bath.)—Courtesy C. M. & St. P. R. R. Co.
Fig. 50. A wheat field near Webster in the northeastern quarter of the state. Courtesy C. M. & St. P. R. R. Co.

Fig. 51. A typical mixed farming home in North Central South Dakota. — Photo by J. W. Parmley, Ipswich, S. D.

Fig. 52. Claim Shanty.
South Dakota State Geological and Natural History Survey

FREEMAN WARD, State Geologist

BULLETIN 8

The Geography of South Dakota

BY
S. S. Visher

Report of the State Geologist
1916—1918

UNIVERSITY OF SOUTH DAKOTA
VERMILION
JULY, 1918
INTRODUCTORY.

The last report carried the Survey up to September 1st, 1916. The present report covers the activities of the Survey from that date to July 1, 1918. The statistics, however, reach only to June 1, 1918, those for the month of June will be included in the succeeding report.

The permanent staff of the Survey remains the same,—Freeman Ward as State Geologist, W. H. Over as Naturalist. R. T. VanTuyl acted as field assistant during July and August, 1917.

The work of the Survey will be considered under the following headings and in the order given,—Field Work, Service Bureau, Museum, Publications, Accessions, Relation of the Survey to the War, Miscellaneous Activities, Needs of the Survey.

FIELD FORK.

1916.—The work of the field season of this year was discussed in the preceding report.

1917.—The State Geologist, starting out about the middle of June, spent a short time in Rapid City in conference with Prof. C. C. O'Hara on the Water Resources situation. Then he went immediately to Mobridge to take up the main work of the season. Soon after the first of July he was joined by Mr. Over and Mr. VanTuyl.

It was planned to survey the Missouri River and the territory immediately adjoining from the north part of the state down to Pierre. In order to make the trip possible a boat was built large enough for the party, equipment and supplies. In addition a light skiff was provided.

Since the territory to be surveyed was in the gas belt of the state the State Geologist hoped that detailed examination might bring to light some positive information regarding oil. But only negative results were obtained throughout the entire course of the trip. Despite this, a considerable amount of valuable information was secured concerning the various geological conditions of the region.

Mr. Over's work was twofold. He made a study of the plant and animal life to supplement the rather meager data we had of that area. In addition, he made a large number of archeological discoveries. His work of previous seasons had lead him to expect a series of ancient Arikara village sites at various points along the river. This proved to be the case. Tools, weapons, implements, of various sorts, ornaments and skeletal material were found in considerable quantity.

While camped some miles below Mobridge word was received that oil was reported to have been found in wells at Mahto and McIntosh, Corson County. Several of the business men of Mobridge, headed by Mr. B. S. Hill, were enough interested in the affair to pay the expenses of the State Geologist for a special trip to these localities. Unfortunately the conditions did not turn out to be as favorable as they seemed to promise at first.

The status of the oil problem of the state is given in outline in Circular Number 1.

Additional Trips.—Several short trips were taken outside of the regular field season.

About the middle of December, 1916, a mastodon skeleton was reported found near Sioux Falls. Mr. Over went there to investigate. The bones proved to be only fragments of chalk rock. But since mastodon
bones have been found in the state all reports need to be looked up whether they turn out to be favorable or not.

During the latter part of December, 1916, the State Geologist attended meetings of the Association of State Geologists in New York City and Albany, N. Y. At that time he presented a paper on the "Geological History of South Dakota."

In September, 1917, an old Indian grave was discovered near Centerville. Mr. Over made a trip there, recovered additional material, and, through the courtesy of Mr. A. A. Norgren, was able to have the whole find returned to the Museum.

In November, 1917, Mr. Over investigated several Indian mounds near Mitchell. He secured some good material.

In April, 1918, a conference on War Minerals was held by the Association of State Geologists with the U. S. Geological Survey and the U. S. Bureau of Mines at Washington, D. C. The State Geologist attended this meeting.

Occasional short trips have been taken in the vicinity of Vermilion from time to time.

SERVICE BUREAU.

This is an important branch of the Survey work seems to be growing. A continually increasing number of inquiries has come in from citizens of the state and from persons and companies in other parts of the country. A great variety of information is sought. Specimens of many kinds are sent in for identification. Some analytical work has been done through the Department of Chemistry of the University. Approximately 375 inquiries have been received and answered by mail. Personal talks with and advice from some one or the other of the Survey staff are of almost daily occurrence.

The completeness of the answers given is determined by the amount of information on hand. Much of this can be gained only by field work. The more thoroughly the state is explored and mapped the better can the Survey serve the people.

The Survey is finding that it can serve the producers of the state by centralizing the statistical information from their mines, mills and prospects. The producers are finding that the Survey, because of the centralization of data therein, is able to save them considerable clerical work and annoyance. This is one of the newer developments of the Service Bureau which promises to expand to much greater usefulness.

The State Mine Inspector is cooperating in this matter also.

MUSEUM.

While the State Geologist is technically the Curator of the Museum, yet the actual museum work—arranging, cataloging, preparation of exhibits, etc., etc.—has been in the hands of Mr. Over who has been extremely successful in all phases of the work.

The Museum is becoming an increasingly important factor in the educational achievements of the state. The collections of exhibit material are increasing. The specimens and other data are so classified that specific information along many lines is quickly available. That use is being made of the Museum is attested by the fact that there were approximately 5000 visitors during the period.

The number of specimens acquired during the above period was approximately 2615. Most of these have been classified, cataloged and arranged for exhibition.

Those deserving of special mention are the fine elk head donated by Mr. Bert S. Hill, Mobridge, S. D.; the mounted mammals and birds loaned by Mr. John Berens, Selby, S. D., and known as the "Berens Collection." This comprises among other things, a buffalo, antelope and four deer. And of unusual interest is the large collection of Indian skeletons and artifacts collected along the Missouri River during July and August, 1917. This material is valuable not only in rounding out our Arkaora and Mandan Indian collections, but has also aided in deciding, conclusively, doubtful questions pertaining to early Indian history in South Dakota.

Below will be found a list of acquisitions. Except where otherwise indicated the specimens are donations.

Hawk, Albert Omdahl, Burbank, S. D.
Snake, Hog-nosed Adder, A. G. Warner, Clear Lake, S. D.
Sioux Indian Skeleton with Flint Lock Gun and Necklace, A. A. Norgren, Centerville, S. D.
LeSeuere Terrapin, George Lumley, Pierre, S. D.
Collection of Plants, Prof. Walter Parish, Gary, S. D.
Avocet, Claude Crew, Interior, S. D.
Old Mauser Rifle and Indian Arrow, Geo. F. Bower, Vermillion, S. D.
Hematite Specimens, Archaeology Prof. R. W. Jones, U. S. D.
2 Cherry Stone Crushers (Sioux) Robt. Lindley, Bonesteel, S. D.
5 Box Terrapins, Wm. Palmier, Imlay, S. D.
48 Bird skins, F. A. Patton, Artesian, S. D.
162 Mounted Mammals and Birds, John Berens, Selby, S. D.
Collection Sea Moss, Prof. A. L. Haines, U. S. D.
43 Mounted Birds and one Mounted Skunk, John C. Green, Sioux Falls, S. D.
6 Mounted Birds and one Waszal Mounted, O. C. Stanghar, Sioux Falls, S. D.
3 Indian Skeletons, Beads and Stone Hammer, W. N. Gilbert, Madison, S. D.
Snake, Hog-nosed Adder, J. C. Dawson, Vermillion, S. D.
Old Lincoln Campaign Chart, Mrs. C. A. Wilson, Vermillion, S. D.
Tarantula, Harlan Richardson, Vermillion, S. D.
Spider, E. Fuhr, Higbe, S. D.
Old Tin Lantern, C. A. Wilson, Vermillion, S. D.
Shrew, Arthur A. Hale, Bison, S. D.
Marine Shells, Walter Willey, U. S. D.
Marine Shells, Miss Jessie Paulson, S. D.
Barndale, W. E. Eastman, Sioux Falls, S. D.
Skull Clay County Court House Yard, Chas. Sunderland, Vermillion, S. D.

Spinning Wheel and Reed, Loaned, Dr. Freeman Ward, U. S. D.
6 Bird Skins, E. C. Ecker, Elk Point, S. D.
Fragments Old Survey Stake, Lake County, Porter Lowey, U. S. D.
Salamander, Dr. A. N. Cook, U. S. D.
Snake, Hog-nosed Adder, C. J. Stringham, Sioux Falls, S. D.
Snake, Red-bellied Snake, C. J. Stringham, Sioux Falls, S. D.
Bull Snake, E. M. Hall, Pierre, S. D.
Snake, Hog-nosed Adder, W. J. Chasseur, Vermillion, S. D.
Lizard, Red-headed, V. A. Lattin.
Models of Road Beds (3) Dept. Civil Engineering, U. S. D.
Indian Flint Knife and Fragments of Pottery, F. E. Ratcliffe, Vermillion, S. D.
Pine, Arajucara, Chris. Hansen, Vermillion, S. D.
Ring-necked Pheasant, Roy Davis, Vermillion, S. D.
Collection Grasses, A. E. Noyes, Redig, S. D.
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Golden Eagle, A. E. Noyes, Redig, S. D.
Bird Skin, A. E. Noyes, Redig, S. D.
Squirrel Nest, Frank Barden and M. Minick, U. S. D.
Old Kentucky Rifle, Loaned, Prof. M. W. Davidson, U. S. D.
Old Revolver, Millard Purdue, Vermillion, S. D.
Colts Revolver and Collection Sioux Indian Relics, Loan, Dr. Freeman Ward, U. S. D.
Nest of Baltimore Oriole, E. D. Cowles, Vermillion, S. D.
Specimen Gypsum, Prof. A. L. Haines, U. S. D.
White Muskrat, Donald Harris and Lyle Swanson, Highmore, S. D.
Porcupine Skin and Buffalo Bones, E. A. Sheldon, Vermillion, S. D.
Indian Stone Hammer, R. E. Brown, Academy, S. D.
Indian Stone Hammer, Porter Lowery, U. S. D.
Indian Stone Hammer, H. L. Ferry, Vermillion, S. D.
Indian Stone Hammer, Rev. P. J. Reinhathensch, Elk Point, S. D.
Young Muskrat, Dr. W. F. Jones, U. S. D.
Indian Stone Tomahawk, Stone Hammer, Mortar, Buffalo Head, 2 Clay Concretions, J. Martin Larson, Elk Point, S. D.
Moth, Polyphemus, Miss Villy Cleland, Vermillion, S. D.
"Kissing Bag," Redidwae, Mrs. Smith, Ft. Bennett, S. D.
Goshawk Roy Jones, Vermillion, S. D.
Goshawk, Roy Jones, Vermillion, S. D.
Abnormal Pig, 3 Snakes, Buffalo Head, C. B. Gilbertson, Vermillion, S. D.
Scorpion, Dick Willis, Andover, S. D.
Collection Minerals, Wood Carving, Buffalo Horns, Fossils and Shells, Mrs. T. M. Goddard, Vermillion, S. D.
Wood Carving by Ants in Norway, E. Ostlund, Vermillion, S. D.
2 Copper Coins, Waldo Graves, Vermillion, S. D.
Dakota Sioux English Dictionary, E. F. Canaday, U. S. D.
Cannon Ball, W. B. Smith, Vermillion, S. D.
Cannon Ball, Cliff Hallas, Vermillion, S. D.
Old Grain Cradle, Atty. A. B. Gundersen, Vermillion, S. D.
Short-eared Owl, Kermit Davis, Vermillion, S. D.
American Horned Owl, J. T. Christensen, "Ake Preston, S. D.
Snowy Owl, Andrew Bolme, Centerville, S. D.
Snowy Owl, Ole Dahl, Ideal, S. D.
Snowy Owl, Harold Rice, Flandreau, S. D.
Snowy Owl, Jerry Smit, Platte, S. D.
Snowy Owl, Wilbur Smith, Mansfield, S. D.
Pair of Black Ducks and Least Bittern, H. G. Taylor, Vermillion, S. D.
Indian Baskets and Beaded Work, Loaned, W. Gray Tisdale, Sioux Falls, S. D.
3 Indian Stone Hammers, Lars Larson, Elk Point, S. D.
Old Photo of Gen. Grant and Brig.-general J. McArthur, and others, H. L. Ferry.
Elk Head Mounted, Bert S. Hill, Mobridge, S. D.
American Horned Owl, Roy Davis, Vermillion, S. D.
Black Rat and Red Bird, Mr. Spatz, Macklin, S. D.
Chinese Coins, E. O. Sheldon, Vermillion, S. D.
2 Indian Stone Hammers, C. B. Rosa, Forest City, S. D.
Indian Beaded Vest and 2 Beaded Bags, Dr. B. F. Lockwood, Yankton, S. D.
Bajonet, Battlefield of Bull Run, Loaned, Prof. W. M. Davidson, U. S. D.
Mounted Deer Head, Deer Antlers and Indian Snow Shoes, changed from loan to donation by R. A. Morgan, Vermillion, S. D.
Indian Stone Hammer, Mrs. Alice L. Overholser, Glenham, S. D.
Indian Stone Hammer, 10 arrow points, R. H. Petersen, Mobridge, S. D.

THE GEOGRAPHY OF SOUTH DAKOTA

Tarantula, J. H. Hartson, Vermillion, S. D.
Moth, Walter Harrington, Vermillion, S. D.
Crows Nest and Eggs, R. T. Van Tuyl, U. S. D.
Polished Agate and 20 old Coins, Loan, Mrs. B. T. Thompson, Vermillion, S. D.
Flax Fiber and old Bread Basket, President Slagle, U. S. D.
Ox Bow, A. T. Kayser, Parkston, S. D.
Coated Well Pipe Point, M. B. West, Vermillion, S. D.
Plants and Sea Moss, Miss Mary Henderson, Calif.
Indian Photographs, Arrow, Minerals, Cane and Indian Ores, Mrs. W. Allen, Vermillion, S. D.
Irish Shillalah, Loaned, D. M. Eastman, Sioux Falls, S. D.
White Oak and Isabell Harrington, Vermillion, S. D.
Snow Goose, C. W. Over, Vermillion, S. D.
Whitefronted Goose, C. J. Stringham, Sioux Falls, S. D.
"Copper Amulet, Worn by a Sioux Indian, James Hughes, Mobridge, S. D.
White Mouse, Adolph Iverson, Vermillion, S. D.
Collection of Algae, Dept. of Biology, U. S. D.
Nest of Chimney Swift, Mortimer Herzbeg, Jr., Vermillion, S. D.
Hand-made Tools from the Philippine Islands, F. Ratcliff, Vermillion, S. D.
Fossil Aggregation, A. N. Williams, Akron, Iowa.
2 Carncks Eggs, Mrs. F. A. Brink, Pensacola, Fla.
Abnormal Pig, Guy Chamberlin, Vermillion, S. D.
2 Porcupines, Loaned, Geo. Butterfield, Pierre, S. D.
Collection of Carboniferous Fossils, changed from a loan to a donation by S. S. Thomas, U. S. D.
Specimens added by the State Geological and Natural History Survey are as follows:
22 Plants, 15 Bird Skins, 12 Snakes, 2 Mice, 4 Amphibias, 40 Arilika Indian Skeletons and 39 extra Skulls, 2000 Flint, Stone, Bone and Shell Indian Implements and Ornaments, 3 Omaha (?) Indian Skeletons and Beads from a Mound at Madison Pass and 4 Omaha (?) Indian Skeletons from a Mound near Brule Creek, Union County.
The following have been mounted for the Museum:
Added to the Museum by exchange:
5 Snakes and 3 Turtles.
An effort has been made to keep for exhibition purposes as many live animals as possible, but on account of no funds to purchase specimens nor to build suitable pens and buildings but little can be done.
The following are on hand:
1 Coyote, 2 Porcupines, 1 Alligator, 1 Snowy Owl, 2 River Turtles and 3 Land Terrapins, and 5 Snakes.
One 2nd hand show case and one new base with 30 large drawers have been added during the period.
3 Arilika Indian Skeletons and 10 Skulls have been presented, and 24 skulls loaned to the United States National Museum for investigation.
A number of Books and Bulletins have been loaned to individuals over the State who have been interested in subjects concerning Natural History.
The limitations and needs of the Museum will be discussed in a later paragraph.
PUBLICATIONS.

A new series of publications—Circulars—has been started by the Survey. The reasons for this step are as follows:

Often during the progress of the work enough information is at hand to be of value to those interested but not enough for a complete treatise. A part of a county may be finished, perhaps, and publication waiting on the complete investigation of the whole county. A problem under investigation may take several years to finish, yet certain phases of the investigation may yield results sufficiently complete to be of value by themselves. There may be a demand for statistical matter, or lists of references, or current information, etc., which would hardly do for a formal bulletin. Such partial reports, summary reports, reports of progress, or lists, etc., are to be handled in the Circulars. The Bulletin is to be reserved for the more detailed and formal treatment of problems whose investigation is complete or practically so. It is planned to publish the Circulars frequently at such intervals as to make the investigation of the Districts complete in one year. With this arrangement much information will reach the public with a minimum of delay.

So far three Circulars have been issued, as follows:

No. 2—South Dakota Fossils, by Freeman Ward, Mch., 1918.
No. 3—Protect the Birds and Help Win the War, by W. H. Over, June, 1918.

The manuscript on "The Geography of South Dakota" by S. S. Visher, which has been on hand so long, is herewith attached for publication as part of this bulletin.

A new geological map of South Dakota on a scale of twelve miles to the inch has been ready in manuscript for a year and a half awaiting publication.

A new base map of South Dakota on a scale of six miles to the inch has just been completed and is ready for publication. This map shows the county boundaries, drainage, railroads, cities, parks, towns, township and range divisions. It also shows the larger relief features by means of contour lines with a 500 foot interval.

The manuscripts for a bulletin on Birds are nearing completion, will undoubtedly be ready for publication early in the fall.

ACCESSIONS.

In addition to the material listed under the Museum, about 65 purely geological specimens—rocks, minerals, fossils, etc.—have been collected by the Survey.

Museum publications—Federal, State, Foreign—are received constantly. They are not kept separate from those received by the Geological Department of the University but are included in the departmental library.

RELATION OF THE SURVEY TO THE WAR.

The raw materials of war, and without which our war program would have to stop, are the natural mineral resources of the country. They are commonly designated as "War Minerals." They have always been in demand even in times of peace. Much has usually been imported by this country. Now that we are at war overseas traffic is difficult and uncertain, moreover, the Shipping Board is withdrawing ships from trade in order to hasten the transportation of men, food, munitions, etc. As a result the importations have been much curtailed, they may be cut off entirely. And the demand for these minerals is much greater than in peace time and of which means that the domestic supply will have to be very much increased and that with a minimum of delay.

MISCELLANEOUS ACTIVITIES.

The clays collected in the Sioux Falls region were tested as far as our facilities allowed. Because of very limited equipment they had to be sent off for the most important tests. For this purpose they were sent to Prof. H. Ries of Cornell University who is one of the leading clay engineers of the country.

There came to the attention of the State Geologist a machine, "Barnes' Electric Water Purifier," which claimed to be a water softener and purifier. The matter of softening hard water is a serious problem in this State and was an unusual experiment run to test its value in this connection. It did not perceptibly soften the water and was demonstrated to be very largely a fake. The agent handling the machine was notified of its limitations and cautioned against the truth concerning the device. The chemical analysis involved in the tests were made in the laboratory of the State Food and Drug Department with the generous permission of the Commissioner, Mr. Guy G. Frary.

At the suggestion of Mr. Over all these in the State interested in archeology were invited to attend a meeting held at Vermillion in the interests of that subject. A good attendance was realized and a number of papers were presented, two of them discussing South Dakota conditions,—"Pre-Historic Man in South Dakota," by W. H. Over, The State Geologist. The same subject from a geological standpoint.

All the work so far reported, including preparation of manuscript for Circulars, papers, etc., and work on maps, has been sandwiched in with the regular university duties during the school year.

Mr. Over has given three lectures,—"Birds," "Early Races of S. Dak.," "The State Survey and Museum."
NEEDS OF THE SURVEY.

As suggested under the topic "Relation of the Survey to the War," the Survey can do the best work and get results quickly only by maintaining a steady and efficient staff of experts. This state is too large for one man to cover, especially when he can be in the field but three months of the year. Nor can one man be an expert in all lines of geology. If experts are employed they must have suitable equipment—laboratory, photographic, clerical, etc.—in order to be most efficient. One of the big aids to rapid and accurate field work is a topographic map. Such maps should be made with all possible dispatch so that the field work does not lag. There are many other uses for topographic maps than that for geological work (see Bull. 7, pp. 11, 12).

Even with the present staff of the Survey—Geologist and Naturalist—the results could be increased at least threefold if there was sufficient money for transportation and unskilled labor and other like aids.

For instance, a year before last the State Geologist did all his work on foot. A large share of his time was spent in getting to and from the work. An auto continually at hand would have enabled him to cover at least three times as much territory.

Again, last season if we had had a house boat with power instead of having to row, we would have covered at least three times as much territory with less exhaustion.

Furthermore, unskilled labor can move and set up camp, rustle wood and water, cook, dig holes, etc., etc., as well as skilled labor. Moreover, if he shares in the unending efforts of Mr. Oser, in housekeeping, he has just that much less to apply to geology or natural history.

One indication of the need for complete and extensive information concerning our resources is shown by the fact that several business interests, with capital amounting to several hundred thousand dollars and desiring to build up industries around our resources, failed to locate in the state because the information was not sufficiently detailed to interest them.

Another most important need is the taking care of what we have and making it more useful. I refer to the Museum. The Museum is housed in a part of Science Hall. This is a most flimsy building. It is in no ways fireproof. It is scarcely weatherproof. A large portion of the collections now reposing in the Museum could never be replaced if once lost. There are historical and archeological materials of the only things of their kind in existence. Our Arkara material, which the Survey has collected through the untiring efforts of Mr. Oser, is unique; there is nothing to equal it anywhere. The State Geologist within the last year visited the Field Museum in Chicago, the American Museum in New York City, and the National Museum in Washington. He finds after careful inquiry that our Museum has at least five times as much Arkara material as those three famous museums together. It is undoubtedly true that we have the best collection of such material in the world. It is the height of indiscrétion to give such fine material so little protection. Moreover it shows a lack of business sense. We have other excellent specimens. We have loan collections for which we are responsible. I cannot too strongly emphasize the need for a modern fireproof structure for our Museum.

The place we have for display is far too small. Such material as is now on exhibition would require twice the floor space to show it properly. In addition, a large collection of botanical specimens that have been acquired through exchange with other State Universities, two collections of fossils, and several hundred Indian implements and relics all stored in boxes and drawers for lack of room to display. Display cases and floor space is needed for collections illustrating the products of South Dakota.

The Museum has reached that stage of growth where the Mammals, Birds and Ethnological material should be displayed by the effective group system, not only to keep pace with other Museums but also to satisfy the demands of the public that use the Museum for educational purposes.

New and better cases are needed. At least $500.00 should be available each year to purchase rare specimens, to fill out incomplete collections, and to send competent collectors after specimens, either in or out of the state, that are becoming rare and more difficult to obtain year by year. An equal amount should be spent annually to build up the live animal exhibit.

$50.00 should be at the disposal of the Museum each year to purchase much needed books pertaining to Natural History, and especially Bulletins, Reports, and Proceedings of scientific organizations of the United States that can be procured only by purchase. Reports and published proceedings that are particularly necessary are those of the Philadelphia Academy of Science and the Carnegie Institute, as well as U. S. Biological Reports that are out of print.

Funds are also needed for publication. The maps and bird bulletin prepared in response to a general call for them, are cases in point.

Collections of South Dakota minerals, rocks, plants, animals are desired in the high schools and other educational institutions of the state. The Survey can get these out when funds for this purpose are available.

In view of the pressing needs of the Survey and the great opportunities it has to further the interests of the State and also aid the country in this time of war, it is hoped that a very generous appropriation will be urged.