# SOIL SURVEY OF THE SAN ANTONIO AREA, TEXAS.

By THOMAS A. CAINE and W. S. LYMAN.

## LOCATION AND BOUNDARIES OF THE AREA.

The San Antonio area is situated in Bexar County, which lies in southwestern Texas, about 125 miles northwest of the Gulf of Mexico

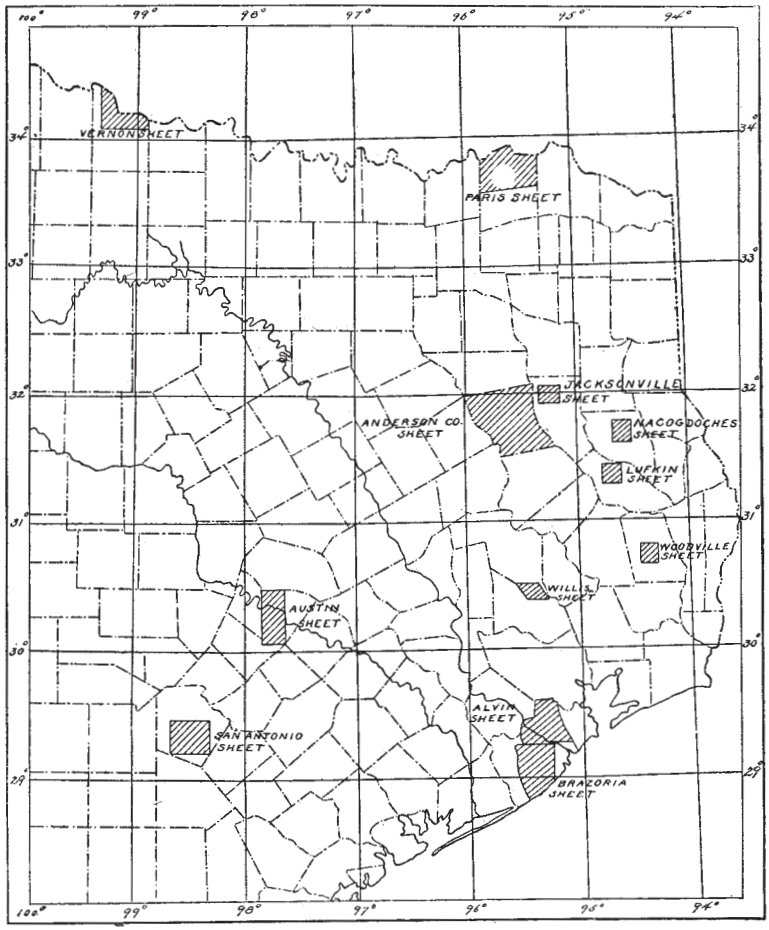


FIG. 18.—Sketch map showing location of the San Antonio area, Texas.

and about the same distance northeast of the Rio Grande. The area includes 310,016 acres, or approximately 484 square miles, in the

southern part of the county, or a little more than one-third of the entire area of the county. San Antonio, the chief town and a railroad center, is situated in the northern part of the area surveyed, and a number of other towns, the most important of which are Elmendorf and Macdona, lie within the area.

The area is comprised between meridians 98° 17′ 30″ and 98° 41′ 30″ west longitude and parallels 29° 12′ 30″ and 29° 30′ north latitude.

## HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first settlements in this area were made in 1716 by missionaries sent out by the Spanish Government. Missions were established south of the present city of San Antonio, and farming was instituted by means of irrigation from the San Antonio River.

In 1734 the town of San Antonio received its first charter. From this time until the beginning of the nineteenth century the progress of the colony was slow, owing to Indian hostilities and inefficient government. There had gradually developed, however, a considerable trade with New Orleans, via the Red River, and with the northern provinces of Mexico. Americans began to come in, and, though not permitted at first to acquire title to property, "squatted" in large numbers. In 1820 official permission was secured to establish an American colony, and as a result immigration of this class was largely increased.

In 1836 the independence of Texas was declared, and nine years later it was admitted as a State of the American Union. Since that time the region around San Antonio has steadily increased in population and wealth.

The earlier surveys divided this part of the State into large tracts of land, generally adjoining streams of water. The chief industry at that time was stock raising, the stock being branded and allowed to run at large. The country was chiefly a prairie, covered with a luxuriant growth of native grasses, but the sod was in time destroyed by continued feeding and trampling, and mesquite bushes have since covered the ground. Some crops were grown with the aid of irrigation.

The area suffered very little from the effects of the civil war, being removed from the region of actual conflict.

In 1877 the Galveston, Houston and San Antonio Railroad reached the area and proved a strong stimulus to progress and agricultural development. Other railways now traverse the area in all directions. Another circumstance which has aided materially in the progress of the area is its popularity as a winter resort, due to its healthful climate, pure spring water, and historic associations. This has attracted large numbers of visitors, chiefly from the North, East, and West,

and many of these have remained and invested in city or country property, with the result that real estate values have increased throughout the area. They have become so high that it is no longer profitable to carry on ranching in the old way, and the larger tracts have been cut up, fenced, and devoted to farming, particular attention being paid to truck and fruit growing. In the region south and southwest of San Antonio water for irrigating purposes can be obtained by drilling artesian wells, and the increased water supply has resulted in the use of better methods and the cultivation of larger areas than heretofore.

## CLIMATE.

The area lies in the semiarid region of the Southwest. Farther west the climate becomes arid, while immediately to the northeast it becomes subhumid or humid. The characteristic plants of the area, such as the mesquite, the huisache, the guaxillo, and the napol, the post oak, black-jack oak, live oak, and hickory, are all such as would naturally be found in a region lying midway between arid and subhumid conditions.

Farming can be carried on at all seasons of the year, and in favorable years two or three crops are sometimes grown. On the truck farms vegetables grow during the entire year.

Occasionally there is a frost as late as April, which kills peaches and plums.

One of the familiar experiences of winter months is the "norther." A cold wave, often accompanied by high wind, comes down from the Middle West, causing almost immediately a great fall in temperature. The summers are warm, but not disagreeably so, as the nights are always cool.

## PHYSIOGRAPHY AND GEOLOGY.

Three different geological periods are represented in the area: The Cretaceous, the Tertiary, and the Pleistocene.

The Cretaceous is the oldest and underlies the others. Both the upper and lower divisions of the Cretaceous occur, but the former is better represented, as it underlies so large a portion of the Rio Grande Plain. The rocks of the Upper Cretaceous are composed of pure white limestone and chalk and the former is so soft that it is cut or sawed into blocks for building purposes. When dried it becomes quite hard and durable. The residual soils from these rocks are deep, black, and waxy. The Lower Cretaceous rocks are much harder and contain considerable quartz. As a result of the slowness with which it weathers, the Lower Cretaceous region stands at a greater elevation than the Upper Cretaceous and forms the "mountains" on the western border of the area. When compared with the

"mountains," the Upper Cretaceous region, or Rio Grande Plain, is characterized by its low relief, though its surface is broken by undulations and water courses, and in places there are hills of considerable height.

The lowest beds of the Tertiary are represented in the southern and southeastern parts of the area, where they overlap the Upper Cretaceous. The Tertiary is characterized by ferruginous sands, sandy clays, and impure marls. There are also some small lignite beds. The underlying grayish-yellow sand rock is sometimes exposed on the hillsides and in the road cuts by erosion. This region is not so level as the Cretaceous immediately to the westward, and in places it is badly cut up by erosion. On the hilltops, which are sometimes quite broad and level and where the eroson is least, the deep sandy type, Orangeburg fine sand, occurs. Farther down, where the soil has been removed by erosion and the sandy clay subsoil exposed, the material was classified as Orangeburg clay.

The Pleistocene occurs as a superficial deposit of flint gravel, with some limestone gravel, both of which are embedded in a matrix of chalky material. The gravel is frequently cemented by the chalky matrix into a firm conglomerate. Most of the materials are derived from the decay of the hard limestone of the Lower Cretaceous found in the hills just west of the area. This material has been spread out like a mantle over the lower plains. The thickness of the deposit depends upon the irregularities of the surface which it overlies; sometimes it is a thin veneering upon the underlying Cretaceous lime rock, and sometimes it is 50 feet deep. This formation is typically developed on the hills in the eastern part of the city of San Antonio and on the Seguin road southwest of Converse. Another typical occurrence is on the Frio City road south of Leon Creek. In places where the underlying porous gravel comes within 20 inches of the surface this formation gives rise to the Houston gravelly clay. In places where the underlying gravel is more than 20 inches below the surface, and where the chalky material is proportionately greater and has weathered into a black, clayey material resembling the residual soils of the Upper Cretaceous beds, the soil derived is either the Houston black clay or the Houston black clay loam, depending upon the texture of the soil and subsoil.

The drainage of the area is toward the southeast, and all the water is carried by the San Antonio River and its tributaries. The lowest point in the area is on the Medina River south of Elmendorf, where the elevation above sea level is approximately 400 feet. The highest point is northwest of San Antonio, on the limestone hills which rise above Culebra Creek, where the altitude is approximately 900 feet. Hence the range in elevation throughout the area is about 500 feet.

From Elmendorf northwest toward San Antonio the rise is a grad-

ual one, but from San Antonio northwest the surface becomes hilly, owing to a zone of faults which crosses the area near San Antonio in a northeast and southwest direction. The fault zone seems to consist of a number of parallel faults, the sum of which represents a downthrow of 200 feet or more. This zone of faulting, together with the superficial deposit which has covered the older formations in the vicinity of San Antonio, has added to the complexity of the geology around the city. It is also due to the faulting that the artesian basin ends so abruptly west of San Antonio.[a]

## SOILS.

There were found and mapped in the San Antonio area twelve distinct soil types. The area and proportionate extent of each type appear in the table given below.

*Areas of different soils.*

| Soil. | Acres. | Per cent. | Soil. | Acres. | Per cent. |
|---|---|---|---|---|---|
| Houston black clay loam | 54,272 | 17.5 | Austin fine sandy loam | 21,440 | 6.9 |
| Houston gravelly clay | 53,696 | 17.3 | Colton stony clay | 16,768 | 5.4 |
| Orangeburg fine sand | 36,736 | 11.9 | Portsmouth sandy loam | 15,488 | 5.0 |
| San Antonio clay loam | 28,608 | 9.2 | Austin clay | 4,480 | 1.4 |
| Orangeburg clay | 27,520 | 8.9 | Norfolk sand | 3,904 | 1.3 |
| Norfolk silt loam | 24,128 | 7.8 | Total | 310,016 | |
| Houston black clay | 22,976 | 7.4 | | | |

### HOUSTON GRAVELLY CLAY.

The Houston gravelly clay is a brownish to black gravelly clay, varying in depth from a few inches to 2 feet, but with an average depth of about 20 inches. Below this is a porous mass of quartz gravel, each fragment about the size of an egg or larger. The thickness of this gravel varies from about 10 inches to several feet, but the average is about 3 feet. Below the gravel is an unconsolidated white limestone, of unknown thickness, which is locally known as adobe and which is so friable that it can be shoveled like flour. This material is often exposed in the road cuts, and in the northwestern part of the area it comes so near the surface as to give the soil a whitish color.

The Houston gravelly clay is confined to the limestone portion of the area, and is found typically developed in the eastern part of the city of San Antonio, and also in the northeastern corner of the area, 10 miles from San Antonio. It is also found in the region between Leon Creek and the Medina River.

[a] Much of the matter contained in this chapter was taken from the Eighteenth Annual Report of the U. S. Geological Survey.

This soil is residual, being derived from the weathering of the underlying limestone. The presence of the gravel is due to an accumulation near the surface of quartz particles, which were originally scattered through the rock mass, and which, being too heavy to be removed by rain wash, and extremely insoluble, have remained behind, while the finer and soluble parts of the rock have been removed in solution or in suspension. A few feet of gravel may thus represent the residuum from 100 feet of the rock.

Owing to the resistant nature of the quartz gravel the areas occupied by this type stand at a higher level than the surrounding country, and this fact, together with the porosity of the subsoil, renders the drainage excellent.

Less than 1 per cent of the area occupied by this type is under cultivation. Owing to the porous nature of the subsoil and the hilly surface, irrigation is usually impracticable, and at present the type is for the most part covered with mesquite and cactus and is used almost exclusively for pasturage.

There is a considerable variation in texture in different areas of this type, but its value is too low to justify recognition of its two principal phases as distinct types. In its less typical phase, where the underlying gravel is exposed, it is absolutely worthless, even for pasture. In its more typical phase, where there is a foot or more of black loam above the gravel, it supports a good growth of native grass and makes excellent pasturage, and in the valleys, as well as on some level spots, where this phase occurs, cotton and corn are grown quite successfully during wet seasons. Cotton has been known to yield 1 bale and corn 40 bushels per acre in the most favorable seasons.

The following table gives mechanical analyses of the fine earth of this soil type:

*Mechanical analyses of Houston gravelly clay.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10538 | 8 miles NE. of San Antonio. | Black clay loam, 0 to 12 inches. | 0.5 | 0.9 | 0.4 | 6.4 | 17.9 | 41.8 | 32.0 |
| 10540 | 6½ miles NW. of San Antonio. | Black heavy clay, 0 to 6 inches. | .4 | .9 | .8 | 2.5 | 5.0 | 44.8 | 45.6 |
| 10539 | Subsoil of 10538..... | Black clay, 12 to 20 inches. | .6 | 1.5 | .7 | 7.0 | 15.4 | 34.5 | 40.3 |
| 10541 | Subsoil of 10540..... | Clay and gravel, 6 to 30 inches. | .5 | 1.1 | .7 | 2.6 | 4.8 | 45.5 | 44.8 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10538, 6.1 per cent; No. 10539, 3.1 per cent; No. 10540, 0.6 per cent; No. 10541, 6.6 per cent.

HOUSTON BLACK CLAY.

The soil of the Houston black clay is a heavy clay, with an average depth of about 7 inches, varying in color from grayish brown to black. The subsoil to 36 inches and more is of about the same texture as the soil, but is a little more compact and of a lighter color.

When dry and properly handled the soil is friable and easily worked, but when wet it becomes very sticky and gummy, resembling the "gumbo" of the Red River Valley of the North. This soil is bored with great difficulty, and when the dry borings are pressed between the fingers the material is found to be hard and compact, while with the Houston black clay loam the material crumbles and has a granular appearance and feel. In its typical phase both soil and subsoil are free from gravel and rock fragments of any kind, but in the present area there is a phase which is closely related to the better phase of the Houston gravelly clay, where gravel occurs at a depth ranging from 4 to 7 feet. In such areas there are strewn upon the surface and disseminated through both soil and subsoil fragments of quartz varying in size from a pea to pieces 3 or 4 inches in diameter.

The type is confined to the limestone portion of the area, and is found typically developed in the region between Salado and Rosillo creeks. In its less typical phase it is found in spots along the San Antonio River in the vicinity of San Antonio, and west and southwest of the city.

The Houston black clay is a residual soil, formed from the slow, even weathering of white limestone belonging to the Upper Cretaceous, and because this limestone weathers so evenly the typical areas of this soil are flat and poorly drained. This feature of poor drainage has given rise to the "hog-wallow" characteristic of the soil. These "hog wallows" are depressions varying in depth from 6 to 20 inches, with a diameter of 3 or 4 feet. They occur at intervals of about 25 feet, and are accounted for by the fact that in dry weather the soil bakes and cracks. Where the cracks cross the surface material rattles down, forming a slight depression. During a rain water collects in these depressions and causes the clay to swell and expand laterally. This process, repeated through long periods of time, forms very noticeable depressions.

Owing to the semiarid condition of the area and the "droughty" nature, or lack of capillarity, of the soil only about 1 per cent of this type is under cultivation. It is largely covered with mesquite and supports an excellent growth of native grass. It is beyond question the best type in the area for pasturage, and is owned in large tracts, nearly all fenced for pasture.

The Houston black clay is one of the strongest and most important soil types in the State. In the northern counties, where conditions of

rainfall are more favorable, this type has contributed largely to the prosperity of the farming class and of the neighboring cities. Under the most favorable conditions it will easily produce 1 bale of cotton or 50 bushels of corn per acre. In Lamar County it has an average value of $50 an acre for the production of these two crops. In the San Antonio area very little use has been made of the type, and then only by means of irrigation. A limited area is irrigated at present in the vicinity of San Antonio.

The following table shows the texture of typical samples of this soil:

*Mechanical analyses of Houston black clay.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | P. ct. | P. ct. | P. ct. | P. ct. | P. ct. | P. ct. | P. ct. |
| 10551 | 5 miles NE. of San Antonio. | Black stiff clay, 0 to 8 inches. | 0.3 | 0.4 | 0.6 | 7.8 | 11.8 | 44.4 | 34.7 |
| 10549 | San Antonio | Stiff clay, 0 to 6 inches | .3 | .6 | .7 | 14.2 | 15.4 | 30.6 | 38.3 |
| 10552 | Subsoil of 10551 | Clay, 8 to 40 inches | .1 | .4 | .5 | 6.0 | 10.9 | 45.8 | 36.3 |
| 10550 | Subsoil of 10549 | Clay, 6 to 30 inches | .6 | .8 | .6 | 12.2 | 14.2 | 27.3 | 44.3 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10549, 3.1 per cent; No. 10550, 4 per cent; No. 10551, 3.4 per cent; No. 10552, 3 per cent.

HOUSTON BLACK CLAY LOAM.

The soil of the Houston black clay loam is a heavy grayish-brown to dark-brown loam or clay loam. The depth of the soil varies from 8 to 15 inches, with an average of about 10 inches. The subsoil has the same texture, but the color changes gradually from brownish gray to yellowish at a depth of 4 or 5 feet, and becomes still yellower at a greater depth. Usually a few small rock fragments are seen scattered upon the surface, and are found disseminated throughout both soil and subsoil, but where the development is typical the underlying rock is found at a great depth and fragments are absent.

The Houston black clay loam is a friable, easily worked soil. It retains moisture well, and in times of drought gives it up to the plants. These features, together with its productiveness, make it a most desirable type, especially under the semiarid conditions which exist in the San Antonio area. About 50 per cent of the type is under cultivation, while farther north, outside the area, where the conditions of rainfall are more favorable, about 95 per cent of it is cultivated, principally to cotton and corn.

This soil is found in all parts of the portion of the area underlain by limestone, but is most typically developed and occurs in the largest

bodies on the gently rolling prairies. It is closely associated with the Houston black clay, but differs from the latter in that it is not so stiff and waxy. The distinction is very evident in a semiarid climate. Owing to the inability of the Houston black clay to give up moisture in times of drought it is permitted to grow up to mesquite and is used almost exclusively for pasture, while adjoining areas of Houston black clay loam are usually cleared and under cultivation. The Houston black clay loam is sometimes found in higher locations, as, for example, on the foothills and in the valleys between the gravel ridges of Pleistocene age.

In its most typical phase it is a residual soil, derived from the weathering of white limestone. It is also found in the valleys, having been carried down by rain wash, or, in some instances, redeposited along streams.

Owing to the porosity of both soil and subsoil the drainage features are excellent. The crops usually grown are cotton, corn, and sorghum, the latter for forage. The soil is naturally productive, and when irrigated it is also well adapted to truck farming and to growing such fruit as can be produced in the region. In a favorable year the average yield of cotton per acre is two-thirds of a bale, while corn yields about 30 bushels. Sorghum fodder generally yields 3 tons for the season, while the native prairie grass produces an average of 1 ton of hay per acre.

The following table shows the texture of the soil and subsoil of this type:

*Mechanical analyses of Houston black clay loam.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10574 | 3 miles N. of San Antonio. | Brown loam, 0 to 12 inches. | 0.3 | 0.6 | 0.8 | 12.1 | 17.1 | 42.5 | 26.6 |
| 10576 | 2 miles W. of San Antonio. | Clay loam, 0 to 14 inches. | .3 | .5 | .4 | 4.3 | 13.6 | 51.4 | 29.3 |
| 10577 | Subsoil of 10576 | Clay loam, 14 to 36 inches. | .5 | .8 | .4 | 8.8 | 15.2 | 43.1 | 30.9 |
| 10575 | Subsoil of 10574 | Brown clay loam, 12 to 36 inches. | .6 | 1.2 | .9 | 12.8 | 16.7 | 34.3 | 33.1 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10574, 1.6 per cent; No. 10575, 8.6 per cent; No. 10576. 6.6 per cent; No. 10577, 4.9 per cent.

### NORFOLK SAND.

The Norfolk sand is a coarse to medium sand, varying in color from brownish gray to gray, and having an average depth of about

10 inches, underlain by a sand of the same texture, but lighter colored, owing to its lower content of organic matter. The depth of the subsoil is usually very great, but occasionally, in limited areas, at a depth of 3 or 4 feet it becomes yellowish in color and of a sandy clay nature.

The Norfolk sand occurs only in small areas in the southeastern and southern parts of the survey, but a few miles farther south it is found in a wide belt, extending in a northeast and southwest direction and following approximately the shore line of the old Tertiary sea. It represents the coarser material carried into this sea by inflowing streams and dropped along the shore, where it was ground up by wave action and piled into beaches. In some cases the finer particles were afterwards blown into sand dunes by the wind. The fine to medium quartz material of which the type is almost entirely composed represents one stage in the reduction of rock fragments from gravel to clay. The particles which were reduced to very fine sand, silt, and clay were either carried away in suspension and deposited in deep, quiet water far from shore, or were deposited in the quiet water of the lagoons along the shore. The occurrence of this lagoon-deposited material and its special adaptation to pottery purposes account for the large and prospering pottery and tile industries in the vicinity of Elmendorf.

Approaching the region from the north the country occupied by the Norfolk sand appears as a series of abrupt hills, which represent the wind-blown material near the ancient shore. After passing over these hills to the southward the region becomes undulating and slopes gradually toward the southeast. Owing to this gradually sloping and gently undulating surface, together with the natural looseness of the soil and subsoil, the drainage features are excellent.

Under present semiarid conditions the areas occupied by this type are almost worthless for farming purposes, and probably less than 1 per cent of the type is under cultivation. Occasionally, in a wet year, the low, flat portions of the type are utilized for watermelons and cantaloupes, and the results are sometimes astonishing. The soil is naturally productive for truck farming, if water for irrigation could be secured. The characteristic growth is scrub black-jack oak and hickory, and the occurrence of the former has given rise to the local term "black-jack land." Besides the scrub forests, the soil supports only a very scanty growth of grass. Land of this type of soil has an average value of $2.50 an acre.

The table on the following page shows the texture of typical samples of this soil.

*Mechanical analyses of Norfolk sand.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10566 | Elmendorf | Gray sand, 0 to 10 inches. | 0.1 | 2.3 | 9.9 | 60.3 | 18.3 | 6.6 | 2.6 |
| 10564 | 1 mile SW. of Bexar | Gray medium sand, 0 to 10 inches. | .6 | 12.9 | 23.6 | 39.1 | 13.6 | 6.8 | 3.1 |
| 10565 | Subsoil of 10564 | White sand, 10 to 36 inches. | .6 | 13.7 | 24.4 | 39.2 | 11.9 | 7.3 | 2.9 |
| 10567 | Subsoil of 10566 | Gray sand, 10 to 40 inches. | .1 | 2.5 | 11.4 | 58.3 | 18.5 | 6.1 | 3.0 |

NORFOLK SILT LOAM.

The soil of the Norfolk silt loam is a loam of medium texture, and has an average depth of from 6 to 8 inches. When dry it is yellowish brown to dark brown in color, but when wet it appears much darker. The plowed fields show that the type is sometimes marked by yellowish-brown and dark-brown spots, usually a rod or more across. The subsoil from 6 to 36 inches is brownish to brownish yellow in color, and is usually a little looser and lighter in texture than the soil. The subsoil gradually becomes yellower in lower depths, and is sometimes quite yellow at about 5 feet below the surface.

The Norfolk silt loam occurs as a belt about 4 miles wide in the southeastern part of the area, and separates the types derived from the Cretaceous limestones from those derived from the Tertiary sandstones. It is typically developed on the east side of Rosillo Creek, 10 miles southeast of San Antonio.

It is a residual soil, derived from a yellowish sandstone, a little more argillaceous in character than that occurring farther to the eastward, which weathers into the Orangeburg fine sand and Orangeburg clay.

The surface of the region where this type occurs is very much broken and eroded. The soil and subsoil seem to be comparatively free from rock fragments, but the crests of the hills and the hillsides are often strewn with red and yellow gravel, the harder parts of the sandstone, left behind in the process of weathering. Large bowlders of the underlying rock are often seen outcropping along the roads.

Owing to the broken and eroded surface of the Norfolk silt loam the rain water is carried off through the depressions and ravines to lower levels, comparatively little being absorbed by the soil. The presence of numerous small rock fragments and fine gravel increases the destructive work of erosion. Owing to these conditions the type is one of the least desirable in the area, and only about 2 per cent

of it is under cultivation. Some of the remainder is so poor that it has never been fenced for pasture. In the vicinity of Martinez, east of San Antonio, where the type occurs in level tracts, and is somewhat mixed with Orangeburg clay, it is cultivated to some extent for cotton and corn, and fair crops are obtained in the most favorable seasons.

The following table gives mechanical analyses of the fine earth of typical samples of the soil and subsoil of this type:

*Mechanical analyses of Norfolk silt loam.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10572 | 4½ miles SE. of San Antonio. | Brown loam, 0 to 6 inches | 0.4 | 0.9 | 0.6 | 11.7 | 23.1 | 48.3 | 15.1 |
| 10573 | Subsoil of 10572 | Yellow loam, 6 to 36 inches. | .4 | .5 | .5 | 9.6 | 26.0 | 36.3 | 26.7 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10572. 4 per cent; No. 10573, 6 per cent.

ORANGEBURG FINE SAND.

The soil of the Orangeburg fine sand is a brownish-red to grayish-red fine to medium sandy loam, with an average depth of 2 feet. It is underlain by a red and sometimes yellowish sandy clay to a depth of 40 inches or more.

The type is a residual soil, derived from the weathering of the unconsolidated material of late Cretaceous and early Tertiary time. In the lower depths of the subsoil the sandy clay represents the material as originally deposited. The surface soil has since been more or less modified by rain wash, a part of the finer particles, such as silt and clay, having been carried away in suspension by the surface drainage waters and a part washed to lower depths in the soil by percolating water.

This type is found on the undulating and flat tops of hills and ridges in the southern and southeastern parts of the area, between the "black-jack" belt on the south and the limestone region on the north. Its location on the tops of hills and ridges is due to the fact that under the conditions of scanty rainfall which exist in the region these are the areas least subject to erosion. Farther down on the hillsides, where the erosion is greater, the soil has been removed, exposing the subsoil, and these areas were mapped as Orangeburg clay.

Owing to its location the type has good drainage. The power of the

soil to absorb falling moisture, and that of the sandy clay subsoil to retain it, place it among the best types of the area for cotton, corn, fruits, and vegetables. About 75 per cent of the area of this type is under cultivation. It is easily worked, and can usually be cultivated regardless of the state of moisture. In a good year cotton will average half a bale, and some fields yield as high as 1 bale per acre. The average yield of corn is about 35 bushels. The type is well adapted to peaches and plums, but as yet there are not very many large orchards. In the vicinity of Senior some tomatoes are grown, and are marketed at San Antonio. The supply of tomatoes has already outgrown local demands, and it will not be long until canning factories are established. The type is especially well adapted to melons and cantaloupes, and many carloads are shipped annually from Elmendorf.

The following table gives mechanical analyses of typical samples of the soil and subsoil of the Orangeburg fine sand:

*Mechanical analyses of Orangeburg fine sand.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10568 | 1 mile N. of Senior | Fine sandy loam, 0 to 12 inches. | 0.1 | 0.2 | 0.2 | 37.2 | 35.8 | 14.2 | 12.1 |
| 10570 | 1 mile NW. of Elmendorf. | Fine sandy loam, 0 to 20 inches. | .6 | .6 | .7 | 45.8 | 21.1 | 15.0 | 16.1 |
| 10571 | Subsoil of 10570 | Sandy clay, 20 to 40 inches. | .3 | .7 | .7 | 35.0 | 42.0 | 13.9 | 7.5 |
| 10569 | Subsoil of 10568 | Red sandy clay, 12 to 36 inches. | .6 | .5 | .2 | 31.5 | 34.9 | 16.8 | 15.4 |

ORANGEBURG CLAY.

The Orangeburg clay is a heavy red sandy loam or red clay loam, with an average depth of 15 inches, underlain by a red sandy clay, very similar in texture, but a little more compact. The subsoil often has some yellow material mixed with the red.

The Orangeburg clay is confined to the sandy region in the southern part of the area and is closely associated with the Orangeburg fine sand. South of Macdona it is found typically developed on the ridge which rises above the Austin fine sandy loam. From this locality the areas of the type extend eastward to Losoya. Beyond that place the areas are found north of the Medina River, extending in a disconnected belt in a northeastern direction and leaving the area about 10 miles east of San Antonio.

This type is a residual soil, derived from the same formation as the Orangeburg fine sand, but it has been more subject to the agencies of erosion, with the result that its texture and composition are more like the subsoil than the soil of the Orangeburg fine sand. The brownish-yellow sandstone which underlies the latter type at so great a depth as to be very seldom exposed is often exposed in the road cuts and on the hillsides of the type under discussion.

The Orangeburg clay is found on the crests of narrow ridges, on the slopes of hills, and in large, rolling areas where the sand has been removed by rain wash. Its drainage features are excellent in most places. In some of the more level and gently undulating areas the soil is so impervious to water that little is absorbed, even after a copious rainfall. Such areas are very unproductive, and support only a scanty growth of mesquite or cactus. The characteristic plant in such places is the guyean or Mexican soap plant. One phase of the type, which is extensively developed in the vicinity of Losoya, and also near Martinez, 8 miles east of San Antonio, is more loamy and absorbs moisture well. In ordinary years this phase produces fair crops of cotton and corn, and near Losoya a large peach orchard has been set out. The trees are watered every few days by going through the field with a tank. Nothing definite can be said of the undertaking as yet, as it has been under way only a short time.

About 5 per cent of the Orangeburg clay is under cultivation to cotton, corn, and sorghum fodder. In its original state it is not very satisfactory as a pasture land, because it is so "droughty" that the grass "burns" out. It is a fairly productive soil, and under favorable conditions of rainfall would be a satisfactory type for agriculture.

The following table gives mechanical analyses of the soil and subsoil of this type:

*Mechanical analyses of Orangeburg clay.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10559 | 8 miles E. of San Antonio. | Red fine sandy loam, 0 to 4 inches. | 0.5 | 0.4 | 0.6 | 22.8 | 47.4 | 23.3 | 5.1 |
| 10557 | Elmendorf | Loam to clay loam, 0 to 8 inches. | 1.9 | .9 | .5 | 27.2 | 26.5 | 19.2 | 23.7 |
| 10594 | Subsoil of 10559 | Red sandy clay, 4 to 36 inches. | .8 | .3 | .3 | 13.6 | 25.7 | 25.6 | 33.4 |
| 10558 | Subsoil of 10557 | Red sandy clay, 8 to 30 inches. | 1.8 | 1.4 | .7 | 19.7 | 18.2 | 24.0 | 34.0 |

AUSTIN FINE SANDY LOAM.

The soil of the Austin fine sandy loam is a brownish-yellow or reddish-gray fine sandy loam. There is no marked difference in texture between the soil and subsoil, and the latter, as shown along the steep river bluffs, often extends to a depth of 40 feet without change. From the surface to a depth of about 3 feet the color gradually becomes lighter. In the plowed fields typically light-colored soil is often broken with black and yellow patches, the former color being due to the slight depressions in the surface and the consequent accumulation of moisture and organic matter—the latter to outcropping of the subsoil. At about 10 feet below the surface the characteristic color of the material as shown in the river bluffs is grayish-yellow. Through the material occur many shells, and the soil is known locally as "shelly land."

This soil is found in a strip varying in width from 1 to 3 miles, extending across the southern part of the area and following the course of the Medina River. A less typical development occurs along the course of some of the larger tributaries of that river.

The type is of sedimentary origin, having been formed by the annual overflow of the streams when their channels stood at a higher level. The surface of the type is very level—almost flat in most places—and elevated from 40 to 60 feet above the present level of the streams. These streams generally have deep, narrow, winding channels, but in some places their valleys widen out, forming first bottom land, subject to annual overflow. The level tops of the bluffs are known as "second bottoms." Next to the bluffs the inflowing rain wash has in some instances cut deep arroyos and subterranean passages. The formation of this type of soil probably dates back to the Tertiary period, when the area occupied by it was an estuary, which in later years gradually filled with sediment.

This type readily absorbs the falling rains, and the drainage is very good. In a dry season it is inclined to be a little droughty, as the soil does not retain moisture so well as some of the heavier types. This condition is quite noticeable at times; and it can be seen that the "black spots" already referred to support a heavier growth of cotton and corn, chiefly because they receive more moisture and retain it better than other parts of the type.

The Austin fine sandy loam is one of the most satisfactory types in the area, and about 60 per cent of it has at one time or another been under cultivation. Some small irrigation plants have been started, the water from the Medina River being pumped to the higher levels. Some of the plants use steam and others gasoline. In a wet season it is not necessary to irrigate at all. The success of irrigation on this

type has not been so great as with that carried on by means of artesian water on the San Antonio clay loam, nearer the city of San Antonio, but the difference is largely due to greater distances from market and the greater expense of installing a pumping plant. The texture and level surface of the Austin fine sandy loam make it an ideal type for irrigation, if there were a ready outlet for the products grown and if the expense of installing and operating the plants could be reduced.

The Austin fine sandy loam was one of the first types occupied by the early settlers, largely because of its river-front advantages for stock. At present cotton, corn, fruit, and some vegetables are grown. In a good season cotton will yield from one-half to 1 bale per acre and corn about 35 bushels. An excellent peach orchard is growing on the "first bottom," in the vicinity of Macdona. Considerable sorghum fodder also is grown upon "first-bottom" areas, and under ordinary conditions alfalfa would also produce abundant crops.

The following table gives mechanical analyses of the soil and subsoil of this type:

*Mechanical analyses of Austin fine sandy loam.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10562 | 2 miles SW. of Elmendorf. | Brown fine sandy loam, 0 to 12 inches. | 0.1 | 0.7 | 2.1 | 32.7 | 24.3 | 26.0 | 13.8 |
| 10563 | Subsoil of 10562 | Fine sandy loam 12 to 40 inches. | .1 | .8 | 2.1 | 28.5 | 22.5 | 21.2 | 14.7 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10562, 47 per cent; No. 10563, 52 per cent.

AUSTIN CLAY.

The soil of the Austin clay is a light-brown to gray clay, varying in depth from 5 to 20 inches, with an average depth of about 10 or 12 inches. This is underlain to unknown depths by an unconsolidated, white chalky or floury material known locally as "adobe." Fragments of this limestone are sometimes found scattered upon the surface and disseminated throughout the soil and subsoil.

The Austin clay is found typically developed on the tops and slopes of the highest hills in the area, about 8 miles northwest of San Antonio. It is a residual soil, derived from the slow, unequal weathering of an impure white chalk of the Upper Cretaceous. Because of slowness in weathering, the areas occupied by this soil lie at a higher ele-

vation than the surrounding country, and the characteristic topography is a succession of hills with long, even slopes. The drainage is very good, although, considering its location and drainage features, the soil retains moisture exceedingly well. It is sometimes spoken of as a "cool soil," and its white color may have some effect in regulating the soil temperature and thus indirectly the moisture supply. These features combine to make it very desirable for hay and pasturage. It is said to produce a better quality of "sage-grass" hay than any other type in the area. In favorable years it also produces fair crops of cotton and corn. The average yield of wild hay is from two-thirds of a ton to 1 ton per acre.

The following table shows the texture of typical samples of the soil and subsoil of this type:

*Mechanical analyses of Austin clay.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10532 | 5 miles NW. of San Antonio. | Brown loam, 0 to 18 inches | 0.4 | 0.8 | 0.4 | 3.5 | 12.8 | 44.6 | 37.3 |
| 10534 | 7 miles NW. of San Antonio. | Loam, 0 to 18 inches | .6 | 1.3 | 1.0 | 3.9 | 7.7 | 37.6 | 47.4 |
| 10535 | Subsoil of 10534 | Gray loam, 18 to 36 inches | .2 | .4 | .4 | 2.3 | 5.9 | 49.0 | 41.3 |
| 10533 | Subsoil of 10532 | White loam, 18 to 40 inches. | .2 | .3 | .2 | 2.0 | 7.7 | 47.1 | 42.2 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10532, 59.8 per cent; No. 10533, 73.4 per cent; No. 10534, 62.4 per cent; No. 10535, 63.1 per cent.

### COLTON STONY CLAY.

The Colton stony clay consists of from 3 to 6 inches of loose, dark-colored clay, underlain by a rotten white limestone. It occurs typically developed in the city of San Antonio at Laurel Heights, and outside the city limits on Alamo Heights. It is also found in large, continuous areas in the high upland region in the northwestern part of the area. The shallow covering of soil on the surface is residual, having been derived from the underlying limestone. The elevation of the hills occupied by this type is due both to the resistance of the limestone to the agencies of weathering, and to the fact that the hills represent approximately a zone of faulting which occurred along the seacoast at the close of the Cretaceous period.

The Colton stony clay is characterized by its scrubby, stunted growth of liveoak and mesquite and cactus. Fragments of the underlying rock are often found strewn on the surface. Under present con-

ditions this type of soil is of no agricultural value, except for the scanty pasturage it affords. It would make an excellent soil for goat ranches or vineyards.

The following table shows the texture of fine earth of this soil:

*Mechanical analysis of Colton stony clay.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10536 | 9 miles W. of San Antonio. | Gravelly loam, 0 to 4 inches. | 10.8 | 8.7 | 3.0 | 6.0 | 11.8 | 38.2 | 21.2 |

PORTSMOUTH SANDY LOAM.

The soil of the Portsmouth sandy loam is a bluish-gray to dark-colored sandy loam of fine to medium texture, having an average depth of about 18 inches. In dry weather it becomes so hard and compact that it can not be cultivated, and the roads become so hard that the hoofs of horses sound as if they were trotting on a pavement. In wet weather it absorbs moisture well. The subsoil is the same in texture as the soil. At about 3 or 4 feet below the surface it generally becomes yellow or red in color. The type is locally known as "black sand."

The Portsmouth sandy loam is confined to the sandy region in the southern part of the area and is usually closely associated with the Orangeburg clay. It is a residual soil, derived from the weathering of an underlying shaly sandstone belonging to the Tertiary. The surface is gently rolling and in some places nearly level, and the drainage good, except in times of unusual rainfall. There is greater danger of too little moisture than of too much. Comparatively little of the type is under cultivation, except in level areas and along stream courses, where the usual crops of the region are grown with fair success. Owing to the dense growth of mesquite which it supports, the clearing of this soil for cultivation is rather expensive.

Greater success would be attained on the Portsmouth sandy loam if it were cultivated in such a way as to preserve the soil moisture. This could be done by always keeping 2 or 3 inches of loose soil on the surface to destroy capillarity.

If properly handled the Portsmouth sandy loam produces fair yields of peaches, plums, and vegetables.

The table following shows the texture of typical samples of the soil and subsoil of this type.

*Mechanical analyses of Portsmouth sandy loam.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10555 | Elmendorf | Dark compact sand, 0 to 8 inches. | 0.4 | 3.0 | 7.6 | 40.2 | 13.7 | 14.3 | 20.7 |
| 10553 | Kirk | Brown sandy loam, 0 to 6 inches. | .1 | 2.0 | 3.7 | 22.2 | 19.9 | 29.4 | 22.5 |
| 10554 | Subsoil of 10553 | Brown sandy loam, 6 to 36 inches. | .1 | 1.9 | 3.5 | 19.9 | 19.5 | 29.0 | 26.0 |
| 10556 | Subsoil of 10555 | Brown sand, 8 to 36 inches. | .6 | 2.8 | 5.4 | 26.8 | 10.4 | 19.8 | 33.9 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10553, 1.4 per cent; No. 10554, 2.3 per cent; No. 10555, 4.8 per cent; No. 10556, 13.2 per cent.

SAN ANTONIO CLAY LOAM.

The soil of the San Antonio clay loam is a brownish or chocolate-colored loam or clay loam, varying in depth from 8 to 12 inches, with an average of about 10 inches. As a rule, there is no definite line of demarcation, either in texture or color, between the soil and the subsoil. Below 12 inches and extending to about 24 inches the color grows gradually lighter, while the texture usually becomes a little heavier; thence to a depth of 36 inches the color changes to reddish, the texture becoming lighter, and the material usually grading into coarse limestone gravel or unconsolidated limestone conglomerate.

This soil is typically developed southwest of San Antonio, where there are large areas of it under irrigation. It extends along Leon Creek from the point where it enters the northwest corner of the area nearly to its junction with the Medina River. Another large area occurs east of San Antonio, along Salado Creek.

The San Antonio clay loam is derived from the even weathering of a pure, unconsolidated white chalk belonging to the Upper Cretaceous formation. This chalk is closely related to the limestone of the region, but differs from it in that it weathers more rapidly and uniformly and has no hard quartz particles in it. The San Antonio clay loam is therefore quite free from rock fragments of any kind, while the Austin clay and Houston gravelly clay soils derived from the limestone have rock fragments on the surface and disseminated through both soil and subsoil.

The areas occupied by the San Antonio clay loam are all quite level, but owing to the semiarid conditions of the region and the porosity of the soil their drainage is not difficult.

About 70 per cent of the type is under cultivation. That portion of it which lies in the artesian belt is irrigated, and is used exten-

sively for trucking to supply local demands. It is a very productive soil, and owing to its level surface and the consequent ease with which it can be irrigated it is highly esteemed. Its average value in the vicinity of San Antonio is $100 an acre, and it brings an annual rent of $25 an acre. Northwest of San Antonio, along Leon and Culebra creeks, it is used almost entirely in the production of hay. In this locality the hills rise abruptly above the type, and it receives much of the drainage water from higher surrounding areas. Its valley position in this vicinity tends to make it one of the most desirable types in the area for the production of wild hay. The average yield is about 1 ton per acre.

East of San Antonio it is used for cotton, corn, and sorghum, the latter grown for forage. When the season is favorable the average yield of cotton is from one-half to three-fourths bale per acre, of corn about 35 bushels, and of sorghum from 2 to 3 tons.

Where irrigation is possible the type is the most desirable and valuable in the area. It makes an ideal truck soil and is excellent for such fruit as is suited to the climate. It is also adapted to cotton and corn, and alfalfa has been successfully grown. The texture of the soil is such that it absorbs moisture freely, and in times of drought the subsoil moisture rises readily. Although there is considerable sand in this soil, it can not be worked when wet, because of its tendency to pack and bake.

The following table shows the texture of the soil and subsoil of this type:

*Mechanical analyses of San Antonio clay loam.*

| No. | Locality. | Description. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 10542 | 5½ miles SW. of San Antonio. | Black loam, 0 to 12 inches. | 0.3 | 0.7 | 0.8 | 9.0 | 19.3 | 46.5 | 23.4 |
| 10544 | 10 miles W. of San Antonio. | Brown clay loam, 0 to 10 inches. | .7 | 2.4 | 1.6 | 7.4 | 12.5 | 46.6 | 28.8 |
| 10546 | San Antonio | Brown clay loam, 0 to 10 inches. | .2 | .6 | .9 | 9.1 | 20.2 | 39.8 | 29.2 |
| 10543 | Subsoil of 10542 | Brown loam, 12 to 36 inches. | .4 | .7 | .7 | 8.6 | 17.0 | 45.2 | 27.1 |
| 10547 | Subsoil of 10546 | Light brown loam, 10 to 30 inches. | 1.4 | 1.4 | 1.2 | 8.0 | 19.3 | 40.2 | 28.6 |
| 10545 | Subsoil of 10544 | Heavy loam, 10 to 36 inches. | 1.4 | 1.8 | 1.2 | 5.3 | 11.2 | 49.0 | 30.1 |

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 10542, 0.9 per cent; No. 10543, 9.8 per cent; No. 10544, 19.3 per cent; No. 10545, 26.4 per cent; No. 10546, 2.1 per cent; No. 10547, 12.9 per cent.

## IRRIGATION.

The town of San Antonio, or San Fernando, as it was originally called, was founded with a view to utilizing the water of San Pedro Springs and the San Antonio River, and irrigation has played an important part in the development of the area.

Each of the five missions established along the river had its own irrigating ditches, and cultivated its own crops. After the arrival of the Canary Island colonists in 1730 it became evident that irrigation ditches were a public necessity, and water rights were granted to the various communities, and secured to subsequent settlers.

The irrigated areas were extended from time to time, to meet the demands of an increasing population, until in 1858 the city of San Antonio took charge of the ditches and appointed a ditch commissioner. The system was improved and other areas farther down the river were supplied with water.

After the advent of railways the delightful winter climate of the city attracted a large number of tourists, many of whom purchased permanent homes. A large part of the territory within the city, which had formerly been under irrigation, was gradually taken up for residences. The drilling of so many artesian wells for the city waterworks and other purposes so affected the underground supply as seriously to diminish the flow of the springs which supply the river, and as a result the supply for the ditches was insufficient. In view of these facts, and also in the interests of sanitation, the ditches, all of which headed above the city and flowed through it, sometimes serving the double purpose of ditch and sewer, were closed, except the San Pedro and Upper Labor ditches, which supply the gardens in the vicinity of the city.

Since the discovery of artesian water in the region south of San Antonio, irrigation has received a new impetus, and it is estimated that there are now 2,000 acres under irrigation in the area, and that there are in addition 4,000 acres which lie within the irrigable basin and can be irrigated.

Of the areas under irrigation, about 600 acres are irrigated by gravity, 400 acres by artesian water, and 1,000 acres by pumping. The city sewerage is carried in pipes and ditches to a point several miles south of the city and used for irrigation purposes. Some of the pumping plants referred to are situated in the southern part of the area along the Medina River.

It would thus seem that in spite of the diminution of the underground water supply, due to the drilling of so many artesian wells, the possibility of extending the irrigated area is by no means exhausted. The sewerage water from the city is being utilized, and water is now taken from the river below the city. It is quite probable, too, that a

further artesian water supply can be found at a considerable distance south of the present source of supply, provided the wells are drilled deeper, as the dip of the water-bearing strata which supplies all the artesian wells in the vicinity of San Antonio is about 80 feet to the mile toward the southeast.

The crops grown under irrigation are cotton, corn, oats, grass, and garden vegetables. Orchard fruits, such as peaches, plums, and figs, also do well when irrigated. Garden vegetables are grown more extensively than any other crop, and are practically all consumed in the city of San Antonio. As larger areas are irrigated, and the supply outgrows the local demands, other markets will doubtless be found.

### AGRICULTURAL METHODS.

The uncertainty of the seasons makes it unprofitable for the farmers to depend wholly upon crop production, and the high price of land makes it unprofitable for them to depend entirely upon stock raising. There are a few large ranches in the area which are used exclusively for grazing, but their owners purchased the land at an early date, when it was much cheaper than now. When lands cost more than $4 an acre it is considered that a profitable return on the investment can not be secured by raising stock exclusively. There is very little land in the area that can be purchased for less than $10 an acre. Nearly every farmer, however, raises some stock as an auxiliary to farming.

Aside from vegetables, cotton has become the principal money crop of the area. Plowing is usually done just before planting, and sulky disk plows are generally used. Before plowing, the cotton stalks are cut and burned or cut in short pieces and plowed under. In the black-clay lands level cultivation is practiced instead of planting the cotton upon ridges, as is done farther north, where the rainfall is more abundant. In the sandy region the cotton is planted in trenches so as to reach the subsoil moisture. When the cotton is cultivated the trenches are gradually filled up, so that by the time it is matured the ground is level or perhaps slightly elevated next to the rows.

In the sandy region near Elmendorf cotton has become the main source of revenue, and the credit system prevails, since the planter has money only once a year, when he sells his cotton in the fall. Some overestimate their ability to pay and can not meet their obligations to the local merchants, who are sometimes forced into bankruptcy as a consequence. The only remedies for such a condition are a more diversified system of farming and a ready market for the products grown. In the vicinity of Senior considerable interest is

being taken in peaches, plums, and tomatoes, and a canning factory will likely be established at an early date.

One difficulty experienced by fruit growers is that the trees are short-lived, peach and plum trees having an average life of about eight years. This is possibly due in part to the so-called "sun-scald" injury affecting the southwest side of the tree, killing the bark. The lives of the trees may be prolonged by allowing them to branch close to the ground, thus providing shade for the trunk. The same result could be obtained by keeping the trees trimmed, and by driving a scantling, 3 or 4 inches wide, into the ground near enough to the tree to supply the necessary shade.

As yet very few cowpeas are grown in the area. The productiveness of such types as Portsmouth sandy loam and Orangeburg clay would be greatly increased by growing cowpeas, the roots of which would penetrate the hard, impervious soil and subsoil, and when the plants died the hollows in their roots would leave air spaces, and thus make the soil mellower and more retentive of moisture, besides adding to its productiveness by the increase of organic matter and nitrogen. Better cultivation would also aid in the retention of soil moisture. At present the fields are not well cultivated. There seems to exist a mistaken idea that in times of drought the ground will become drier if the fields are frequently cultivated. If shallow cultivation is practiced and kept up in dry periods, so as to retain a " dust blanket " on the ground, this destroys capillary connection from below, and the moisture is not evaporated from the surface as rapidly as where a crust is allowed to form. In such cultivation, however, care should be taken not to turn the soil over, but simply to loosen it.

The cotton yields of the area have been seriously diminished by the ravages of the boll weevil.

Heretofore the cotton planters have entirely neglected such matters as seed selection. They have sold to the oil mills their early seed, which is more vigorous for reproduction, and have retained for planting the late seed, which is of low vitality; or else they have bought unknown varieties from dealers, when by careful selection they might have developed a better strain of long staple. The farmers are beginning to realize this error, and in the near future some system of seed selection will be adopted.

## LIVE-STOCK INTERESTS.

At the time of the first American settlement the Texas ranges were stocked with Spanish cattle from Mexico, and the State soon became noted as one of the great cattle-grazing regions of the world.

At an early date it was discovered by Texas stockmen that their

cattle took on flesh much more rapidly in the cooler climate of the north. Besides, there was no home market for Texas stock. At that time cattle were so cheap that large numbers were often slaughtered for their hides and tallow. Hence the Texas ranchmen began to drive their cattle northward to the prairies of Kansas, Nebraska, and Dakota, there to be fattened and sent to market.

Some cattle were taken north before the civil war, but the great northward movement did not begin until 1866. After that time, during the spring and summer months, hundreds of thousands of cattle were driven up the trail to northern pastures. This manner of marketing continued until about 1887, at which time shipments by railroad began. At present Texas cattle are shipped quite generally to the corn-feeding States for fattening.

Formerly the cattle raised in this area were chiefly "natives" or "scrubs," very few belonging to good beef and dairy breeds. Most of the stock raised is for beef or feeding. Some of the farmers milk only enough cows to supply their own families with milk and butter, while others have small quantities to sell. No creamery butter is manufactured. Near the city of San Antonio are some large dairy herds of good breeding, which supply the city with milk.

Owing to the irregular and scanty rainfall of the area, there is often a shortage of feed, especially of a succulent nature, and farmers are often forced to feed cactus plants, after burning off the spines. One large dairyman near San Antonio has found silage feeding so profitable that he is building new silos before filling the old ones a second time. Silos can be constructed at a low cost, and their use affords a cheap and convenient means of storing feed. It is possible to fill them twice a year by using for the first filling an early variety of corn, such as the "Mexican June corn." Where irrigation is possible, alfalfa could be grown and fed with profit.

A large number of the farmers allow their stock to drink the stagnant water held in ravines by dams built across their lower ends.

San Antonio, which a few years ago was one of the large horse markets of the United States, has practically ceased to be a market at all. On two or three ranches Texas ponies are trained for the game of polo, and these bring fancy prices. The few mules that are raised are all taken by the local market. Not many hogs are raised, owing to the uncertainty of the corn crop.

In recent years steps have been taken toward the improvement of the native cattle, and now that northern cattle can be made so immune to the malignant Texas fever that less than 8 per cent of the cases prove fatal, the standard of Texas cattle should be materially and rapidly improved. No additional expense is involved in raising the better grades of beef cattle, aside from that of placing a high-grade

animal at the head of each herd, and progressive stockmen have already learned the advantages of introducing the improved beef breeds.

## AGRICULTURAL CONDITIONS.

The rainfall of the San Antonio area is too variable and usually too light for successful general farming, although many farmers of the area follow this system. It is probably most successful in the southern and southwestern parts of the area, on the sandy soils having clayey subsoils, and here the farmers are fairly prosperous. Elsewhere, outside the irrigated districts, the agricultural class, owing chiefly to the uncertainty of the seasons, is not in a very enviable condition, and it would be even worse if it were not for the popularity of San Antonio as a winter resort.

An army of health and pleasure seekers annually make this city their home, and much money is brought into the country in this way. Land values have risen in the last few years from $2 to $10 or $15 an acre for unirrigated tracts, and land under irrigation, which has always been much more valuable, is now held at from $150 to $200 an acre, with little for sale at any price.

About three-fourths of the farms of the area are worked by the owners. The uncertainty of the seasons tends to discourage the tenant class, whether they work on shares or pay a cash rent.

The greater number of farms range in size from 160 to 640 acres. The size varies greatly in the different types of soil, the largest farms being found on such types as the Colton stony clay or Houston gravelly clay, while the smaller farms are found on the types best adapted to diversified farming. Nearly all the old Mexican grants fronted on the rivers and often extended back several miles. In the subdivision of property among heirs each claimant wished to retain a river frontage. On the Medina and San Antonio rivers some of the grants have been divided and subdivided so many times that some of the holdings are now less than 100 feet wide and extend back from the river from 4 to 10 miles. The existence of these "shoe string" tracts, as they are called, is very unsatisfactory, and tends to retard the progress of the country. At the present time river-front advantages are regarded as desirable, but not absolutely necessary, in view of the fact that water can be obtained almost anywhere by drilling. Nearly every farm has from one to three windmills for pumping purposes.

The labor of the area is of a rather cosmopolitan character. There are Mexicans, Russians, Germans, Belgians, Italians, Americans, and negroes. The Belgians and Italians devote themselves almost exclusively to vegetable farming in the irrigated districts, and espe-

cially in the vicinity of San Antonio. Their work is very satisfactory, and they are much sought after. The Germans usually work by the month until they get a start, and then buy property of their own. They are thrifty, and make good citizens, being among the most successful farmers in the area. The Mexicans and negroes are employed largely by the day.

The crops grown are cotton, corn, fruit, vegetables, sorghum for fodder, native prairie hay, and winter oats.

The growing of vegetables is carried on principally in the vicinity of San Antonio, where the local markets are convenient and where irrigation is practicable. All of the soil types of the area, with the possible exception of the Colton stony clay, are naturally productive, needing only water. The San Antonio clay loam is very satisfactory for vegetables, and is used largely for that purpose near San Antonio. Ten miles northwest of San Antonio, along Leon and Culebra creeks, this type is used quite successfully for the production of native prairie grass, known as "sage grass." It contains enough sand to render it easily worked, and still has enough clay to make it retentive of moisture after irrigation. For trucking purposes it is recognized as more desirable than the Houston black clay, because the latter is too sticky and waxy, and upon drying has a tendency to bake and crack, thus "choking out" growing plants.

The Orangeburg fine sand is regarded as the best type in the area for all-around diversified farming without the aid of irrigation. The reason for this is that the loose sandy loam readily absorbs moisture, while the sandy clay subsoil is very retentive. Cotton and corn are the principal products grown upon this type. Watermelons and cantaloupes, as well as some smaller fruits, are grown, and the former are shipped in large quantities. The type is also well adapted to peaches and plums.

The Austin fine sandy loam is a very satisfactory type for all crops grown in the area when the season is not exceptionally dry. The subsoil being of a rather loose texture, the moisture is not easily maintained through very dry seasons. The type is used largely for cotton, corn, and sorghum for fodder.

The Austin clay is the most desirable type in the area for the production of prairie hay, the quality being excellent and the quantity averaging about three-fourths of a ton per acre. A ready market for the hay is found in San Antonio.

The Houston black clay loam, which resembles the Houston black clay, but is free from the disadvantages of the latter in that it does not bake and "choke out" the plants, is a desirable type for cotton and corn in favorable years. A large percentage of the type is under cultivation to the above crops, and some native prairie grass is also grown for the San Antonio market.

The Houston gravelly clay, Colton stony clay, and Houston black clay are types which are cultivated very little and are largely devoted to pasturage. It is upon such types that the largest farms are found, one of these containing about 7,000 acres.

The Orangeburg clay, in its typical phase, is regarded as too droughty for agriculture without irrigation, but by careful handling it produces fair yields of cotton in the most favorable seasons.

The Norfolk sand in the present area is nearly all worthless, because its subsoil does not retain moisture. In a few of the lower locations, where it has considerable moisture, it does very well for watermelons and cantaloupes.

The area is well supplied with railroads, connecting it with all parts of the United States and parts of Mexico. San Antonio is the railway center of the area. The Southern Pacific Railway (Galveston, Houston and San Antonio) passes through the area, giving it access to both the Atlantic and Pacific coasts. The International and Great Northern Railway connects with northern points and Mexico. Besides having these through lines, San Antonio is the terminus for the Missouri, Kansas and Texas Railway, the San Antonio and Gulf Railway, and the San Antonio and Aransas Pass Railway. The wagon roads of the area are excellent. The county is at present expending $500,000 for road construction. The flint and lime gravel of the region is being utilized for road building in the "black land" portion of the area, and in the sandy region the roads are being surfaced with clay.

The many railways give the area ready access to the markets of the country, but as yet very little fruit and vegetables are shipped out of the area, because the consumption at San Antonio has been greater than the supply.

# Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

**Nondiscrimination Statement**

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.