U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF THE MIDDLE GILA VALLEY AREA, ARIZONA.

BY

E. C. ECKMANN, IN CHARGE, MARK BALDWIN, AND
E. J. CARPENTER.

MACY H. LAPHAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

WASHINGTON:
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1920.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 15, 1919.

SIR: I have the honor to transmit herewith the manuscript report and map covering the survey of the Middle Gila Valley Area, Arizona, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1917, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL SURVEY OF THE MIDDLE GILA VALLEY AREA, ARIZONA.

By E. C. ECKMANN, In Charge; MARK BALDWIN and E. J. CARPENTER—Area Inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

The Middle Gila Valley area is situated in the south-central part of Arizona, mainly in Pinal County, only 2 square miles being in Maricopa County. It lies in a region of isolated or discontinuous, barren, rocky peaks and ranges, mainly of eruptive and crystalline formations, which rise from sloping or nearly level desert plains. This part of the State is recognized physiographically as the Desert region, in contrast to the much higher lying Plateau region of sedimentary rocks occupying the northern and northeastern parts of the State. As the title implies, the survey includes the middle valley of the Gila River, which presents a contrast to both the upper valley, in the eastern part of the State, and the lower desert valley above the confluence of the Gila River with the Colorado.

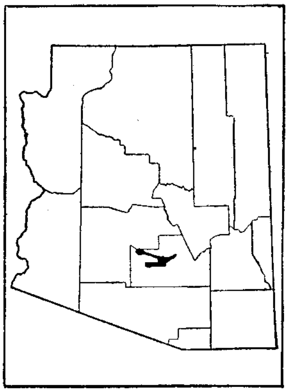


FIG. 1.—Sketch map showing location of the Middle Gila Valley area, Arizona.

The area surveyed is irregular in outline, and roughly Y-shaped. Beginning at the mouth of the Gila River Canyon, about 5 miles northeast of Florence, it spreads out westward and southwestward as a fan-shaped area, which is soon divided into two arms by the Sacaton Mountains, which it practically surrounds on the north, east, and south. The northern arm, lying between the Sacaton Mountains on the south and the Santan Mountains on the northeast, extends westward to Pima Butte. It includes the alluvial bottoms of the Gila River, with parts of the adjacent higher lying plains. The southern arm is confined to a tier of townships extending westward from Picocho Reservoir in townships 5 and 6 south to the middle of range 5 east. Small parts of the adjoining townships to the south are also included. The area includes the Sacaton, Casa Blanca, Agency, and Blackwater units, and parts of the Casa Grande and Florence units, of the Gila River irrigation project of the Office of Indian Affairs. The Casa Grande National Monument and part of the Gila River Indian Reservation also are within the survey. The total extent of the area is 352 square miles, or 225,280 acres.

The area is made up almost entirely of river bottoms or smooth, nearly level plains, the adjoining mountains having been practically excluded, except for several small hills or buttes. The most prominent of these are Twin Butte, Granite Knob, part of Cholla Mountain, and part of the eastern slope of Pima Butte. The slopes of the included hills are stony and steep.

Elevations within the area range from about 1,150 to 1,525 feet above sea level. Casa Grande has an elevation of 1,396 feet; Casa Grande Ruins (Casa Grande National Monument), 1,422 feet; Florence, 1,493 feet; and Sacaton, 1,280 feet.

The Gila River, which crosses the area from east to west, is the second largest stream in Arizona. The lands lying along this stream are directly drained by it, but the greater part of the area is drained directly by McClellan Wash, which reaches the Gila River within the area. Santa Cruz Wash carries the drainage from the southern part of the area, around Casa Grande, and enters the Gila River a short distance west of the area. The McClellan and Santa Cruz Washes are not everywhere well defined, and they are inadequate to drain a number of large flat areas. The Gila River has a channel varying in width from less than one-fourth mile to a mile or more. The banks of this stream are generally poorly defined and unstable. Shifting of the channels and cutting of the banks take place at each overflow, and the process is increasingly destructive as the stream-bottoms are used more extensively for agriculture. The stream has an average gradient of about 10 feet per mile through the area.

The McClellan and Santa Cruz Washes are the continuation of the drainage of the Santa Cruz River, which ceases to maintain a definite channel below a point in the southern part of Pinal County, its waters spreading over the level plain or flowing slowly down the numerous shallow washes between Picocho Reservoir and Casa Grande. The lands along the McClellan and Santa Cruz Washes are subject to overflow from flood waters that come from the region of Tucson, southeast of the area surveyed. The McClellan Wash has a fall of about 20 feet in its course from the Picocho Reservoir to its confluence with the Gila River.

The retarded drainage of the southern part of the area gives rise to many shallow lakes or playa flats, which are dry except during heavy rains. These flats are dotted with and bordered by shifting sand dunes.

In 1910 the population of Pinal County was 9,045—an increase of 16 per cent over that reported in 1900. While the area surveyed covers only about 350 square miles in Pinal County, whose total extent is 5,380 square miles, it includes by far the most thickly settled part of the county. The number of Indians in 1910 on that part of the Gila River Indian Reservation in Pinal County was 2,970, or about one-third the total population of the county. About 64 per cent of the total population is white. There are a few Negroes, Chinese, and Japanese. About 46 per cent of the population consists of native white persons and 18 per cent of foreign-born white persons. Of the foreign born, people from Mexico form by far the largest number, the Mexicans numbering 1,360 in 1910.

The population of the cities and towns is made up chiefly of white persons. The Indian population is of the Pima tribe and confined almost entirely to the reservation. Most of the younger Indians have had some education in the schools maintained by the Government and are able to use the English language. The Mexican population speaks Spanish.

Cities and towns in the Middle Gila Valley area are few and small. Florence and Casa Grande are the only incorporated places. Sacaton, an Indian village, the location of the Indian Agency and of an experimental station maintained by the United States Department of Agriculture, lies within the area covered by the survey. Blackwater, Casa Blanca, Santan, and Sweetwater are the most important of the Indian villages within the reservation. Florence, with a population of 807, is the largest town in the area and the county seat of Pinal County. Casa Grande is the principal railroad and shipping point of the area. Sacate is a station on the Arizona Eastern Railroad, in the western part of the area.

Three railroad lines touch the area, but none traverse it for any distance. The Southern Pacific Railroad cuts across the extreme southwestern part, passing through Casa Grande. The Arizona Eastern Railroad crosses the extreme western portion. Florence has access to a branch of the latter railroad which follows the north bank of the Gila River in this part of the area. The town is on the south side of the stream, and during flood periods shipping from this point is sometimes delayed and frequently hazardous.

Some work has been done on public roads in this area, but large tracts are still without roads. During dry weather most of the roads are readily passable, but in the rainy season travel is frequently very difficult. There are no bridges across the Gila River at the present time and fording is often impossible.

The products raised in the Middle Gila Valley area are mostly of nonperishable nature and suitable for shipment with ordinary facilities. In many places farming has not been undertaken or is not sufficiently well developed to meet the local demands for agricultural products, which must be brought from outside points.

CLIMATE.

The climate in this region is characterized by a long, warm growing season; a shorter cooler season, during which frosts occur; and a scanty supply of rain, insufficient to insure crops without irrigation. Two so-called wet seasons occur, one in the spring and one in late summer. Except for the hot summer months the climate may be said to be exceptionally pleasant and favorable for the production of crops.

The weather records kept at various places in and near the area are incomplete. In some instances statistics are available for only a short period of years, although Casa Grande and Maricopa have kept partial records since 1876. The data nevertheless indicate in a general way the conditions of temperature and rainfall. Phoenix is representative of a large region of which the area surveyed is a part. The mean annual precipitation at Phoenix for 8 years, from 1896 to 1903, inclusive, was 6.8 inches. The average number of days with a precipitation of 0.01 inch or more was 34 per year. The precipitation for the driest year was 3.7 inches and for the wettest year 12.8 inches. At Maricopa, about 5 miles southwest of the area, on the open desert or plain, the mean annual precipitation for a period of years extending from 1876 to 1907, except 1878 and 1879, was 6.06 inches. The amount for the driest year recorded (1900) was 2.09 inches, and for the wettest year (1905), 13.51 inches. The table below, compiled from records of the Weather Bureau, shows the mean annual, seasonal, and monthly rainfall and temperature, the maximum and minimum temperatures, and the rainfall for the wettest and driest years.

Normal monthly, seasonal, and annual temperature and precipitation at Maricopa.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year. (1900).	Total amount for the wettest year. (1905.)
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	50.9	89	19	0.82	0.00	0.85
January	50.2	88	8	.59	.00	1.60
February	54.4	92	23	.62	T.	2.70
Winter	51.8	92	8	2.03	T.	5.15
March	60.4	98	25	.52	.20	1.72
April	66.7	104	32	.20	.40	1.71
May	74.3	110	39	.09	T.	T.
Spring	67.1	110	25	.81	.60	3.43

Normal monthly, seasonal, and annual temperature, etc.—Continued.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1900).	Total amount for the wettest year (1905).
	°F.	*°F.*	*°F.*	*Inches.*	*Inches.*	*Inches.*
June	85.9	126	49	.08	.00	T.
July	90.8	123	48	.78	.24	.33
August	90.5	119	65	.99	T.	.72
Summer	89.1	126	48	1.85	.24	1.05
September	83.3	117	46	.52	T.	.41
October	70.3	110	30	.43	T.	.00
November	58.1	101	22	.60	1.25	3.47
Fall	70.6	117	22	1.55	1.25	3.88
Year	69.6	126	8	6.24	2.09	13.51

While precipitation may occur in any month in the year, two wet seasons are the general rule. The spring and fall months are usually warm and dry. The following table gives the best data available as to the annual precipitation at five stations:

Annual precipitation at five stations, Middle Gila Valley Area.

Year.	Casa Grande.	Casa Grande Ruins.	Maricopa.	Florence.	Sacaton.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1876			3.87	9.33	
1877			6.27	5.35	
1878				13.49	
1879				12.02	
1880			4.16	5.35	
1881	1.58			12.14	
1882	T.		0.38		
1883	2.11		7.27		
1884	9.26		11.96		
1885	2.02		2.97		
1886	5.02		6.12		
1887	7.71		7.61		
1888	3.65		3.99		
1889	3.95		9.32	13.25	
1890	10.70		8.63	13.85	
1891	3.62		3.01	8.24	
1892	8.75		6.05	9.95	
1893	4.92		6.00	9.63	
1894	5.82		6.57		
1895	6.30		6.07		
1896	6.43		6.69		
1897	4.23		6.06		
1898	5.67		5.90		
1899	3.20		4.95		
1900	3.21		2.09		
1901	5.04		4.69		
1902	6.40		4.89		
1903	4.65		4.72		
1904	7.18		3.15		
1905	19.52		13.51		
1906	9.53		9.10		
1907	5.70		7.57		
1908					
1909		7.26		8.87	8.89
1910	5.57	6.35	4.33	6.63	5.45
1911		9.83			
1912	9.56	13.17	8.89	8.96	12.12
1913	7.15	7.85	5.03	9.81	8.22
1914	9.87	16.08		12.41	16.75
1915		12.11	9.37	15.32	15.28
1916			10.33	12.66	10.39
Annual mean.	6.28	10.38	6.24	10.40	11.01

Where blanks occur, no record is available.

The precipitation depends somewhat upon the location with reference to mountains and canyons. The summer rains or showers are often very local, and in the form of heavy downpours accompanied by lightning and thunder, while the winter rains are more general and fall more gently over a longer period of time. The summer rains are of little benefit to agriculture directly and they hinder harvesting and fruit-drying operations, but they are important from the standpoint of irrigation. It will be noticed from the tables that to some extent wet cycles or years seem to be followed by extremely dry ones. During the wet cycles there is more underground water present and the lands are farmed for the time being by irrigation with pumped water, which during dry periods is scanty.

The following table shows the mean annual and the absolute maximum and minimum temperatures for several stations in different parts of the area:

Average annual temperature and extremes of temperature at Casa Grande Ruins,[1] Florence, and Sacaton.

	Casa Grande Ruins.			Florence.			Sacaton.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
1916				70.6	113	20	69.9	114	15
1915		114		69.0	113	24	68.9	113	22
1914	69.9	112	23	71.0	112	27	70.4	114	21
1913	67.2	114	8	68.9	114	11	68.2	112	9
1912	66.8	113	18		115		67.6	113	17
1911	68.4	110	19						
1910	68.5	113	16	71.2	115	22	71.3	117	17
1909				68.2	114	19	68.5	111	17

[1] Now Casa Grande National Monument.

The mean annual temperature as recorded at Phoenix, for an 8-year period from 1896 to 1903, inclusive, was 70°. The absolute maximum for Maricopa is 126°, and this is the highest temperature on record in this area or vicinity. Temperatures ranging between 110° and 120° are recorded yearly, and the temperature frequently remains above 100° for periods of several days or several weeks during the summer. During the early summer the nights are cool, but the high relative humidity accompanying the extremes in temperature during the rainy season of the middle and late summer makes this part of the year uncomfortable. The dry part of the year is one of remarkably low relative humidity. Although the temperatures during the greater part of the year are moderate, during the winter and spring low extremes of temperature for this part of the United States are recorded. For instance, absolute minimum recorded at the Maricopa station is 8° F., though temperatures as low as 25° are unusual, and even crops sensitive to cold can be successfully grown.

The prevailing wind direction is from the west. Hot, drying winds are frequent during the summer months. Snow very seldom falls, and hail is of local occurrence and unimportant.

The growing season for the more hardy crops extends throughout the year, but frosts occur during December, January, and February. The average date of the last killing frost in the spring is about March 7, while that of the earliest in the fall is about November 27. The latest killing frost recorded in the spring at the Maricopa station occurred April 4, while the earliest in the fall was recorded by the same station on October 22.

AGRICULTURE.

Agriculture has not reached a very high state of development in the Middle Gila Valley area, although there is abundant evidence that irrigation farming was carried on by the prehistoric races and Indians for centuries preceding settlement by the whites. The lack of game and wild food plants on the arid plains and treeless mountains forced the early peoples to turn their attention to agriculture, and the river bottoms and adjoining higher lands that could easily be irrigated from the Gila River were made to produce. The Pima Indians have no traditions of the prehistoric race or races that carried on agriculture in this valley, but the ruins of their dwellings and canals indicate that they had reached a rather high state of culture. Before the advent of the white man, in the latter part of the sixteenth century, American Indians were irrigating land and producing food crops. These Indians were not concerned mainly with warfare, but they were continually called upon to protect their stores of grain and their families from other tribes. The small farms along the Gila River were irrigated with the silty waters of the stream by means of small ditches, which carried the flood waters a short distance to the cultivated land. Overflows either stimulated the yields or destroyed the crops, depending upon the time and manner of occurrence. The grain was harvested in the crudest fashion and thrashed with a flail or by trampling with horses. This method of harvesting and thrashing grain has changed little among the Indians, their hard-earth thrashing grounds being everywhere in evidence. The farming of desert land lying outside the river bottoms was not looked upon with much favor by the white settlers, and little of the desert slopes is cultivated to-day. Extremely long droughts and low average rainfall have forced settlers to abandon some areas formely cultivated.

Agriculture is confined very largely to that part of the Indian Reservation occupying the river bottoms, to scattered ranches in the vicinity of Casa Grande and Florence, and to a few scattered farms in various other parts of the area. The construction of irrigation works by the Government for the Indians, covering lands in the river bottom, has practically assured the permanency of agriculture in that section.

Farming as carried on by the settlers and squatters on the desert, until a more stable supply of water for irrigation is obtained, can hardly be considered profitable. The canal which supplies some of these farmers carries water only part of the season, or may even be dry, depending upon the rainfall. Others irrigate from wells, which seem to furnish a considerable supply of water in wet years, but can hardly be depended upon in dry seasons. The expense of application is also too great for profitable irrigation. A comprehensive storage and irrigation system is necessary before the barren desert plains will be turned into permanently producing fields.

The present type of agriculture differs little from that of past years. It consists largely in the production of cereals, alfalfa, and other hay and forage crops, and the raising of cattle and horses. Egyptian cotton is grown on a small acreage. Vegetables are grown, and some shipments are made from the area, but most of the produce is used locally, as the demand for truck and garden crops far exceeds the supply. Small quantities of tree fruits, mainly peaches and nectarines, apples, quinces, apricots, and figs are produced. A small planting of the date palm has been made by the Department of Agriculture experiment station.

Statistics of agriculture strictly applicable to the area are not available. The data given by the Federal census for Pinal County are, however, of some significance, as the survey covers the most important agricultural region in the county.

The following table gives data for the three principal classes of products for the years 1899 and 1909:

Acreage and production of leading classes of crops and value of live stock, 1899 and 1909.

Product.	1899.		1909.	
	Acreage.	Production.	Acreage.	Production.
		Bushels.		*Bushels.*
Cereals	3,196	79,330	8,744	132,571
		Tons.		*Tons.*
Hay and forage	4,633	6,987	4,232	6,709
	Number.	*Value.*	*Number.*	*Value.*
Live stock sold or slaughtered	....	$134,895	8,162	$148,905

This table shows a very considerable increase in the acreage of cereals, but a decrease in the acreage of hay and forage crops during the decade, while the value of live stock sold and slaughtered was materially greater at the end than at the beginning of the period. It is certain that the acreage and production of the classes of crops stated have increased since the last census. The value of all crops and live-stock products in 1909 amounted to $406,228.

Wheat, barley, and corn occupied practically the entire acreage devoted to the cereals in 1909, and this was true in 1899, though the relations between the crops were different. In 1899 the acreage in barley was slightly greater than the acreage in wheat, while in 1909 the acreage in wheat was nearly twice that in barley.

Wheat in 1909 occupied 4,762 acres, from which the production was 57,894 bushels, an average yield per acre of about 12 bushels. There were 2,552 acres in barley, with a production of 58,220 bushels, or an average yield of 22.8 bushels per acre, and 1,275 acres in corn, producing 13,999 bushels, or about 11 bushels per acre. Corn does not yield well in the hot valley of the Gila River. It is grown under irrigation. The cereals are grown mainly for home consumption, although wheat and barley are cash crops with some of the white farmers.

From these returns it appears that the average yields per acre of the cereal crops are low, and this is substantiated by facts obtained during the survey. The low average yields are in some measure due to the antiquated methods still generally used by the Indians, notwithstanding the efforts of the Government to educate and train them in better farming practices.

Among the hay and forage crops of 1909, grains cut green for hay occupied 2,721 acres, or more than half the total acreage in such crops. The production of grain hay amounted to 4,119 tons, or an average yield of 1½ tons per acre. Alfalfa was the next important hay crop, the acreage being 776 acres, the production 1,569 tons, and the yield per acre a little more than 2 tons. Millet occupied 87 acres, other tame grasses 278 acres, wild grasses 250 acres, and coarse forage 119 acres. Millet yielded about 3 tons per acre; the coarse forage between 2 and 3 tons; and the other crops about 1 ton per acre.

In this region, where stock runs on the range throughout the year, the production of hay is not likely to be considered very important, but some hay is made by most farmers. The acreage in alfalfa, which decreased greatly between 1899 and 1909, has increased since the latter year, and the area in this crop is extending annually, both on the river-bottom soils and on the desert ranches. This legume is one of the most valuable crops for the desert farms, where water for irrigation can be obtained. The land is flooded in checks and when the supply of water is sufficient an irrigation is given after each cutting, of which there may be as many as seven. Alfalfa is allowed to occupy the land for many years without reseeding. Much of the land in cultivated grasses is pastured a part of the year, which tends to reduce the yield of hay. The forage and hay crops are used largely to feed the work stock and dairy animals.

According to the census neither cotton nor the sorghums were grown in Pinal County in 1909. Since then, mainly as the result of investigations by the Bureau of Plant Industry, long-staple Egyptian cotton and Egyptian corn and milo have been introduced.

Long-staple Egyptian cotton is grown extensively in adjacent parts of the Salt River Valley, and it bids fair to become an important crop in this area when facilities for irrigation have been extended. Several strains of this cotton, which seems to be particularly adapted to the soil and climate, have been bred to a high standard at the United States experiment station at Sacaton. Small fields have been set out in the Middle Gila Valley area, both white and Indian farmers taking up culture of this crop. High prices during the last two years (1916 and 1917) have stimulated the interest in cotton. It is planted after all danger from frost is past, and is cultivated and irrigated during the growing season. Much hand labor is necessary in thinning, chopping, cultivating, and picking. Harvesting begins in the fall and may continue until late in the winter, which usually is favorable for such work.

Egyptian corn and milo are grown more extensively each year and promise to become important crops, as they are well adapted to the soil and climatic conditions and can be grown late in the summer after other crops are disposed of. It is necessary to irrigate the land before seeding. Later irrigations depend upon the season and rainfall. These grains, which make excellent stock feed, are generally grown by the white farmers; the Indians, who grow grain for food, prefer corn.

Stock raising is the most important source of income of the Pinal County farmers. Cattle and horses are kept in the largest numbers, but some hogs, sheep, and goats are raised. Practically all of the stock subsists on the desert range the year round, seldom being fed at any time of the year, except locally during severe drought. Some dairy cattle are fed and pastured on alfalfa the year round. Dairying is almost entirely in the hands of white farmers, and is best developed in the vicinity of the larger towns. The income from dairy products in 1909 was $10,546. Poultry raising is carried on in conjunction with general farm operations, the value of poultry raised in 1909 amounting to $15,306. The Indians seem more adept in the raising of stock than in farming. The quality of the cattle on the reservation is being improved through the agency of the Government.

Up-to-date methods are used in grain farming by the white farmers, but the Indian is slow to adopt modern methods and the use of machinery. Plowing for grain is usually done in the fall and winter months, about the time of the first winter rains or following an irrigation, after which the crop is planted. In dry seasons the crop is irrigated a number of times, but irrigation may be entirely dispensed with in years of greater precipitation. Not much grain is produced by dry farming. Indians continue to cut their small fields of grain with the hand sickle and thrash the crop by driving horses over it on a hard earth floor, later separating the grain from the chaff by winnowing or throwing it into the air on a windy day.

Little or no fertilizer except barnyard manure is used, and rotations are not practiced to any extent. The application of very silty irrigation waters, rich in organic matter, tends to maintain or increase the productiveness of the soils, even though the same crop be grown for a period of years.

Facilities for irrigation and alkali-free soils have more to do with the present distribution of crops than the minor differences in the texture and color of the soil or the source and character of the soil material. Ordinarily grain does best on the rather heavy, silty soils. Because of the droughty nature and low organic content of the upland soils, the present agriculture is largely confined to the river bottoms. The farms on the heavier, lower-lying soil types, in the river bottom, are much smaller than those on the upland soils, probably owing to the fact that the Indians, occupying much of the river bottoms, hold only small parcels of irrigated land. Except in case of the Pinal gravelly sandy loam, topography has had little influence on the distribution of crops, as the surface of all the other types permits of irrigation and cultivation without great difficulty.

Farm labor is supplied principally by the Pima Indians. Practically all the Indians own small tracts of land, which they cultivate during part of the growing season, but many of them do farm labor in the vicinity. In and around Florence and Casa Grande there are many Mexicans who perform day labor on the ranches in that section. The wages of farm labor are relatively high at the present time (1917). Mexicans are paid $1.25 to $1.50 a day and board for hand labor, while men who handle teams receive $1.50 to $1.75 a day and board.

In 1910 only 1.3 per cent of the total area of Pinal County was in farms. The total number of farms was 614, and the average size 70.4 acres. Of this 43.5 per cent, or 30.6 acres, was improved. The average value per farm of all farm property was $3,757, the land making up 51.4 per cent of the total and the live stock 37.2 per cent. In 1910, 95 per cent of the farms were operated by owners, a small number by tenants, and a very few by managers. This high percentage of farms operated by owners is due mainly to the large Indian population.

The average assessed value of land in 1910 was $27.47 an acre. It is very difficult to estimate the average value of farm lands at the present time, as no sales of the Indian holdings take place, and transfers of other lands have been few in recent years. Values probably range from a few dollars to $75 an acre, depending upon the means or irrigation and other local conditions.

SOILS.

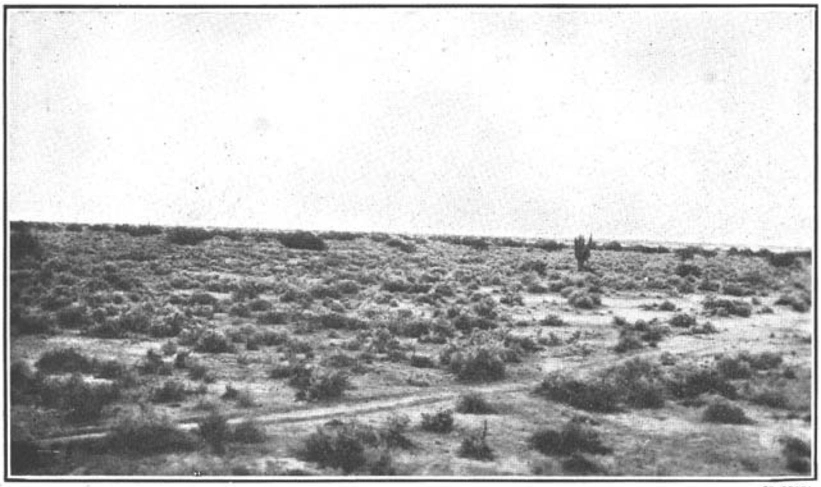
The soils of the Middle Gila Valley area are derived from a variety of rocks, all the soils except those identified with the several small buttes and parts of the adjacent mountains having been transported and laid down by water. The predominating rocks in the mountains and buttes are granite, mica schist, and other crystallines. Igneous rocks of low quartz content and of basic character occur on some of the buttes, and have entered into the formation of the soils to a small extent. In the western and southern parts of the area small fragments and bowlders of igneous rocks have been washed down over the desert plains by torrents.

The soils may be classed in three main groups—namely, residual soils, or those derived in place through the weathering and disintegration of consolidated rocks; old valley-filling or desert soils, which are derived from the weathering and other modification of old unconsolidated, water-laid material; and recent alluvial or stream bottom soils, consisting of comparatively recent alluvial products which have undergone no important changes by weathering or internal modification subsequent to deposition. Another main group—namely, wind-laid soils—is represented, but is not of sufficient extent in this survey to warrant separate grouping, and it is included with the old valley-filling soils.

The main groups of soils are divided into series in which the soils are similar in color, origin, mode of formation, subsoil conditions, and other essential features except texture. The series are divided into types, the latter being determined by the proportions of sand, silt, and clay present in any particular case. The soil type is the unit of mapping.

Following this system of classification, five series of soils, each represented by one or more types, are recognized in this survey. In addition, two miscellaneous, nonagricultural soils are shown on the map—viz, Rough stony land and Riverwash.

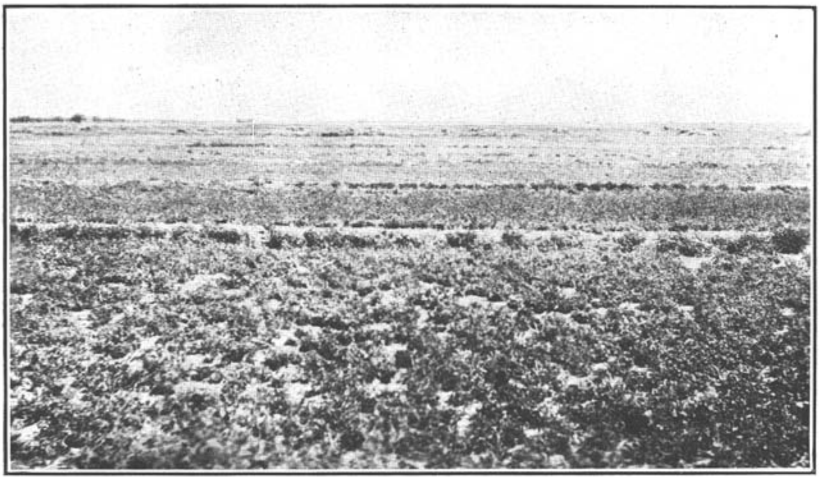
Residual soils.—The residual soils in the Middle Gila Valley area are of little importance. They are represented only by Rough stony



SS.9500

FIG. 1.—VIEW OVERLOOKING DESERT SOILS GROUPED IN THE MOHAVE SERIES.

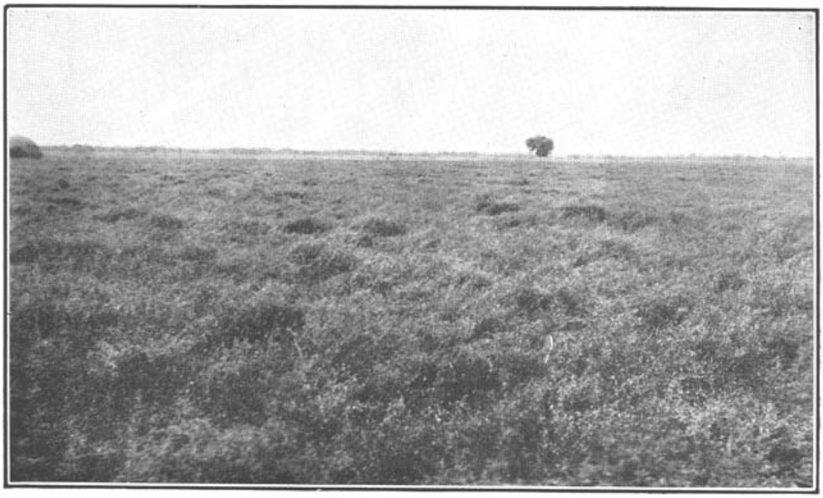
The surface is smooth and gently sloping. The vegetation is typical of the soils of this series.



S. 9496

FIG. 2.—ALFALFA ON MOHAVE SANDY LOAM, NEAR CASA GRANDE.

The crop has been cut recently. The horizontal ridges are irrigation checks.



S. 9507

FIG. 1.—VIEW IN GILA RIVER BOTTOMS NEAR FLORENCE.

This shows the smooth, level topography of the Gila silty clay loam. The field in the foreground is in grain stubble.

S. 9509

FIG. 2.—ALFALFA ON THE GILA SILTY CLAY LOAM, NEAR FLORENCE.

land and are confined to the small rocky buttes and mountain slopes.

Old valley-filling soils.—The soils of the old valley-filling province occupy about 75 per cent of the area. They are derived from weathered and otherwise modified, relatively old, water-laid, unconsolidated deposits, which originally had their source in a variety of formations in which granites and related rocks seem to have predominated. The color of the surface soils ranges from brown to reddish brown or red. Oxidation is well advanced and the soils are characteristically low in organic matter. An abundant supply of lime is present. Heavier, more compact subsoils occur in places, and frequently a greatly compacted, or in some cases cemented, layer lies within a few inches of the surface. These soils cover practically the whole of the area except the valley of the Gila River. The surface is smooth and comparatively flat or gently sloping. The soils have a moderate elevation, and in places are eroded. Drainage is good over most of this area. Three series of soils are recognized—the Pinal, Mohave, and McClellan.

The soils of the Pinal series are pale red or grayish red to light reddish brown in color, and predominantly gravelly or stony. Cemented, calcareous, gravelly hardpan or "caliche" layers are prominently developed. The surface is gently rolling and dissected and drainage is good. The Pinal series is inextensive in this area and unimportant agriculturally. Only one type, the Pinal gravelly sandy loam, occurs in the survey.

The soils of the Mohave series have a range in color from light reddish brown to dull red or dull reddish brown. They are usually underlain by grayish or pinkish-gray very compact subsoils, frequently containing irregular, partially cemented seams or layers, with an approach to a dense, cemented "caliche" or hardpan. The soils are low in organic matter and high in lime. They generally have a smooth and gently sloping surface (see Pl. I, fig. 1), which is little affected by erosion. Surface drainage is usually well established, but the subdrainage is restricted and some areas are affected by alkali salts. Two types of this series are mapped. the Mohave sandy loam and fine sandy loam.

The McClellan soils are browner than those of the two series just described. The surface soils are low in organic matter, high in lime, and underlain by a very compact, grayish, calcareous subsoil, which retards the movement of moisture and limits root development. The clay-loam member of the series is usually very low, flat, and poorly drained, while the loam has a gently sloping surface and much better drainage. Part of the series is affected by the accumulation of alkali salts.

155289°—20——3

Recent-alluvial soils.—The recent-alluvial soils of this area, while not the most extensive, are the most important agriculturally. They have been made to produce crops since prehistoric times. They are confined to the Gila River bottoms and consist of recent sedimentary materials laid down by this stream. As distinguished from the old valley-filling soils, they are naturally friable and lack a compacted and cemented or altered subsoil. They are much higher in organic matter than the old valley-filling types. The soil profile represents the various coarser or finer strata laid down by the stream under different conditions of velocity, volume, and load of suspended material. The surface is generally level and smooth, and the soils are in places poorly drained and affected with alkali salts. They are also subject to overflows. Two series are included under this soil province—the Gila and the Pima.

The Gila series consists of brown soils, ranging from rather light grayish brown to rather dark brown in color, frequently with a slight reddish or chocolate tint. The subsoils are generally similar in color and texture, but they may consist of variably textured, alternating strata. They are free from any consistent compact or hardpanlike layers. There is a rather high percentage of organic matter in the surface soil, and both surface soil and subsoil are calcareous. In many places the content of mica is large. The surface of the Gila soils is usually smooth and level or very gently sloping, and drainage is only fairly good. Alkali salts are sometimes present in excessive quantities. The soils are subject to periodic overflow and have a high water table.

The Pima soils are dark brown or dark grayish brown, with, in many places, a slight reddish or rich chocolate brown tint. The subsoils are of similar or of lighter and more grayish color, particularly where highly calcareous. Both surface soil and subsoil are calcareous, effervescing freely with dilute acid. The subsoil is similar in texture to the surface soil or consists of variably textured strata without cementation or alteration in place through weathering. The surface is generally smooth and level. The soils are subject to overflow, and at times are poorly drained. In some places the Pima soils contain alkali salts, but the affected areas are easily reclaimed by drainage and flooding.

In the following pages of this report the various soils of the Middle Gila Valley area are described in detail, and their relation to agriculture discussed. The distribution of the soils is shown on the map accompanying this report, and the table below gives the actual and relative extent of each:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
McClellan loam	60,096	30.6	Riverwash	14,208	6.3
Shallow phase	5,568		Pima clay	6,464	2.9
Silty phase	3,264		Gila fine sand	5,056	2.2
Mohave sandy loam	40,384	17.8	Pinal gravelly sandy loam	4,608	2.0
McClellan clay loam	37,824	16.8	Rough stony land	1,728	0.8
Gila silty clay loam	30,144	13.4			
Mohave fine sandy loam	15,936	7.2	Total	225,280	

PINAL GRAVELLY SANDY LOAM.

The Pinal gravelly sandy loam is a grayish-red to light reddish brown calcareous sandy loam, carrying a large quantity of rounded and subangular gravel, as well as bowlders and stones. The stony surface material usually extends to a depth of 6 to 10 inches, where a gray, calcareous hardpan or "caliche" is encountered. The soil is of rather loose, friable structure, owing to the large content of coarse material. It is high in lime but low in organic matter. The hardpan is a firmly cemented, gravelly layer or series of layers, varying in thickness from 12 to 36 inches or more. The subsoil consists of a grayish or grayish-brown, calcareous, compacted mass of gravel and bowlders in a matrix of material finer than that in the surface soil. It extends in many places to a depth of 6 feet or more, but locally is underlain at varying depths by compact, heavy and more silty material, free from gravel. A deep, gravelly substratum underlies the type. This also is calcareous.

The Pinal gravelly sandy loam occurs in areas of varying size, the largest lying west of Florence along the Blackwater and Florence Road. For several miles this area, occupying a more or less eroded terrace, forms the southern boundary of the Gila Valley. Areas of similar characteristics skirt the valley north of the river, but only a small part is included in this survey. Three small areas are mapped east of Casa Blanca and one southeast of Casa Grande. The latter is of particularly stony character.

The surface of the type is somewhat undulating and eroded and not well adapted to irrigation. The gravelly, stony nature of the soil and the nearness of the "caliche" to the surface render the type difficult to handle. The surface run-off is rapid and the soil is not retentive of moisture.

The Pinal gravelly sandy loam is at present used solely for pasture. It supports only a sparse growth of grasses or creosote bush, and its pasturage value is low.

MOHAVE SANDY LOAM.

The Mohave sandy loam consists of a pale-red to reddish-brown, friable, calcareous, light-textured sandy loam, about 12 or 14 inches deep, underlain by a calcareous, light reddish brown or pinkish-gray compact sandy loam or loam. The surface soil is open in structure, and, containing little organic matter, has little power to retain moisture. Considerable quantities of coarse sand and fine gravel and grit are normally present. Coarse angular gravel occurs in the soil where it adjoins the Pinal gravelly sandy loam or other stony types. The subsoil, while calcareous and compact, is not advanced in cementation to the stage of a true hardpan. In most places a water-bearing stratum of rounded gravel underlies the type at a depth of 25 to 35 feet or more, and it is from this stratum that water for irrigation is usually obtained.

Small areas of a sandy variation are included in this type, and it may include some areas having the texture of a sand. In the sandier areas the soil is usually deeper and more open in structure, and the subsoil carries some fine angular gravel.

The Mohave sandy loam is an extensive and important soil. It is mapped in all parts of the area, but the largest bodies occur in the eastern and southern parts. Many of the soil areas are elongated and roughly parallel. They may extend along drainage courses, or bound large flat areas. Some are small, isolated areas of sandier material, which have been modified by wind action and may locally have a veneer of wind-laid material. The soil boundaries in most cases are definite and in many cases sharp.

The surface of the type is generally smooth and well suited to irrigation and agriculture, but some of the smaller, sandy areas are marked by small hillocks and are difficult to handle. Leveling is necessary to prepare much of the type for irrigation.

This soil usually lies slightly higher than the surrounding or adjacent types, and drainage is toward the latter. It is well drained and is seldom affected by alkali, which occurs only along marginal areas.

The greater part of this type still supports the native vegetation of creosote bush and varieties of cacti or other desert plants. Small areas are irrigated and farmed, alfalfa being the principal crop. (Pl. I, fig. 2.) Where sufficient water is available the yields are good, but all crops require irrigation. Some grain is produced, but the yields are often poor. Kafir, milo, and truck crops are grown locally, and their acreage is being extended. A small acreage is devoted to peaches, apricots, and figs. Egyptian cotton is not grown on the type in this area, but it is produced on similar or identical soils outside the survey. The seed farm of the Indian Agency near Sacaton is located on this type of soil.

The value of raw land of the Mohave sandy loam ranges between $12 and $75 an acre, depending upon the location and water supply.

The addition of organic matter to this soil would improve its physical condition. Where manures and green crops have been plowed under, or where the silty irrigation waters of the Gila River, rich in organic matter, have inundated the surface, the improvement is noticeable.

MOHAVE FINE SANDY LOAM.

The surface soil of the Mohave fine sandy loam is a pronounced reddish-brown or pale-red to grayish-red, rather coarse and gritty, calcareous fine sandy loam, 6 to 10 inches deep. The subsoil is a very compact, light-red or brownish-red or grayish-red calcareous fine sandy loam, or loam in which occur lenses or layers of partly cemented material. Under irrigation the hard layers soften somewhat, but even the uncemented subsoil is so compact that the movement of moisture and the penetration of plant roots are hindered. The same condition decreases the water-holding capacity of the soil. A gravelly substratum underlies the type at considerable depth.

This type is very uniform over large areas, but in places the soil has been modified by winds, the surface soil in such places being deeper and more open and friable than typical. The surface of the greater part of the type is smooth and favorable to cultivation and irrigation.

The larger areas have sufficient slope to insure good drainage, and as a result of the structure of the subsoil most of the precipitation is lost as run-off. Some lower lying areas of the type are affected by accumulations of alkali. The narrow ridges of this type, which border flats occupied by heavier soils need leveling before they can be cultivated.

The Mohave fine sandy loam is an extensive soil. Most of it occurs in large bodies north of Casa Grande and along McClellan Wash. Smaller areas are mapped to the southeast of Casa Grande, northwest of Santan, and north and northwest of Twin Butte. One small area occurs west of Blackwater and another west of Casa Blanca. The native vegetation consists of a growth of desert sage, creosote bush, and several varieties of cacti. In areas where alkali salts have accumulated "seep weed" is a common plant.

Little of the type is under cultivation. Several farms are producing alfalfa, but no data as to yields are obtainable. The nonsaccharine sorghums, cotton, and truck crops can be produced where the soil is free from alkali and where subsurface conditions are favorable. Peaches, apricots, and figs are produced locally. The type is low in organic matter and responds to applications of manure or to the incorporation of green manures. Much of it is very droughty, owing to the shallow soil and compact structure of the subsoil.

The results of mechanical analyses of samples of the soil and subsoil of Mohave fine sandy loam are shown in the following table:

Mechanical analyses of Mohave fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
510411	Soil	2.5	9.4	5.1	34.1	30.0	16.7	2.4
510412	Subsoil	2.0	7.1	4.2	28.0	22.0	17.3	19.4

M'CLELLAN LOAM.

The surface soil of the McClellan loam typically consists of a brown, gritty, light-textured loam, 10 to 20 inches in depth. It has usually a slight reddish or purplish tint. The surface soil is more compact and retains moisture better than the Mohave fine sandy loam and sandy loam, but it lacks organic matter and has a tendency to bake upon drying. Some fine gravel is generally present on the surface and coarser material occurs along the small washes or drainage ways. The soil contains much lime.

The subsoil is a compact, highly calcareous, gritty loam, of light grayish brown or pinkish-gray color. In places it is weakly cemented and occasionally the deeper subsoil is a very compact, reddish, or reddish-brown loam or clay loam, not well adapted to root development. Where it has been subjected to a high water table, the subsoil is often grayish or grayish brown. The type is underlain by a deep gravelly substratum.

The McClellan loam in this survey is subject to some variations in texture, color, and depth. In several places south of Casa Blanca small areas have a pronounced reddish brown color and others occupying slopes have a somewhat deeper surface soil than typical. Small areas of lighter or slightly heavier texture are also included. Much of the type in the western part of the survey contains alkali in injurious quantities.

The McClellan loam is one of the most extensive types in the area. It occurs in all sections except the Gila River flood plain, in both large and small bodies.

The type represents part of an extensive plain, in which drainage ways are poorly developed. It is generally level or gently sloping, and is easily handled, such surface irregularities as exist being of little hindrance to irrigation or cultivation. Parts of the type are well drained, but in general surface drainage is not well established, and the subdrainage is retarded by the impervious or compact subsoil. The poorly drained areas contain more or less alkali.

The type is used largely for pasture because of the lack of water for irrigation. A desert growth of *Atriplex* or desert sage, mesquite, creosote bush, cacti, and seep weed forms the principal vegetation. Where the soil is free from alkali and can be irrigated, alfalfa, non-saccharine or grain sorghums, and other grains are produced. Alfalfa and the sorghums give good returns, but the yields of other crops are only fair. Garden truck, melons, peaches, apricots, and figs are grown locally. Egyptian cotton is produced on this type outside the area. The content of organic matter in this soil is low, oxidation of humus being rapid. Liberal applications of manure or the turning under of green crops is necessary for best results.

The selling value of land of this type varies greatly, depending upon the location and the facilities for irrigation.

McClellan loam, shallow phase.—The shallow phase of the McClellan loam differs from the typical soil chiefly in the depth of the surface soil. The soil section consists of (1) a layer of brown loam or fine sandy loam, 3 to 6 inches deep, and (2) a layer of compact, reddish-brown or brown loam weakly or intermittently cemented and approaching a hardpan in general characteristics. Both soil and subsoil are calcareous.

The principal areas of this phase are mapped along McClellan Wash and southwest of Casa Blanca. It supports in general a stunted vegetation of sage, seep weed, and dwarf cactus. A few barren spots occur. The soil is level and poorly drained. It is overflowed frequently from the McClellan Wash, and occasionally receives seepage from the higher lying types. The unfavorable structure of the soil, the liability to overflow, and the accumulations of alkali render the land of little value except for pasture, and none of it is cultivated at present.

McClellan loam, silty phase.—The silty phase differs from the typical McClellan loam in having a larger content of silt in the upper foot or two, and in having larger proportions of organic matter. The soil consists of a dark-brown silty loam 5 to 24 inches deep, and the subsoil of material like that of the typical soil, but somewhat more porous. The excess of silt is due to the deposition of material carried by irrigation or overflow waters. The soil is darker than the typical McClellan loam. Parts of the phase are spotted with alkali.

This soil is not very extensive. The principal areas are situated several miles east and southeast of Casa Grande, and southeast of the Casa Grande National Monument. Those east and southeast of Casa Grande are elongated and form shallow drainage channels. The phase lies lower than the adjacent soils, and in places receives run-off from surrounding areas. The drainage is nevertheless good over most of it.

The silty phase is better adapted to farming than the typical McClellan loam and practically all of it is cultivated, being devoted to alfalfa, grain, and the sorghums.

M'CLELLAN CLAY LOAM.

The McClellan clay loam consists of a brown, rather smooth, sticky, compact clay loam, relatively high in silt from 3 to 12 inches deep. The soil is somewhat darker than the soils of the Mohave series and the red color is much less pronounced, though a reddish or purplish brown tint is noticeable in most of the areas. The content of organic matter also is higher than in the Mohave soils, but nevertheless the type bakes and hardens upon drying, and assumes a dense, impervious structure which retards percolation and absorption of water. The subsoil is a light reddish brown or pinkish, sticky clay loam, which becomes more compact with depth and is weakly and irregularly cemented in places, in character approaching a hardpan. Its close structure renders the percolation of water very slow and retards root development. The subsoil usually becomes lighter colored or reddish brown at a depth of 3 feet or more. In some places, where the shallow, silty surface material has been removed, the entire soil column consists of the impervious, compacted subsoil material. A substratum, consisting of gravel and bowlders, lies at about 25 feet below the surface. Both surface soil and subsoil, but particularly the latter, contain large amounts of lime.

The McClellan clay loam is a very extensive soil, occurring principally in the southern, western, and northwestern parts of the survey. Many of the areas are large "playa" flats, or smooth flat areas of puddled soil, barren of vegetation. Others occupy elongated, shallow depressions or channels which may carry the run-off or may hold water until it is removed by evaporation and percolation. The elongated areas roughly parallel the principal drainage ways.

Areas of this type are frequently separated from each other by ridges of lighter textured, wind-blown material, and the flats are usually bordered by such ridges. In general the areas of this soil lie near the principal drainage ways in the desert part of the area.

The surface is uniformly level and flat, drainage ways being very feebly developed except in the case of the larger washes. During periods of drought these flats are dry and the soil is baked, but during the rainy season, or after heavy showers, they are occupied by shallow lakes. The surface material, consisting mainly of silt and clay, is largely the result of deposition from the turbid drainage waters. Alkali salts are usually present in greater or less concentrations. In the southern part of the survey only small amounts of alkali are present, but injurious quantities occur in the western and northwestern parts.

While much of the McClellan clay loam is without vegetation, parts of it have a growth of mesquite, sage, and dwarf cactus. The occasional presence of standing water, followed by a baked condition of the soil, renders the broad flats occupied by this type unsuited to the native plants even where the content of alkali is low. The barren areas are known locally as "slicks."

The soil is used to some extent for pasture. Owing to the generally poor physical condition of the soil, the poor drainage, the alkali accumulations, and the cost of reclamation, farming has not been attempted except in a few of the more favorable situations. Grain is the principal crop grown. Where the subsoil conditions are better than typical and the soil is free from alkali, good yields are obtained under irrigation, but the selling value of the land is low.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the McClellan clay loam:

Mechanical analyses of McClellan clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
510417	Soil	0.3	2.0	1.4	10.8	18.2	42.8	24.6
510418	Subsoil	2.4	7.1	3.5	14.5	17.1	25.6	29.6

GILA FINE SAND.

The Gila fine sand consists of a friable, brown fine sand, 3 to 6 feet deep, underlain by variably textured stratified sediments. The mellow, open soil is not as high in organic matter as the Gila silty clay loam, but it is moderately well supplied. It absorbs moisture easily, but does not retain it as well as the silty clay loam. The soil is micaceous and well supplied with lime. In poorly drained areas the subsoil is often slightly more compact and lighter colored than the surface soil, but it is favorable to root development except where waterlogged.

In local areas adjacent to the Gila River the soil is more silty than typical, and sometimes a light fine sandy loam in texture, while along the Little Gila it contains more sand and fine sand. The subsoil is highly calcareous. Small amounts of gravel occur locally along the streams. Two small islands in the Gila River are classed with the type, although the soil is coarser textured than typical. The channels of the Gila and Little Gila Rivers are occupied by material similar to this soil, but owing to their position they are classed with Riverwash.

The Gila fine sand is not extensive. It occurs only in the Gila River bottoms from the northeastern end of the area westward to Pima Butte. The soil is developed in long, narrow strips along the channel of Gila and Little Gila Rivers.

The soil is well drained in the upper 3 or 4 feet, and in places to a much greater depth, but much of it has a high water table. The texture and structure of the soil being favorable to the capilliary movement of the water, parts of the type contain large quantities of alkali, though the areas periodically overflowed do not contain injurious amounts.

The surface is generally level, but not always smooth. Overflows usually leave it in a hummocky or slightly eroded condition, and considerable leveling is necessary to fit the land for irrigation.

Where alkali is absent there is a growth of cottonwood and willow. In the alkali areas such plants as seep weed, mesquite, greasewood, and pickleweed flourish. Alfalfa, cotton, nonsaccharine sorghums, grains, corn, and truck and root crops produce good yields on the well-drained parts of the type, which are free from alkali. Many kinds of tree fruits, the date palm, vegetable crops, and melons are grown at the experiment station at Sacaton, and it is likely that some of these crops will be more extensively grown by the farmers. Manures and fertilizers are not widely used.

The results of mechanical analyses of samples of the soil and subsoil of the Gila fine sand are given in the following table:

Mechanical analyses of Gila fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
510407	Soil	0.0	0.8	0.5	66.6	20.0	8.6	2.8
510408	Subsoil	.0	.2	.1	15.9	11.1	54.8	17.6

GILA SILTY CLAY LOAM.

The Gila silty clay loam is a smooth, close-structured, brown, silty clay loam, the color in places having a slightly reddish or chocolate-brown tint. The soil usually extends to a depth of 3 to 6 feet with little change, except that below a depth of 1 or 2 feet the color may be somewhat lighter and the structure somewhat more compact. The surface soil contains a relatively large proportion of organic matter and is distinctly micaceous. The soil and subsoil material is high in lime. In many places the materials forming this type do not appear to be of as recent deposition as those giving the Gila fine sand, but even here the subsoil has not been cemented or altered by weathering.

The type as mapped includes some variations. While the color of the surface soil is uniform for so extensive a type, some areas have a darker color, owing to a larger admixture of organic matter. In depressions the soil is both heavier and darker than the typical soil, and on some narrow ridges it is coarser and lighter. As mapped some material of silt-loam texture is included. Where poor drainage exists and alkali has accumulated the subsoil is usually lighter colored and more compact than the subsoil in other parts of the type. Harmful concentrations of soluble salts occur over a large part of the type. The substratum is similar to the subsoil to a depth of many feet. Below this are beds of river gravels.

The Gila silty clay loam is an extensive and important soil occupying the greater part of the Gila River bottoms. The surface is generally level and moderately smooth, well adapted to irrigation and cultivation (see Pl. II, fig. 1). The sandier ridge areas require leveling before they are farmed. Much of the type lies on a second terrace a few feet above the normal overflow of the river. On the whole it is not thoroughly drained, and much of it as the result of seepage has a high water table. Capillary movement of moisture is rapid and much of the type is damaged by alkali, small tracts being barren of vegetation. While not often overflowed by floods in the Gila River it is subject to overflow from other sources. Mesquite, greasewood, seep weed, and a little salt grass are the characteristic plants in the vegetation.

The Indians have farmed parts of the Gila silty clay loam for many years, growing wheat, barley, hay, alfalfa, corn, sorghums, and, recently, cotton. Truck and root crops are grown locally. Because of its low-lying position the type is not well adapted to fruit culture. Large areas are unproductive because of the excessive accumulations of alkali, but in the eastern part of the area less alkali is present, and the white farmers here produce good crops of grain. The Indians get only fair yields on this type, considerably below those obtained by the white farmers. The uncultivated areas of the type are used as pastures. All crops are grown under irrigation, water being obtained from the Gila River and by pumping from wells. Much of this type within the Indian reservation is under a canal system installed by the Government. Reclamation is accomplished by checking the land and flooding it for several months or for several seasons, depending upon the concentration of salts. Much of the type requires artificial drainage. No fertilizers are used and crop rotations are seldom followed.

The price of land of this type depends largely upon its condition for farming and the location. Little of it has changed hands recently and the Indian lands are not sold. Prices range from as low as $5 or $10 an acre to $100 an acre where good stands of grain can be obtained.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Gila silty clay loam:

Mechanical analyses of Gila silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
510405	Soil	0.1	0.4	0.3	3.4	18.2	53.2	24.3
510406	Subsoil	.0	.2	.1	6.1	22.3	48.0	23.1

PIMA CLAY.

The soil of the Pima clay consists of a dark-brown or dark grayish brown clay, in many places relatively high in silt, 18 to 24 inches deep. It is sticky when wet and cracks when dry, but it contains much organic matter and retains moisture well. The type throughout contains a large amount of lime. The subsoil is a light grayish brown silty clay loam to clay, extending to a depth of more than 6 feet. It differs from the surface soil in its lighter color, and in being compact, but it has not been materially changed by leaching, cementation, or weathering in place. Small areas here and there are underlain by gravel or sand at a depth of several feet, which allows the water to penetrate more rapidly, and a gravelly substratum underlies the type at various depths.

The Pima clay is not extensive, but it is important in the agriculture of the area. The type is confined to the flood plain of the Gila River, where it occurs in irregular-shaped areas or in long, narrow strips, generally roughly paralleling the stream. It is found in all parts of the valley from the eastern to the western boundary of the area.

The surface is level or slightly depressed. Flood water stands on the surface until removed by percolation or evaporation. This is a slow process, and more time must elapse between overflows and cultivation than in case of some of the other bottom soils. The type maintains a better moisture supply during droughts than the river-bottom soils of lighter texture. Parts of the type contain alkali, but injurious accumulations are less common than in the Gila silty clay loam. The type is not directly overflowed by the river, the water coming from other sources. Water is easily applied in irrigation, and much of the type is under gravity canals.

In most places the vegetation consists mainly of a heavy growth of mesquite, but where alkali is present such plants as greasewood, saltbush, and salt grass grow.

Many of the Indian farmers cultivate parts of the Pima clay, building their towns and houses on the adjoining terraces of Gila silty clay loam, which are generally affected by alkali. Wheat, barley, alfalfa (Pl. II, fig. 2), corn, hay, sorghum, truck, and root crops are grown, and good yields are obtained. None of the farmers use fertilizer, and no crop rotation is followed. The type brings as high prices as any in the Gila Valley.

In the table below are given the results of mechanical analyses of samples of the soil and subsoil of the Pima clay:

Mechanical analyses of Pima clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
510415	Soil	0.1	0.5	0.2	3.1	4.7	37.0	54.4
510416	Subsoil	.0	.1	.0	2.8	18.6	52.7	25.8

ROUGH STONY LAND.

Rough stony land consists of steep, rough, and stony areas that have no present agricultural value. It includes various shallow soils occupying buttes and the lower slopes of mountains. The soils are of residual origin, and derived almost entirely from granite, gneiss, mica schist, and associated rocks. There are numerous outcropping ledges, and loose stones and rock fragments of all sizes are abundant, especially around the lower slopes of the buttes and mountains.

This type is of small extent, as the survey covers only the most desirable agricultural lands of the region. The most important areas lie southeast of Casa Grande, at Twin Butte, and on Cholla Mountain. Smaller areas are mapped on small buttes within the area, and on parts of the hill and mountain slopes.

The vegetation over the greater part of the Rough stony land is sparse and of low grazing value. It consists mainly of cacti of various kinds, creosote bush, and several other unimportant plants.

RIVERWASH.

Riverwash consists of the material occupying the bed of the Gila River. The soil is a mixture of coarse, medium, and fine sands, together with some finer sediments, and differs chiefly from the Riverwash of the Solomonsville area, in the Upper Gila Valley, in carrying less gravel, stones, and coarse sandy material. The type is usually more silty along the edges of the stream bed, where the current is sluggish.

The boundaries of the strip of Riverwash are very irregular, and in many places they are drawn rather arbitrarily. The surface of the type is smooth, with a very gentle gradient toward the stream. It is flood-swept during periods of high water and during the rainy season, and at all times the water table is high. The type is of no present agricultural importance.

IRRIGATION.

Irrigation is necessary in the Middle Gila Valley area because of the low rainfall and the long dry seasons. The Indians practiced irrigation before the coming of the white man, using a rude system of canals to take water from the river and distribute it over the river bottoms and near-by desert slopes. The 1910 census reports a total of 89,400 acres in Pinal County embraced in irrigation projects, but only 25,431 acres actually irrigated, of which 13,831 acres were supplied with water by partnership and individual enterprises, 3,500 acres by cooperative enterprises, and 8,000 acres under the Indian Reservation project. The irrigated acreage for Pinal County is practically all within the limits of the present survey. Nearly all the water for irrigation is drawn from the Gila River by gravity canals. In 1917, 9,000 acres were under irrigation on the units of the Indian Reservation within the present survey.

The Gila River is a broad stream, with poorly defined banks throughout most of its course. During the rainy season great volumes of water fill the channel and overflow the banks, but during the dry season its sandy bed is bare. In the absence of a storage supply, irrigation from the river is impossible during parts of the year.

The water of the Gila River is of good quality for irrigation, the flood waters containing only small amounts of soluble salts. A sample of such water taken at Florence contained 68 parts of soluble salts per 100,000, but during normal flow the water is slightly higher in salts. The river water is very high in silt, and the flood waters carry in addition much organic matter washed from mountain slopes by the torrential rains. These sediments are deposited on the soils by irrigation and overflow waters, and while some inconvenience is caused by the rapid and frequent silting up of canals, much benefit results from such deposits, especially in the case of the desert soils of light texture and low organic content. The continued use of the silty irrigation water even improves the texture of the lighter soils.

During the last few years many wells have been sunk for irrigation purposes in various parts of the river bottoms, and a few in the adjacent areas of old valley-filling soils of the desert. In most instances a good supply of water has been obtained, the shallower wells in the stream bottoms furnishing a more abundant supply than the wells in the desert areas. Water obtained in the desert sections generally is of good quality, usually containing less than 50 parts of soluble salts per 100,000. The water from wells in the river bottom is usually higher in soluble salts, the proportion ranging from 120 to 160 parts per 100,000. In a number of instances there are indications of sodium carbonate. Most of the wells in the desert section tap a strata giving moderate supply of water at depths ranging from 125 feet downward, the water rising in the wells to within 35 feet of the surface.

The United States Indian Office has quite thoroughly investigated and developed the water supply for parts of the Indian reservation within the area. Most of the water is obtained from the Gila River and conducted to the land by a system of main ditches and laterals, wells supplementing the gravity water supply during the dry season. A series of nine wells supplying 25 second-feet extends across the Santan District, and furnishes water for a main ditch when the river supply is short. A well at Sacaton supplements the river supply for the experimental farm of the Bureau of Plant Industry and that of the Indian agency. Another series of wells is used to irrigate the United States Indian seed farm near Sacaton, no gravity water being applied.

The amount of water necessary to mature crops in this region depends largely on the situation of the land, the nature of the soil, and the crop grown. Areas in the river bottoms require less water than those in the desert, and the heavier textured soils produce good yields with less water than the types of more open structure. Many of the bottom lands are naturally subirrigated, but this condition is likely to be accompanied by accumulations of alkali, which is brought to the surface through the capillary rise and evaporation of soil water. Surface irrigation is beneficial on the subirrigated soils, as this tends to wash the salts into the subsoil.

Alfalfa requires much water for maximum yields, one flooding for each cutting being necessary during the dry season. Other crops such as grain and grain hay require less water, as they mature early. Cultivated crops like corn, cotton, truck, and tree fruits require water during the growing season, and this is applied by the furrow method.

Most of the irrigated land lies in the Gila River bottoms and includes Indian allotments as well as large ranches. Only small patches are cultivated in the desert section, but farming centers are developing in the vicinity of Florence and Casa Grande. The development of the greater part of the agricultural area outside the stream bottoms will probably depend upon effective storage of the Gila River waters.

DRAINAGE.

The natural drainage in the Gila River bottoms, where most of the agricultural development has taken place, is poor. These lands lie only a little above the channel of the stream. An underlying stratum of gravel and sand permits of the ready movement of underground water, and there is generally a high water table. The poor drainage of the bottoms is further accentuated by seepage from irrigation upon adjacent terraces or uplands and by the underground flow from tributary creeks and drainage ways. The latter is of importance in numerous places, but is especially pronounced at the place where the McClellan Wash enters the Gila River bottoms. Drainage is also poorly developed locally in the shallow and imperfect drainage ways of the desert. Here the gradient is low, and the run-off and percolation much retarded. The greater surface slope and more pervious subsoils of the bottoms make the drainage more perfect than in the case of the low, flat desert areas of old valley-filling soils, with their slight slope and dense compacted subsoil. The high water table of the bottoms is often relieved by open ditches and sometimes by tile drains. Little attempt has been made to provide drainage for the broad flats of the desert, cultivation being confined to the better drained soils.

ALKALI.

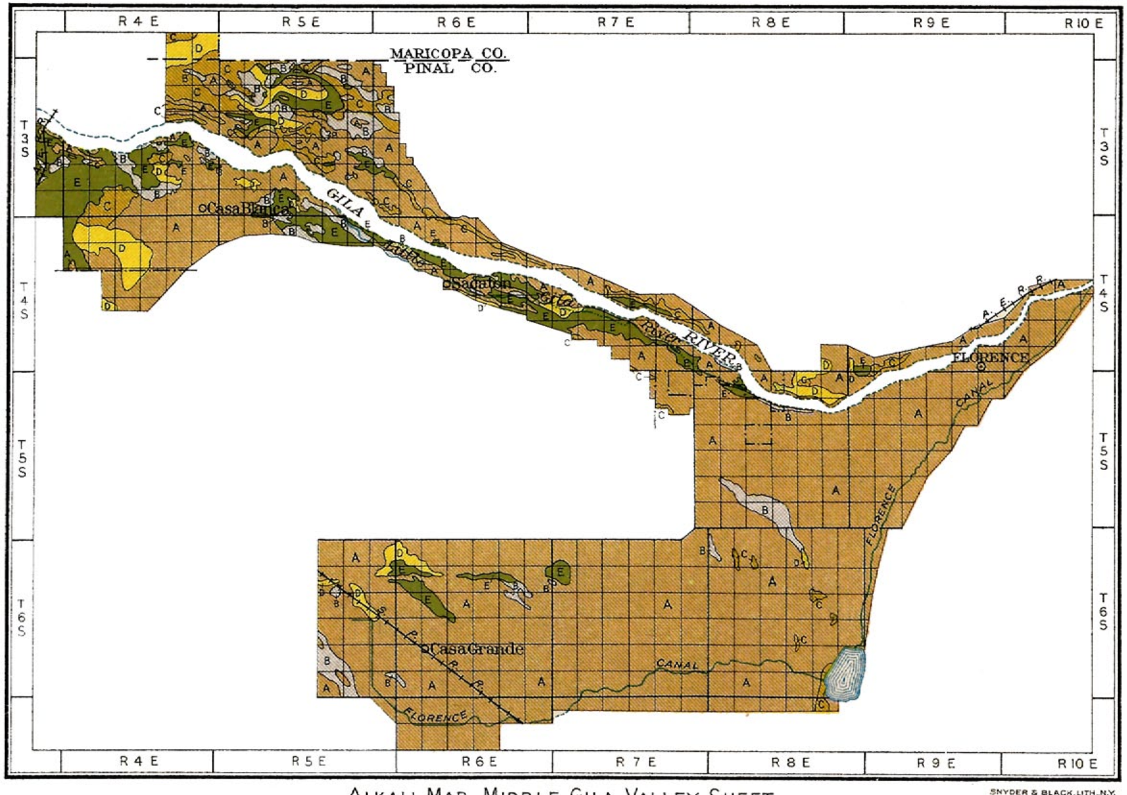
The Middle Gila Valley area is situated in an arid region of excessive evaporation, where soluble salts are readily accumulated. More than 50 per cent of the area is more or less affected by alkali accumulation. The following table shows the results of an analysis of a composite sample of alkali crust taken in various parts of the survey:

Chemical analysis of alkali crust.

[Parts per 100,000.]

Constituent.	Quantity.	Constituent.	Quantity.
Ions:		Conventional combinations:	
Mg	Trace.	$CaSO_4$	Trace.
Na	16,673	$MgSO_4$	Trace.
K	208	K_2SO_4	463
SO_4	8,408	Na_2SO_4	12,066
Cl	16,080	NaCl	26,535
HCO_3	424	$NaHCO_3$	584
CO_3	2,792	Na_2CO_3	4,937
Ca	Trace.		

The above results show that sodium chloride, sodium sulphate, and sodium carbonate predominate in the alkali of this area. Sodium chloride, or common salt, is by far the most abundant, composing a little more than 25 per cent of the average crust. The sodium sulphate constitutes a little over 12 per cent, while the proportion of sodium carbonate, commonly known as black alkali, is less than 5 per



ALKALI MAP, MIDDLE GILA VALLEY SHEET

A	B	C	D	E
Less than 200 parts per 100,000	From 200 to 400 parts per 100,000	From 400 to 600 parts per 100,000	From 600 to 1,000 parts per 100,000	Over 1,000 parts per 100,000

cent. A very small proportion of sodium bicarbonate is also present. Of the principal bases which combine to form the alkali salts, sodium is the only one of importance represented in the surface crust. Potassium, magnesium, and calcium exist only in very small amounts, or traces.

The alkali salts are all highly soluble and their presence in the surface soil is due principally to the evaporation of soil waters. They have for the most part been transported to the localities in which they occur by subsurface and surface drainage waters carrying them in solution.

The conditions of drainage in the bottom soils differ from those in the upland or desert soils. The soils of the Gila River bottoms, as has been pointed out, are affected by seepage and have a high water table; this, with their texture and structure, which favor capillarity, has caused the large accumulations in the valley. The heavy alkali crusts formed during the dry season are partly removed in surface drainage waters or are carried downward during the rainy period.

The desert or upland soils generally have impervious subsoil layers, and where they are affected by alkali, little free movement of the salts in subsurface waters is possible. In many places the crusts of surface salts are very thin even during the driest season, although the areas are barren of vegetation and the total average alkali content high. Many of the barren alkali flats are interrupted or bordered by slightly higher lying soils of lighter texture, which are frequently free from surface accumulations of alkali. The flats receive run-off from the adjacent soils, and the water remains until removed by evaporation or percolation. Both the suspended sediments and the salts in solution are deposited, and upon drying form a smooth, hard, surface which greatly retards the movement of the salts.

Owing to these different conditions the distribution of alkali salts in the 6-foot profile varies greatly with the different soils and situations. Alkali in general is more uniformly distributed through the soil profile in the recent-alluvial soils than in the old valley-filling or desert types with compacted subsoils. Where the distribution is unequal, the zone of maximum concentration usually lies between the first and third feet in the recent-alluvial soils, while in the desert types the zone of highest salt content is usually deeper.

The distribution and degree of concentration of the alkali areas are shown on the accompanying alkali map. The mapping is based upon field determinations with the electrolytic bridge method. The average salt content of the 6-foot profile, based upon the content of each foot section, is determined. The results are expressed in terms of parts per 100,000. Five grades of alkali land are shown. Grade A comprises soils in which the average concentration of salt is under

200 parts per 100,000 of air-dry soil; grade B represents soils containing between 200 and 400 parts; grade C between 400 and 600 parts; grade D between 600 and 1,000 parts; and grade E those containing over 1,000 parts.

Alkali conditions in the field are indicated largely by surface appearance, vegetation, and topography, and the differentation of the alkali soils into the above grades is aided largely by field observations of these factors. On soils free from alkali or possessing only small amounts in the root-feeding zone, such native plants as desert sage, creosote bush, rabbit brush, and several varieties of cactus thrive. On the more heavily impregnated soils squaw-bush, salt-blight, greasewood, and pickleweed grow. Of course, where alkali is concentrated in the subsoil the vegetation is not a safe guide, but enough checks are made with the bridge to guard against mistake of this kind.

The areas of alkali soil increase in size and in degree of salt concentration as the lower levels to the west are approached. Many of the flat, shallow valleys that traverse the area in a northwesterly direction have only slight indications of alkali at their higher levels, but include areas of high alkali concentration in their lower reaches. While much of the soil of the Gila River bottoms below Blackwater contains alkali, alkali-free areas occur in places. Above Blackwater the alkali areas are smaller and of less importance. The immediate overflow plain of the Gila River is little affected by alkali, the low terrace between the overflow plain and the uplands containing the areas of highest concentration. The largest alkali-free areas lie in the southern part of the survey, between McClellan Wash and Casa Grande, and east and northeast of McClellan Wash. An extensive alkali-free area roughly parallels the Southern Pacific Railroad. The slopes about the mountains and foothills are generally free from injurious amounts of alkali, except in the vicinity of seepage channels. Plate A shows the general distribution of alkali lands in the area.

All of the soil types except the Pinal gravelly sandy loam are affected in places by alkali. The Gila fine sand and silty clay loam frequently contain injurious amounts, but the Pima clay, one of the important agricultural soils, generally contains only small amounts. The McClellan loam, silty phase, is free from alkali, while the shallow phase of the same type generally contains varying amounts. The Mohave sandy loam and fine sandy loam are generally well drained and contain alkali only locally or in the marginal zones of the areas.

Prior to the coming of the white man the Indian reclaimed small patches of land in the Gila River bottoms, using the floodwater of the Gila River for irrigation. In many instances lands high in concentration of salts were brought to a productive state by repeated flooding over several seasons, and further improved by irrigation and cultivation.

The elevation and subsoil characteristics of the alkali lands greatly influence the possibility of reclamation. The mere flooding of the upland soils frequently removes enough alkali to permit the growing of crops, where the subsoil is not too compact and impervious, but in the bottoms the usually high water table must be lowered by resorting to artificial drainage before the lands can be permanently reclaimed. Many tracts of land in the Gila bottoms have been made productive merely by repeated flooding, but when cultivation and irrigation cease for several seasons these soils tend to revert to their former condition. Soils containing small amounts of alkali, evident only in level spots, produce well when properly cultivated and irrigated. In upland areas of high salt concentration where there is an impervious subsoil several feet in thickness, and in many of the badly affected bottom soils, the cost of permanent reclamation by means of drainage and flooding is prohibitive under present economic conditions.

SUMMARY.

The Middle Gila Valley area includes the bottom and terrace lands of the Gila River from a point about 5 miles northeast of Florence to Sacate and a part of the desert plains east and south of the Sacaton Mountains. Almost all the territory lies in Pinal County. The survey covers 352 square miles, or 225,280 acres.

Elevations range between 1,150 feet and 1,525 feet above sea level. Several small buttes within the area and the included parts of the adjacent mountain slopes are stony and of little agricultural value.

The Gila River is the principal drainage way in this part of the State. McClellan Wash and Santa Cruz Wash drain the greater part of the desert plains within the area. The channel of the Gila River is broad, with poorly defined banks, and overflows are frequent. The channels of the McClellan and Santa Cruz Washes are poorly defined and have little fall, much land being flooded at irregular storm periods along their courses.

The population of Pinal County in 1910 was 9,045. Nearly one-third of this consisted of Indians on the Gila River Indian Reservation. There are many Mexicans and small numbers of Negroes, Chinese, and Japanese. There are two incorporated towns in the area and several Indian villages. Florence is the largest town and the county seat of Pinal County.

The Southern Pacific Railroad and the Arizona Eastern Railway touch the area, but most of the farms are remote from shipping points.

The climate is warm and arid. The mean annual precipitation at Phoenix is 6.8 inches and at Maricopa 6.24 inches. Two wet seasons occur, one in the spring and one in the late summer. The mean annual temperature at Maricopa is 69.6°. Maximum temperatures as recorded at this station range between 110° and 126°. The lowest temperatures are usually above 25°, but a minimum of 8° has been recorded. The average date of the last killing frost in the spring is March 7, and that of the earliest in the fall, November 27.

Irrigated farming was carried on in the Gila Valley by prehistoric races, and by Indians for centuries preceding settlement by the whites. Grain was the chief crop grown by the Indians, and is still very important.

The principal agricultural products are cereals, chiefly wheat, hay, mainly alfalfa, and live stock. Corn is grown to some extent. Egyptian corn and milo are becoming important crops. Long-staple Egyptian cotton has been introduced and promises to become a very important money crop with both white farmers and Indians.

The methods in use by the white farmers are good, but the Indian is slow to adopt modern methods and machinery.

The possibility of irrigation and presence of alkali have had more influence on the distribution of crops than has soil character.

The Pima Indians and Mexicans supply most of the farm labor. Over 95 per cent of the farms were operated by the owners.

The soils of the Middle Gila Valley fall into three main groups—residual, old valley filling, and recent alluvial. The old valley-filling group is most extensive, and includes the desert or upland soils. The recent-alluvial group includes the soils at present of greatest agricultural value. The residual group is unimportant, including the one nonagricultural type, Rough stony land.

Five series, including eight soil types, are recognized and mapped in this area, in addition to Rough stony land and Riverwash. The old valley-filling soils cover about 75 per cent of the area. They are derived from weathered and altered old-alluvial deposits, and are characterized by a limy, compacted or cemented subsoil or hardpan. The surface is smooth or undulating. Three soil series are recognized under this group, the Pinal, Mohave, and McClellan.

The Pinal gravelly sandy loam has a cemented, gravelly hardpan. The Mohave series consists of light-textured, red or reddish-brown soils, with a compact subsoil approaching a hardpan. Two types, in which some alkali occurs, are included in this series. The McClellan series is darker and browner in color than the Mohave. Two types are included, the heavier of which has a level surface and contains alkali.

The recent-alluvial soils, confined to the bottoms and low terraces of the Gila River, are classified with the Gila and Pima series. These types have more friable subsoils, contain more organic matter, and are more poorly drained than those of the old valley-filling group. The Gila soils are brown and underlain by a permeable subsoil; the soils of the Pima series have similar characteristics except color, which is darker. Alkali is present in places in both these series. The soils are overflowed and have a high water table.

Irrigation is necessary to insure crops in this region. In 1910 there were 25,431 acres under irrigation. Practically all the water for irrigation is obtained by gravity from the Gila River. This is generally of good quality. Water is also obtained from wells. This may be somewhat higher in soluble salts than the river water. Storage of the waters of the Gila River is necessary to the permanent development of the desert lands.

More than 50 per cent of the lands in this area contain more or less alkali. Sodium chloride, sodium sulphate, and sodium carbonate predominate in the alkali crust. Sodium chloride is by far the most abundant. The chief alkali areas occur at the lower levels, in the western and southwestern parts of the survey. The largest alkali-free areas occur northeast and east and to the west of McClellan Wash. Alkali-free areas also occur along the Southern Pacific Railroad and on the mountain and foothill slopes.

[PUBLIC RESOLUTION—No. 9.]

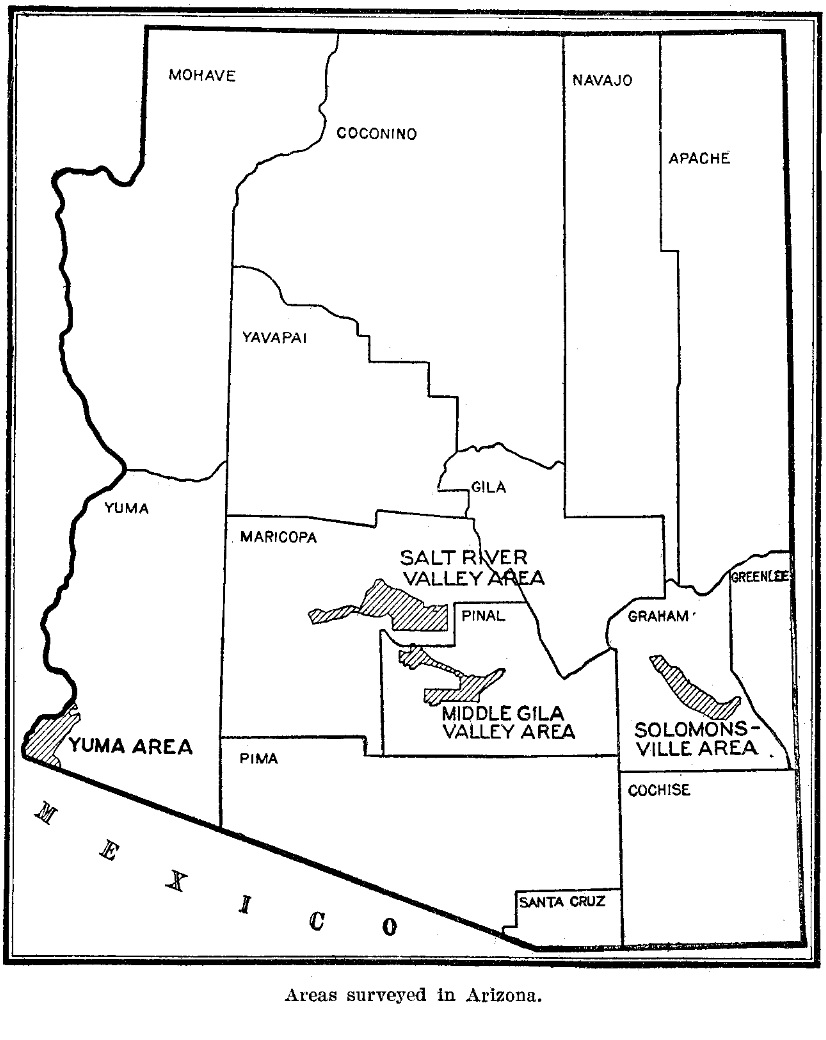
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Arizona.

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