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South Dakota Soils : A Generalized Soils Map of the West River Area of South Dakota

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SOUTH DAKOTA STATE COLLEGE

Agricultural Experiment Station

and

Cooperative Extension Service

South Dakota Soils

F.S. 134B

A Generalized Soils Map of the West River Area of South Dakota

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Soil Survey Series No. 5, South Dakota Soils, consists of three separate fact sheets, 134A, 134B, and 134C.
F.S. 134A. A Generalized Soils Map of the East River Area of South Dakota.
F.S. 134B. A Generalized Soils Map of the West River Area of South Dakota.
F.S. 134C. The Distribution and Average Yields for Crops Commonly Grown in South Dakota.

South Dakota Soil Forming Factors

The kind of soil that develops in any area is the result of the interaction of five soil forming factors—climate, vegetation or organisms, parent material, relief, and time.

Climate controls the distribution of vegetation. Together climate and vegetation often are called the active factors of soil formation. This is because on gently undulating topography within a certain climatic and vegetative zone a characteristic or climax soil will develop unless parent material differences are great. Thus Chernozem soils develop across a great variety of parent materials.

The factor of parent materials exerts its influence on soils principally by determining their texture and to a great extent their mineralogical composition. Whereas climate and vegetation tell what **group** a soil is in, parent material, to a large extent, determines its **series**. For example, Chernozem soils from glacial till are classed in the Vienna series, while Chernozem soils developed in thin loess overlying glacial till are classed in the Kranzbu[illegible] series.

The fa[illegible] of relief exer[illegible] its greatest influence by determining what drainage a soil will have. Steep slopes have excessively drained, thin soils; flat or depressed areas usually have poorly drained, thick soils. Mature Chernozem or Chestnut soils develop only on undulating relief where climate and vegetation are given full expression.

The factor of time in soil formation can be illustrated by comparing a soil on a flood plain which receives annual increments of alluvium with a soil on a terrace. The former is without horizons although it may have strata of contrasting alluvium, while the latter usually has an ABC horizon sequence. Actually much work needs to be done in South Dakota for assessing the importance of time in soil formation.

Details of these five soil forming factors as they affect soil development in South Dakota will now be considered.

Climate

South Dakota, because of its inland position, has a continental climate with extremes of summer heat, winter cold, and rapid fluctuations of temperature. Annual precipitation ranges from 24 to 25 inches in the southeastern part to about 14 inches in the northwestern part of the state. Most of the precipitation comes in the spring and early summer. The fall, winter, and spring moisture falls mostly as frontal precipitation and is the result of condensation as warm moist air from the Gulf of Mexico overrides heavier polar air masses. Much of the summ[illegible] precipitation c[illegible] as short hard showers of the c[illegible]ectional thunde[illegible]ower type. In eastern South Dakota, June normally has the most thunder-

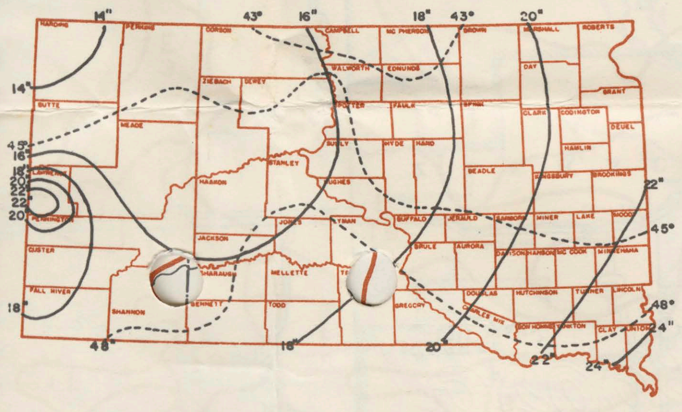


Figure 1. Average annual precipitation and air temperature for South Dakota.

——— Precipitation (Normal annual precipitation, 1921-50)
- - - - Temperature

Source: U. S. Weather Bureau Records

storms; in western South Dakota most of them normally come in July.

During the cold seasons winds are from the northwest, while they flow from the southeast during the warm season. The annual average surface wind velocity for the state is 10 to 12 miles an hour.

The average number of clear days per year is 120 to 140. There are 100 to 130 partly cloudy days per year on the average and 100 to 120 cloudy days. The normal annual number of hours of sunshine is about 2,850 in the southwestern part of the state to 2,700 in the northeastern part.

Average depth of frost penetration ranges from about 25 inches in the southwestern part to 50 inches in the northeastern part of the state.

The average number of days without killing frost varies from 130 days along the northern part of the state to 160 days in the southeastern part. The Black Hills area generally has shorter growing seasons than the rest of the state, with the average number of frost-free days ranging from 110 to 130 days.

It is possible to evaluate the climatic factor in South Dakota in relation to the climate of the United States by classifying the climate according to a national scheme. Several schemes may be used, but the system of Thornthwaite (5) classifies the climate of South Dakota as follows: Moist subhumid—southeast South Dakota; Dry subhumid—eastern and south central South Dakota; Semiarid—western South Dakota except for Black Hills. The Black Hills climate ranges from dry subhumid to humid.

The annual precipitation and temperature characteristics of South Dakota are shown in figure 1.

Native Vegetation

Except for the Black Hills, which are timbered, and the river valleys where trees and brush grew, the native vegetation of South Dakota was grassland.

Starting with the eastern border of the state and extending to the eastern edge of the James Valley, the principal association was one of tall grasses. Big bluestem, sand dropseed, and switchgrass were present along with upland and lowland forbs.

Moving westward across the James Valley, the tall grasses gradually dropped out, being found only on sandy soils and on cool northern exposures and the medium and short grasses assumed dominancy. Important species of the midland area were needleandthread, green needlegrass, western wheatgrass, slender wheatgrass, blue grama, prairie junegrass, and buffalograss.

Moving into western South Dakota, due to decreased rainfall, the shorter grasses largely replaced the midgrass species. Here were found blue grama, needleandthread, western wheatgrass, prairie junegrass, and little bluestem.

Certain variations in this general pattern occurred in western South Dakota as a result of extremely sandy or clayey soil texture. For example on the Pierre plain, an area of clay soils, the principal association was one of western wheatgrass, blue grama grass, and buffalograss. In the sand hills of southwestern South Dakota an important association was little bluestem, prairie sandreed, and needleandthread.

Parent Material

The kinds of soil parent material in South Dakota are shown in figure 2. This map was generalized from maps by Flint and Rothrock.

As this map illustrates, there is a large variety of materials from which the soils of the state have developed. They include ancient crystalline rocks in the central Black Hills, sedimentary rocks including shale, sandstone, and limestone in western South Dakota, and glacial materials of several ages in eastern South Dakota. Additional parent materials include loess and alluvial and colluvial materials formed from upland deposits. As soil development is extremely slow on crystalline rocks and as few soils have been recognized to date as having been developed from them in South Dakota, they will not be further discussed.

Sedimentary rocks. Sedimentary rocks have formed by consolidation and cementation of sand, silt, clay and other clastic material, and the precipitation from solution of the carbonates of calicum and magnesium. All of this took place on the floors of ancient seas.

The sands formed sandstone, the silts and clays formed siltstone and shale, and the basic carbonates formed limestone. Few of these rocks in South Dakota are pure—instead they are calcareous sandstones, sandy limestones, and so on. The principal sedimentary rock parent materials include: 1) the Pierre shale of the central part of the West River area; 2) the upper Cretaceous sandstones and sandy shales of the northern part of the West River area; and 3) the Tertiary sandstones and siltstones of the southern part of the West River area.

The **Pierre shale** area is sometimes called the "gumbo region" because of the plastic clay which weathers from the shale. The strata of the Pierre shale are soft and easily eroded. They generally are not butte-formers, rather they weather into soft rounded hills and ridges with convex tops. The Pierre clay and Lismas clay are soil series developed from Pierre shale.

Upper Cretaceous sandstones and sandy shales of northwestern South Dakota give rise to a great variety of soil textures. The sandstones weather to give rise to sandy soils and the shales which contain admixtures of silts and sands are parent materials for sandy loams, loams clay loams, silty clay loams, silty clays, and clays. The dominant textures are sandy loams and loams. Morton loam and Vebar sandy loam are soil types mapped in this area.

Tertiary sandstones and siltstones of southwestern and south central South Dakota give rise principally to

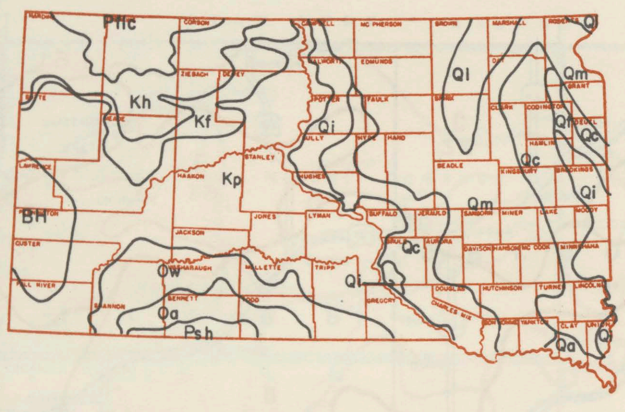


Figure 2. Soil parent materials in South Dakota.

West River

Psh Sand Hills
Oa Oligocene—Arickaree—sandstone and siltstone
Ow White River beds—silts and clays
Pflc Cannonball, Ludlow, Fort Union undifferentiated
Kh Hell Creek—sandy shales
Kf Fox Hills sandstone
Kp Pierre shale
BH Black Hills—undifferentiated crystalline metamorphic and sedementary materials

East River

Qa Alluvium
Ql Lake Basin—silts, clays, sands
QM Glacial till
Qc Silty Glacial Materials
Qt Glacial Till and Thin Loess
Qi—Thick loess in south, thin loess over loam till in north

Source: Flint USGS Prof. Paper 262 and Petsch, B. C., Geologic Map of South Dakota. See also recent Geological Map of Eastern South Dakota published by State Geological Survey for correlation of the glacial drift sheets.

sandy and silty soils. The sandy materials on the south are an extension of the Nebraska Sand Hills. Going north the materials progressively have higher silt and clay increments. Some of the strata in this area and also some of those of the Upper Cretaceous area in northwestern South Dakota form benches, plateaus, and buttes because they are more resistant than other associated beds to weathering, mass wasting, and stream cutting.

Pleistocene geology. Pleistocene means "most recent" and this name is given to the events of glaciation. Glacier ice entered the state from the northeast or north and flowed south and west, the western margin of glaciation being the Missouri River. As the ice moved over the preglacial surface it filled valleys, planed off hills, forced the cutting of new valleys, piled up large ridges, and otherwise changed the preglacial topography.

The character of the rocks of the preglacial surface determined to a large extent, the composition of the glacial deposits formed from them. This is because most of the glacial deposits consist of altered rocks of local origin.

Glacial deposits cover South Dakota east of the Missouri River. Geologic evidence consisting of a boulder line of glacial stones shows that an early glacier pushed into western South Dakota 30 to 50 miles west of the present course of the Missouri River. Subsequent geologic erosion has removed this West River glacial drift except for scattered boulders, and a few isolated patches of glacial till, and the soil parent materials in this belt principally are sedimentary in origin.

Glacial deposits are divided physically into four groups: till, outwash, glacial lake deposits, and ice-contact stratified drift. All are present in eastern South Dakota as soil parent materials.

Till, which is the most abundant, is a mixture of all size particles. It is thought to have been deposited from the under part of the flowing ice. Barnes, Houdek, and Vienna are soil series developed from till.

Outwash was deposited by melt water as it flowed away from the ice and consists principally of mixed gravel and sand, usually crossbedded. Ordinarily the outwash material is overlain by alluvium, as in the case of the Fordville soils; or loess, as in the case of the Estelline soils.

Glacial lake deposits, called lacustrine materials, consist of parallel-bedded silt and clay with small admixtures of sand. They were formed in depressions or basins temporarily blocked by glaciers and filled with ponded water. The Beotia, Harmony, and Aberdeen are soil series developed in these deposits.

Ice-contact stratified drift accumulated upon or against melting glacier ice. It occurs as knobs or small convex hills usually in rough terrain. In South Dakota the Sioux series, which is associated with the Buse series on the soil association map, is an example.

Although several older glaciers traversed eastern South Dakota, glacial drift left by them has been largely obliterated or covered by drift deposited by more recent ice sheets.

Loess and other wind-deposited sediments. Loess is a nonglacial deposit of wind blown and deposited particles of silt size. The loess in South Dakota came from mixing of silt from nonglacial deposits to the west with silt which was blown out or deflated from outwash bodies and even from the till itself as the glaciers melted. The loess may consist of thin veneers to deposits 30 or more feet in thickness.

Strictly speaking, loess refers to particles of silt size. Sandy and silty clay loam materials, also carried and deposited by the wind, are called respectively **eolian sand** and **eolian silty clay loam.** They also are important South Dakota soil parent materials. The distribution of these wind-deposited sediments is shown in figure 2 along with the other soil parent materials of South Dakota.

Alluvium. Alluvium consists of stream-laid deposits of gravel, sand, silt, and clay, generally interbedded and almost always mixed. Generally, the alluvium of the West River is clayey in texture while that of the East River is mostly loamy.

RELIEF AND THE PHYSICAL DIVISIONS

Relief. Relief, as used[illegible], refers to t[illegible]lay-of-the-land. It may be level, un[illegible]ting, rolling[illegible]ly, rough broken, or mountainous. It may be smooth with a network of small streams, or it may be choppy with many closed basins dotting the landscape. Relief usually varies from acre to acre so it is difficult to show on small-scale soil association maps. However any particular area is usually dominated by certain relief characteristics. For example, most of the Black Hills area is mountainous while most of the glacial Lake Dakota Plain in Spink and Brown Counties is level.

Physical divisions of South Dakota. This section and the map (figure 3) are devoted to a description of the natural land forms of South Dakota as classified by Fenneman and Rothrock and revised by Flint. The most significant physical boundary is that separating the Central Lowland from the Missouri Plateau. As can be noted from the soil association map, this line and the line separating the Chernozem area from the Chestnut area coincide over the northern two-thirds of the state.

The Minnesota River-Red River Lowland (Division 1, figure 3) is a broad, gently undulating, valley-like area with an elevation of 900 to 1,100 feet above sea level. Browns Valley, Minnesota, located midway between Lake Traverse and Big Stone Lake, is the continental divide between drainage to the Artic Ocean and to the Gulf of Mexico. The northeastern slope of the Coteau des Prairies rises sharply nearly 1,000 feet to form the western limit of this lowland.

The Coteau des Prairies (Division 2) is a highland area between the Min[illegible]ta-Red River [illegible]wland and

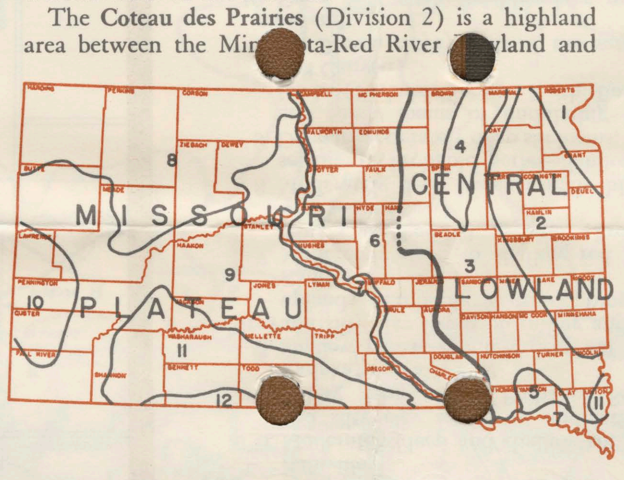


Figure 3. Physical divisions of South Dakota.

1. Minnesota River—Red River Lowland
2. Coteau des Prairies
3. James River Lowland
4. Lake Dakota Plain
5. James River Highland
6. Coteau du Missouri
7. Missouri River Trench
8. Northern Plateaus
9. Pierre Hills
10. Black Hills
11. Southern Plateaus
12. Sand Hills

Source: Flint, R. F. Prof. Paper 262, USGS

the James River Lowland to the west. It slopes gently to the south and west. Its eastern and western slopes are steep at the northern end and taper off on the south. Elevations range from 2,000 feet above sea level on the north to about 1,600 on the south. It is drained to the south by the Big Sioux River, whose tributary streams enter mainly from the east. West of the Big Sioux River, the surface of the Coteau is dotted with lakes, while very few lakes occur east of the river.

The James River Lowland (Division 3) is a gently undulating plain lying considerably lower than the Coteau des Prairies on the east and the Coteau du Missouri on the west. The James River drains through the area from north to south and occupies a rather narrow steep sided valley. Elevations range from 1,300 to 1,400 feet above sea level.

The **Lake Dakota Plain** (Division 4) is the nearly level surface formed by deposition of sediment when glacial Lake Dakota was ponded with water. The area is sandy at the northern end and of a silty clay loam and silty clay texture elsewhere.

The **James River Highlands** (Division 5) consist of a group of three ridges located at the southern end of the James River Lowland. They are remnants of former stream divides. From east to west, these highlands are Turkey Ridge, James Ridge, and Yankton Ridge.

Turkey Ridge, the largest of the three, is more than 40 miles long, 10 miles wide, and stands more than 300 feet higher than the surrounding country. Below the mantle of glacial drift is bedrock consisting of the Niobrara chalk, overlain in places by the Sharon Springs member of the Pierre shale. These strata are exposed in the Canyon of Turkey Creek; other exposures are rare, as the drift mantle is 30 to 200 feet thick.

Yankton Ridge forms the northern bluff of the Missouri Valley from Yankton westward for 16 miles. Below the drift its core is Niobrara chalk, overlain by Pierre shale.

James Ridge, located west of the James River a few miles above its mouth, is only 9 miles long, 1½ miles wide, and 100 to 260 feet high. Like the other two ridges, it is underlain by shale over chalk.

The **Coteau du Missouri** (Division 6) is part of the Missouri Plateau of the Great Plains province, separated from the main body of the Missouri Plateau by the Missouri River. This highland area is covered with glacial deposits and underlain by Pierre shale and older formations. Several broad shallow sags traverse the coteau, which marks the positions of former stream valleys of eastern continuations of the Grand, Moreau, Cheyenne, Bad, and White Rivers. These sags are shown in plate 7 of USGS Professional Paper 262.

The **Missouri River Trench** (Division 7) averages a little over a mile in width with the valley floor 300 to 600 feet below the tops of the steep dissected bluffs. The river flows south-southeast with a gradient of about a foot per mile. Erosion and deposition are believed to be in equilibrium. As early travelers to the region reported the water to be turbid, rapid erosion apparently was in progress before the advent of agriculture, although cultivation in the tributary region certainly has added to the sediment load.

The **Northern Plateaus** (Division 8) is a series of plateaus and isolated buttes underlain by the Fox Hills sandstone and younger Cretaceous strata. It ranges in elevation from 2,000 to over 3,000 feet above sea level.

Pierre Hills (Division 9) consist of a series of smooth hills and ridges with rounded tops. The region is underlain by the Pierre shale formation and has lower elevations (1,800 to 2,800 feet) than the plateau country which rims it to the north and south.

The **Black Hills** (Division 10) is a region of mountainous terrain consisting of a series of turned up sedimentary strata, called hogbacks, arranged concentrically around a core of ancient crystalline rocks. Elevations range from 3,200 feet to about 7,000 feet.

The **Southern Plateaus** (Division 11) are divided into two regions. The large area to the southwest consists of a series of benches and buttes, underlain by Tertiary sandstones, siltstones, and shale. Elevations range from 2,800 to 3,600 feet. The Badlands comprise the northwestern part. The second area occurs in southeastern South Dakota principally in Union County. This is a stream-dissected highland underlain by a thick mantle of loess. Elevations range from 1,200 to 1,500 feet.

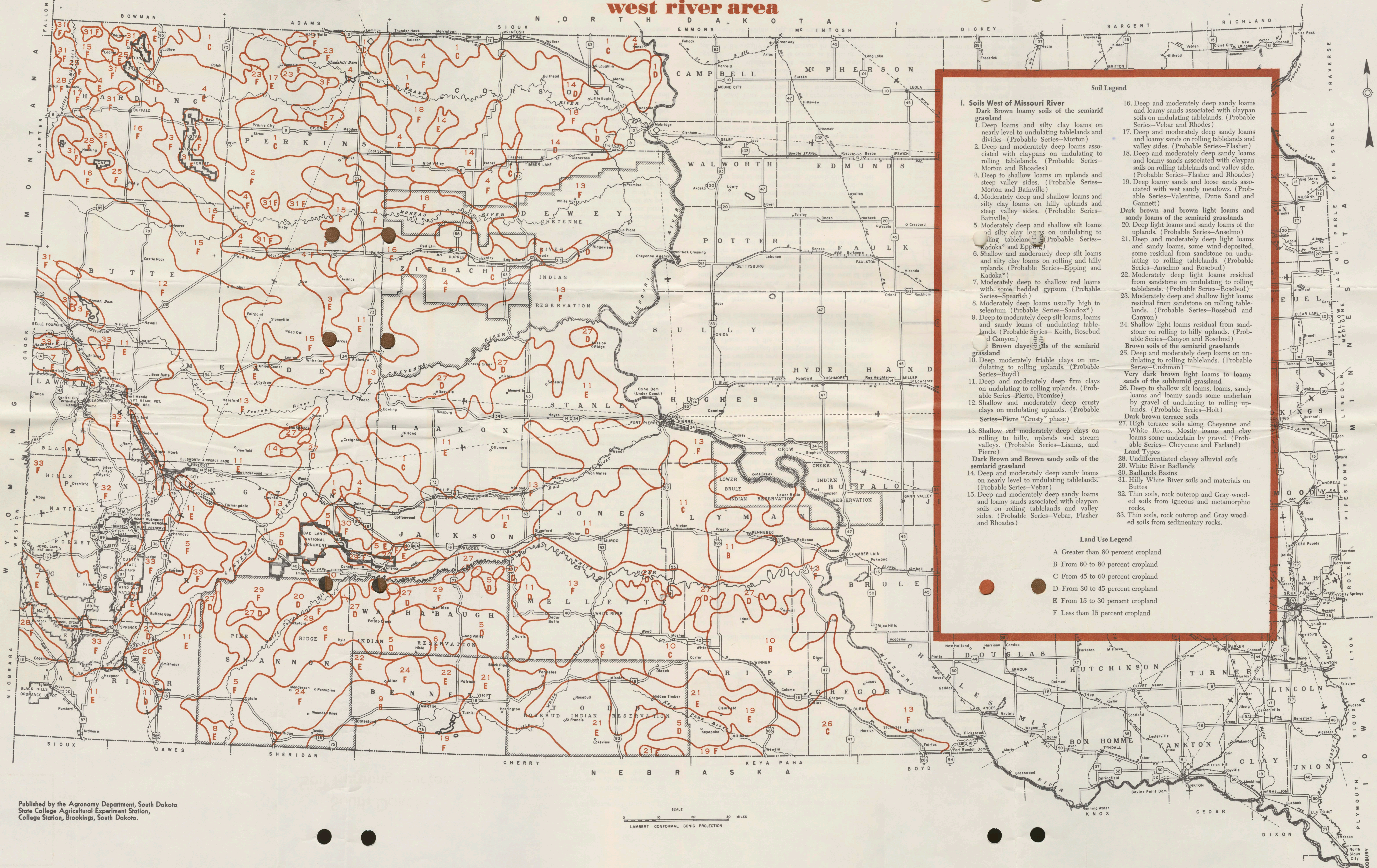
The **Sand Hills** (Division 12) is an extension of the Sand Hills region of Nebraska. It consists of a series of rounded hills interspersed with low, swampy areas, the whole region being underlain by eolian sand. Elevations range from 3,00 to 3,600 feet.

Time

Time is important in the formation of a soil. If the materials are easily eroded by wind and water, as in the case of the Pierre shale, the soil of steep slopes is destroyed almost as fast as it is formed. On undulating topography, soil formation on these materials and erosion go on at about the same pace. On flat slopes, due to the grass root mat which retards destructive processes, deeper soils develop which relatively are older from the standpoint of soil formation, than are the undulating and rolling soils. Thus the time factor is relative and varies across materials of the same geological age. Much research needs to be done in South Dakota evaluating the precise role of time as a soil forming factor.

Soils of South Dakota

west river area



Soil Legend

I. Soils West of Missouri River

Dark Brown loamy soils of the semiarid grassland

1. Deep loams and silty clay loams on nearly level to undulating tablelands and divides—(Probable Series—Morton)
2. Deep and moderately deep loams associated with claypans on undulating to rolling tablelands. (Probable Series—Morton and Rhoades)
3. Deep to shallow loams on uplands and steep valley sides. (Probable Series—Morton and Bainville)
4. Moderately deep and shallow loams and silty clay loams on hilly uplands and steep valley sides. (Probable Series—Bainville)
5. Moderately deep and shallow silt loams and silty clay loams on undulating to rolling tablelands (Probable Series—Kadoka* and Epping)
6. Shallow and moderately deep silt loams and silty clay loams on rolling and hilly uplands (Probable Series—Epping and Kadoka*)
7. Moderately deep to shallow red loams with some bedded gypsum (Probable Series—Spearfish)
8. Moderately deep loams usually high in selenium (Probable Series—Sandoz*)
9. Deep to moderately deep silt loams, loams and sandy loams of undulating tablelands. (Probable Series— Keith, Rosebud and Canyon)

Dark Brown clayey soils of the semiarid grassland

10. Deep moderately friable clays on undulating to rolling uplands. (Probable Series—Boyd)
11. Deep and moderately deep firm clays on undulating to rolling uplands. (Probable Series—Pierre, Promise)
12. Shallow and moderately deep crusty clays on undulating uplands. (Probable Series—Pierre "Crusty" phase)
13. Shallow and moderately deep clays on rolling to hilly, uplands and stream valleys. (Probable Series—Lismas, and Pierre)

Dark Brown and Brown sandy soils of the semiarid grassland

14. Deep and moderately deep sandy loams on nearly level to undulating tablelands. (Probable Series—Vebar)
15. Deep and moderately deep sandy loams and loamy sands associated with claypan soils on rolling tablelands and valley sides. (Probable Series—Vebar, Flasher and Rhoades)
16. Deep and moderately deep sandy loams and loamy sands associated with claypan soils on undulating tablelands. (Probable Series—Vebar and Rhodes)
17. Deep and moderately deep sandy loams and loamy sands on rolling tablelands and valley sides. (Probable Series—Flasher)
18. Deep and moderately deep sandy loams and loamy sands associated with claypan soils on rolling tablelands and valley side. (Probable Series—Flasher and Rhoades)
19. Deep loamy sands and loose sands associated with wet sandy meadows. (Probable Series—Valentine, Dune Sand and Gannett)

Dark brown and brown light loams and sandy loams of the semiarid grasslands

20. Deep light loams and sandy loams of the uplands. (Probable Series—Anselmo)
21. Deep and moderately deep light loams and sandy loams, some wind-deposited, some residual from sandstone on undulating to rolling tablelands. (Probable Series—Anselmo and Rosebud)
22. Moderately deep light loams residual from sandstone on undulating to rolling tablelands. (Probable Series—Rosebud)
23. Moderately deep and shallow light loams residual from sandstone on rolling tablelands. (Probable Series—Rosebud and Canyon)
24. Shallow light loams residual from sandstone on rolling to hilly uplands. (Probable Series—Canyon and Rosebud)

Brown soils of the semiarid grasslands

25. Deep and moderately deep loams on undulating to rolling tablelands. (Probable Series—Cushman)

Very dark brown light loams to loamy sands of the subhumid grassland

26. Deep to shallow silt loams, loams, sandy loams and loamy sands some underlain by gravel of undulating to rolling uplands. (Probable Series—Holt)

Dark brown terrace soils

27. High terrace soils along Cheyenne and White Rivers. Mostly loams and clay loams some underlain by gravel. (Probable Series— Cheyenne and Farland)

Land Types

28. Undifferentiated clayey alluvial soils
29. White River Badlands
30. Badlands Basins
31. Hilly White River soils and materials on Buttes
32. Thin soils, rock outcrop and Gray wooded soils from igneous and metamorphic rocks.
33. Thin soils, rock outcrop and Gray wooded soils from sedimentary rocks.

Land Use Legend

A Greater than 80 percent cropland

B From 60 to 80 percent cropland

C From 45 to 60 percent cropland

D From 30 to 45 percent cropland

E From 15 to 30 percent cropland

F Less than 15 percent cropland

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