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Soil Survey
of
The Rincon Area, New Mexico

By

A. T. SWEET, in Charge

and

E. N. POULSON

Bureau of Chemistry and Soils

In cooperation with the

New Mexico Agricultural Experiment Station

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CONTENTS

SOIL SURVEY OF THE RINCON AREA, NEW MEXICO

By A. T. SWEET, in Charge, and E. N. POULSON

AREA SURVEYED

The Rincon area occupies a part of the Rio Grande Valley in the south-central part of New Mexico. (Fig. 1.) It is about 50 miles in length, its southern boundary being about 65 miles north of El Paso, Tex., and its northern limit about 170 miles south of Albuquerque, N. Mex. The northern part of the area lies in Sierra County and the southern part in Dona Ana County. The northern part is known as the Palomas Valley, the southern part as the Rincon Valley. In width the area varies from about 1½ to 2½ miles, and it includes 89 square miles, or 56,960 acres. It occupies the upper part of the Rio Grande Federal reclamation project.

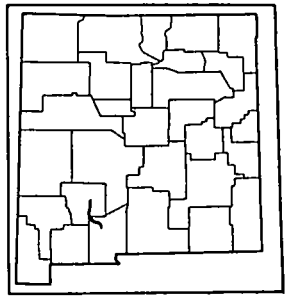


FIGURE 1.—Sketch map showing location of the Rincon area, N. Mex

The area consists mainly of a nearly level alluvial plain through which meanders the Rio Grande. The river occupies a broad, shallow channel only a few feet lower than the adjacent flood plain which is not of uniform height but consists of a series of low terraces, low-lying old stream channels, outwash slopes, and alluvial fans. This recently formed flood plain is in places bordered by old high level terraces which are separated from the stream valley by steep gravel-capped slopes. In other places steep hill and mountain slopes rise abruptly from the edge of the valley. Arroyos entering the valley from either side cut low belts across the high terraces and deposit large quantities of bowlders, gravel, sand, and finer soil material in the main valley.

Beyond the high terraces and adjacent hills the Caballo Mountains form the first range along the east side of the valley and the Black Mountains the first range on the west side. Farther eastward are the higher San Andres Mountains which have an elevation of more than 7,000 feet above sea level, and on the west the Mimbres Range, parts of which reach an altitude of more than 8,000 feet.[1]

The elevation of the Rio Grande Valley at Tonuco, near the southern extremity of the area, is 4,012 feet above sea level, and at

[1] DARTON, N. H. "RED BEDS" AND ASSOCIATED FORMATIONS IN NEW MEXICO, WITH AN OUTLINE OF THE GEOLOGY OF THE STATE. U. S. Geol. Survey Bul. 794, 356 p., illus. 1925.

the proposed diversion dam site a mile south of Hot Springs, at the extreme northern end of the area, it is 4,250 feet.[2] The average slope is therefore approximately 5 feet a mile.

The area surveyed is confined largely to the soils of the river flood plain, but the lower adjacent mountain slopes, parts of the valleys of the tributary arroyos, and parts of some of the adjacent high terraces have been included.

The immediate flood plain of the valley proper consists of narrow low-lying belts, in most places adjacent to the river channel and lying at an elevation ranging from about 2 to 4 feet above it. Within the channel are numerous low-lying islands. Back of the low belts and in places bordering the channel are broader low terraces, most of them from 6 to 10 or more feet higher than the low belts or the river. These terraces are not uniform in height and in many places consist of two or more low terraces separated by slight, abrupt drops of only a few feet.

In places, meandering through the valley and cutting into the terraces or following along the foot of the bordering hill slopes and escarpments are remnants of old abandoned stream channels. In some places these form horseshoe lakes, but in most places they consist of long, narrow, poorly drained low belts of darker-colored soil of heavy texture. Along the outer edge of the valley are narrow sloping rims of outwash material which has been eroded from the slopes above.

The old high terraces, parts of which have been included in the area surveyed, lie at elevations ranging from 40 to more than 75 feet above the valley floor. The surfaces of these are nearly level and terminate on the valley side in very steep slopes, in the upper part of which are exposed thick beds of rounded stream gravel. On the outward side they merge into the higher adjacent hills or are terminated by steep escarpments marking still higher old terraces.

Through the adjacent hills and the old high terraces, large arroyos have cut broad valleys almost to the level of the main valley. In these smaller tributary valleys the streams follow one or more channels filled with a mass of bowlders, gravel, and sand. In addition to the gravel-strewn channels of the tributary arroyos, their valleys also include broad terraces which are, for the most part, too high for irrigation from the main ditches.

CLIMATE

The climate of the Rincon area is typical of the arid Southwest. It is characterized by a high percentage of clear days, light rainfall, and very little snow. The air is dry, the wind movement free, and evaporation high, all of which increase aridity.

United States Weather Bureau records at Garfield and Rincon are fairly representative of climatic conditions in the area as a whole. The mean annual precipitation at Garfield is 10.47 inches, about one-half of which falls during the spring months. This is insufficient for growing crops without irrigation but is of value in adding moisture to the soil, especially during the planting season. It also

[2] United States Reclamation Service map, Rio Grande reclamation project, 1922

supplies moisture for a sparse grass growth on the mesas and adjacent hill and mountain slopes.

The mean annual temperature at Rincon is 59.6° F., with a very wide range in actual temperature from −10° to 114°. The average length of the frost-free season at Garfield, from April 9 to October 23, is 197 days. The frost-free season in the northern part of the area is slightly shorter, and injury from late frosts in the spring and early frosts in the fall is somewhat greater than in the southern part. This is especially important in the growing of cotton, a difference in the length of season of but a few days, at times, making an important difference in the crop yield. For this reason, the Rincon area is not so well suited for growing cotton as is that part of the Rio Grande Valley only a short distance to the south.

Table 1, compiled from the precipitation records at Garfield and temperature records at Rincon, gives the more important climatic data for the area.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Garfield and Rincon, N. Mex.*

[Elevations, Garfield, 4,100 feet, Rincon, 4,030 feet]

Month	Temperature [1]			Precipitation [2]			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1857)	Snow, average depth
	° F	° F	° F	*Inches*	*Inches*	*Inches*	*Inches*
December	40 5	79	2	0 58	0 10	1 10	1 4
January	41 3	80	−10	45	[3]	0	1 7
February	46. 2	82	4	50	[3]	2. 51	.6
Winter	42. 7	82	−10	1 53	10	3 61	3 7
March	52. 6	92	14	32	[3]	0	3
April	58. 6	94	17	27	41	01	[3]
May	66 8	110	29	18	[3]	0	0
Spring	59 3	110	14	77	41	01	3
June	75 9	114	39	69	1 02	0	0
July	79 0	113	48	2. 15	16	4. 70	0
August	77 1	104	44	2 39	1 89	5 10	0
Summer	77 3	114	39	5 23	3 07	9 80	0
September	70 8	102	30	1 88	48	6 13	0
October	59 3	93	19	64	29	1 00	[3]
November	48. 1	84	5	42	46	0	[3]
Fall	59 4	102	5	2 94	1 23	7 13	[3]
Year	59 6	114	−10	10 47	4 81	20 55	4. 0

[1] Record from Rincon

[2] Record from January, 1854, to December, 1856, at Fort Thorn, about 10 miles southwest of Garfield, from 1894 to 1918 at Rincon, 12 miles southeast of Garfield.

[3] Trace.

AGRICULTURE

Agriculture in the Rio Grande Valley was carried on prior to the earliest Spanish explorations, early in the sixteenth century. The Pueblo Indians and later Mexicans farmed in a small way, growing

food supplies of corn, melons, peppers, and possibly other crops. Within the section included in the Rincon soil survey area there were a few American settlements prior to the establishment of irrigation under the Rio Grande irrigation project. These were largely livestock ranches, but some general farming was done and a few orchards were planted.

Although this area covers but a small part of the Rio Grande reclamation project, the same crops are grown in about the same proportions as on the project as a whole and the same changes have taken place. The comparative importance of these crops is well shown in Table 2, which gives the acreage of crops grown on the Rio Grande Federal irrigation project from 1915 to 1926.[3]

TABLE 2.—*Acreage of crops on Rio Grande Federal irrigation project, 1915–1926* [1]

Crop	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Cotton				608	289	15,996	4,318	13,319	36,364	58,721	81,373	83,337
Alfalfa	22,152	37,762	26,112	28,867	27,087	27,099	29,919	33,971	31,671	25,411	23,159	25,833
Other hay	20	141	440	387	293	785	1,562	1,409	805	2,053	386	403
Alfalfa seed	29	607	33	83	156	152	477	118	387	41	8	
Corn	3,718	8,253	10,566	10,175	10,925	10,544	14,406	10,905	6,068	3,303	3,978	7,844
Corn and cane fodder	961	1,254	2,113	4,978	4,493	2,284	3,696	2,846	5,839	1,753	2,258	2,771
Grain sorghums		703	1,894	296	38	268	282	226	31	35	181	63
Wheat	2,009	5,988	11,714	11,651	10,233	8,335	9,995	7,769	2,377	663	465	495
Oats	771	1,623	1,145	697	769	332	992	923	390	95	83	684
Barley	193	1,271	3,610	428	789	909	650	448	101	50	17	60
Rye		1	65	85	110	71	2		13	1		10
Apples	166	309	378	95	451	511	243	732	728	412	578	449
Pears	246	615	814	476	750	576	454	955	657	791	621	513
Peaches	121	194	228	99	162	47	81	147	199	197	162	133
Prunes					7	9			6			
Small fruits	132	103	115		148	177	83	84	339	368	231	137
Cabbage					303	119		308	105	122	44	140
Cantaloupes	105	168	548	57	906	2,232	981	881	1,312	1,697	1,976	2,550
Sweetpotatoes	158	226	338	177	605	365	671	636	313	309	238	535
Potatoes			7	7		9		2	11		3	7
Beans	448	1,292	4,011	2,648	686	616	790	1,264	928	279	198	411
Onions	7	8	11	1	7	131	134	146	94	50	121	131
Chilies					23	20	73	56	50	117	182	193
Tomatoes			148	204	250	30	14	32	5	41	72	155
Peas	3	18	114	10		114	21	42	63			43
Watermelons		15	84	85	42	116	212	232	213	112	28	178
Sugar beets	1	103	1,078	5	10			43	1			
Garden crops	1,147	2,010	2,160	657	2,301	2,373	2,475	3,839	2,715	2,046	3,119	1,108
Total	32,246	61,818	63,626	64,002	65,462	77,880	77,651	84,413	93,731	103,115	121,799	128,858

[1] Data from U S Bureau of Reclamation records

From Table 2 it will be noted that the total cropped area increased from 32,246 acres in 1915 to 128,858 acres in 1926. The cotton acreage increased from 608 acres in 1918 to 83,337 acres in 1926. Alfalfa, the second crop in importance, increased from 22,152 acres in 1915 to 37,762 acres in 1916. The acreage in this crop has fluctuated considerably. Corn, the third crop in importance, during the early years of irrigation under the Federal project, increased from 3,718 acres in 1915 to 14,406 acres in 1921, but, as the cotton acreage expanded, decreased to 7,844 acres in 1926. Small grains, especially wheat, have shown a steady decrease and are at present crops of little importance. The acreage in tree fruits (apples, peaches, and pears),

[3] NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANIC ARTS, EXTENSION SERVICE. ECONOMIC SURVEY AND CONFERENCE ELEPHANT BUTTE IRRIGATION DISTRICT, FEBRUARY, 1927 OUTLINE REPORT AND SUMMARY OF RECOMMENDATIONS. Conference held at State College, N. Mex., Feb. 15–16, 1927 El Paso, Tex., Feb. 18–19, 1927. [441] p., illus. [Mimeographed]

crops of only minor importance, has remained nearly stationary. The acreage in cantaloupes increased from 105 in 1915 to 2,550 in 1926, and that of sweetpotatoes has increased slightly. Beans, onions, chilies, tomatoes, and watermelons are grown but are crops of comparatively minor importance.

In 1926 cotton occupied 64.6 per cent of the crop acreage, alfalfa 20.5 per cent, corn 6.1 per cent, corn and sorghum cane fodder 2.1 per cent, cantaloupes 1.9 per cent, and other unimportant crops less than 1 per cent each.

The number and value of livestock on the project in 1926 is shown in Table 3.

TABLE 3.—*Number and value of livestock on the Rio Grande Federal irrigation project, 1926* [1]

Kind of livestock	Number	Value	Kind of livestock	Number	Value
Horses	6,473	$382,363	Hogs	2,662	$40,652
Mules	3,423	267,540	Brood sows	214	7,890
Beef cattle	303	12,775	Fowls	145,368	153,693
Dairy cattle	6,599	601,440	Hives of bees	1,584	7,784
Sheep	2,848	18,937			

[1] Data from U. S. Bureau of Reclamation records

Beef cattle in 1926 had decreased to less than one-eighth the number in 1915, but during this time the number of dairy cows had greatly increased.

Committees of farmers of the Rio Grande Federal reclamation project in 1927 made the following recommendations that are applicable to the Rincon area at the present time.

Since the cotton acreage had increased from less than 1 per cent of the total crop acreage in 1919 to 65 per cent in 1926 and yields, when grown on new land or following alfalfa, are large, cotton was recommended for the major crop. It was also recommended that only one variety—Acala—be grown, that sufficient hay be provided to feed all farm animals, and that at least one year in four cotton land be seeded to alfalfa.

In 1926 only about one-fourth of the feed consumed on the project was grown locally. Since corn is the most satisfactory grain and forage crop, each farmer should produce all the corn for grain, forage, and silage needed for his own livestock. Corn as a cash crop should be grown only where yields of 50 or 55 bushels can be obtained. Sweet sorghums are recommended only when the season is too far advanced to plant corn.

The production of small grain is not encouraged unless 40 bushels an acre can be obtained, which is double the average yield on the project, or unless the small grain is to be followed by another crop. Winter wheat is preferred to spring wheat. Barley, oats, and rye should be grown for feed or pasture only. More extensive use of sweetclover, where alfalfa does not do well, is recommended.

Livestock production is not encouraged, on account of the high price of grain feeds. Hogs for home consumption, with some production beyond this, is recommended. The feeding of cattle and sheep on a large scale is not recommended. Milk is produced on

a whole-milk basis, and it could not be produced on a butterfat basis unless the cost of feed were reduced. No increase in egg production is encouraged.

There is room for expansion in the production of early varieties of apples. If the production of winter varieties is increased, they should be Jonathan, Delicious, or Starking, which ripen in late summer or early fall. It is not advisable to increase peach production, and no increase in the production of pears or grapes for eastern markets is recommended.

Cabbage and tomatoes have been produced in quantities sufficient for car-lot shipments. The growing of cantaloupes might be increased, if Government inspection were provided. Sweetpotatoes are grown commercially, also chilies to some extent. Spinach, beets, carrots, turnips, string beans, parsnips, asparagus, and eggplant should be grown for mixed car-lot shipment. Sweet corn and watermelons should be grown for local requirements.

It is recommended that prospective purchasers rent land for a year before purchase is made, and that the first purchase be small and additional land rented for a year or two before buying. The advantage of purchasing land that is improved rather than raw land is emphasized.

The desirability of having land properly leveled before irrigating is recommended, and leaching is recommended as the best means of reclaiming land from alkali. Horses rather than tractors are favored for farms of less than 80 acres.

In the Rincon area, on account of the season being very slightly shorter, with more danger from late frosts in the spring and early frosts in the fall than in the lower part of the valley, cotton is not quite such a dependable crop. It should, however, be grown as the leading money crop, but more attention should be given to alfalfa, dairying, and poultry raising. Corn for use on the farm, truck, garden crops, and fruits for home use and to supply the local demand should be grown. There would seem to be opportunity for the establishment of small local canneries, especially for the canning of tomatoes, green beans, and a few other crops.

Considerable manure from work animals, dairy cows, and other livestock is available and seems to be carefully used, especially on cotton. Good results have been obtained on alfalfa by applying from 125 to 150 pounds an acre of superphosphate every third year.

In the Rincon Valley and that part of the area south of the Garfield flume, probably 80 per cent of the irrigable land is cleared and under irrigation, a large acreage having been cleared, leveled, and cultivated within the last few years. At present, 1930, clearing and leveling are being carried on in a number of places.

In the Palomas Valley and all that part of the area north of the Garfield flume, probably not more than 40 per cent of the land which may be irrigated is under cultivation. This lack of development has been due in part to the poor roads by which this part of the area could at one time be reached before the construction of United States Highway No. 85 and the bridge south of Garfield flume. Drainage ditches for this part of the area have not been constructed, therefore the danger from alkali is increased after the land has been irrigated. Much of the land is held in large tracts by nonresident owners. A

secondary storage dam below Caballo is proposed. Should this be constructed a large area of valley land will be inundated. These conditions have combined to retard settlement of the northern part of the area.

The cost of clearing new land varies widely, depending on the character of the vegetal growth, and is believed to range from $10 to $25 an acre. Where large cottonwoods are abundant, they are pulled over with stump pullers and the wood cut for the market, but the demand for such timber is not great. The cost of clearing land overgrown with tornillo and cachanilla is less than of clearing land supporting a heavy growth of cottonwoods. The cost of leveling the land and preparing it for irrigation is, in most places, much more than the cost of clearing. For this reason, land which may seem low in price to the inexperienced settler often proves to be very expensive. In general, the better grade of land—that having good soil texture, fairly level, free from alkali, and well drained—is the most profitable investment. Such land cleared and under cultivation can frequently be bought for less than the cost of new land with the added expense of putting it under cultivation.

The Rio Grande Valley was settled by Spanish-Americans long before it became United States territory. The principal settlement of the Rincon area by English-speaking Americans has taken place, however, since the completion of the dam of the Elephant Butte project in 1916. Settlers have been attracted by the climate, and some were induced to settle through advertising by chambers of commerce.

Only a small percentage of the total acreage in the Mesilla and El Paso Valleys, which have since become highly developed, was in cultivation at the time of the inauguration of the Federal reclamation project, and even a smaller acreage was under cultivation in the part of the valley included in the Rincon area. Since that time settlement has steadily increased, the larger number of new settlers coming from Texas and Oklahoma, some from other States to the east, and some from Arizona and California. Much of the land, especially in the Palomas Valley, is held in large tracts by nonresidents and is unimproved. The average farm unit under irrigation is only about 40 acres.

A study of 69 farms in the Mesilla Valley in 1927 showed a total investment of more than $17,299 a farm and an indebtedness of $7,461 a farm.[4]

Farm improvements, as in most newly developed sections, are in general not very good. Adobe houses and farm buildings are in general use, many of which are permanent and comfortable. Many farm tenants and sometimes the owners live in "jacales," or temporary dwellings, built of poles set in the ground, the cracks daubed with mud, and the roof made of cachanilla covered with soil.

Many small farms are owned and operated by Spanish-Americans, but there is said to be a gradual increase in the number of English-speaking landowners and tenants.

Hatch is the largest town in the area, and Rincon, in the eastern part of the Rincon Valley, is the second largest. Other villages are

[4] NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANIC ARTS, AGRICULTURAL EXTENSION SERVICE Op cit, p 39 (See footnote 3)

Garfield, Las Palomas, Derry, Rodey, Arrey, Caballo, Salem, and Santa Teresa. Hot Springs is a health resort near the site of the Elephant Butte Dam, only a short distance north of the area surveyed.

The Albuquerque-El Paso branch of the Atchison, Topeka & Santa Fe Railway reaches the surveyed area at Rincon, and the Silver City branch extends from Rincon through Hatch to Deming and Silver City. United States Highway No. 85 extends throughout the full length of the area, connecting with El Paso on the south and Albuquerque on the north.

Three cotton gins are within the area, one at Hatch, one near Rincon, and one at Garfield. The larger part of the freight of the area is hauled by truck to and from El Paso. Daily autobus service is available to and from El Paso and Albuquerque.

Considerable areas of the main soil types have not yet been cleared or are at present being cleared. The character of the natural vegetation is therefore readily seen.

The alluvial soils of the Rio Grande flood plain, before being cleared, support a rather dense growth of trees and shrubs. In places this consists principally of large cottonwoods, the branches of which are covered with a heavy growth of mistletoe. (Pl. 1, A.) In many places the trees are very tall, grow close together, and shade the ground so that smaller trees and shrubs can not grow. Many clumps of large cottonwoods occupy soils (of medium or heavy texture) of the Pima and Gila series.

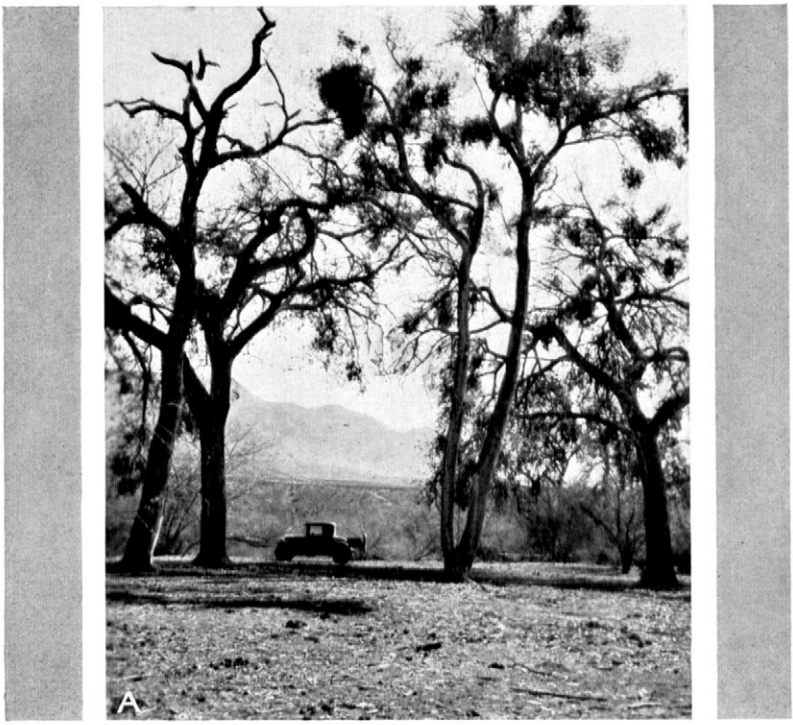
Areas in the valley, in which the undergrowth is dense, are known as "bosques." In the bosques the most common shrub is the tornillo, or screw bean. It grows from 5 to 10 feet tall, is wide spreading, and very thorny. Associated with it in many places are low-growing mesquites. In the valley small willows and in places ash are present.

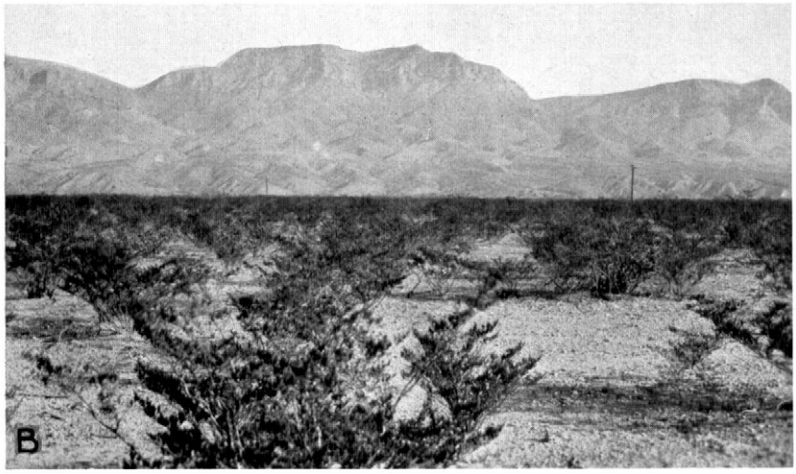
Sandy areas of the valley support a thick growth of cachanilla, or arrowwood, the most reliable indicator of sandy soils in this region. On the high level terraces, with shallow soil which contains a high percentage of lime, creosote bush is the predominant growth. (Pl. 1, B.) On the low terraces of the arroyo valleys popotillo, or Mormon tea, grows abundantly. On the slopes occupied by the Anthony soils is a mixed growth consisting of mesquite, yucca, buckthorn, chamiza, the common name used in New Mexico for fourwing saltbrush (*Atriplex canescens*), crucifixion thorn, and several other shrubs. Over much of this region there is also a thin growth of buffalo grass and grama. Cacti of several varieties were noted during the progress of the survey.

IRRIGATION, DRAINAGE, AND ALKALI

The normal annual rainfall in this region is about 10 inches, the summer season is long, and evaporation is high. From a free water surface, evaporation has been found to be nearly 8 feet a year.[5] The growing of field crops without irrigation is therefore practically impossible.

[5] WILLARD, R E, and HUMBERT, E P SOIL MOISTURE N Mex Agr Expt Sta Bul 86 45 1913





A, Valley cottonwood which grows mainly on heavier types of Gila and Pima soils Note heavy growth of mistletoe on the branches B, Old high terrace, showing characteristic vegetation of creosote bush on Mohave and Pinal soils

Irrigation in the Rio Grande Valley began long before the arrival of the white man. Coronado, in 1541, found the Pueblo Indians growing crops by means of irrigation, but the early irrigation systems were crude and inefficient.[6]

Before the construction of the Elephant Butte Dam by the United States Bureau of Reclamation, a treaty was made with Mexico by which the United States agreed to furnish 60,000 acre-feet of water at the head of the old Mexican Canal near El Paso. "This was approximately the amount that had been used annually for about 300 years in the old Mexican Canal prior to 1880."[7]

Construction of Elephant Butte Dam in the Rio Grande a short distance north of the upper end of the Rincon area was begun in 1911 and completed in 1916 at a cost of $5,000,000. The reservoir formed has a capacity of 2,600,000 acre-feet, and the completed project includes about 632 miles of canals and laterals and 386 miles of drainage ditches. Only a comparatively small part of this mileage is included in the Rincon area.

The cost of construction has been about $90 an acre for the land which is irrigated. Under present arrangements this cost is to be paid in 27 years at the rate of $3.60 an acre each year. In addition, water is paid for at the rate of $1.65 an acre for the first acre-foot, 75 cents for the second acre-foot, and a smaller amount for water used in excess of this.

Only a small percentage of the acreage in the Mesilla and El Paso Valleys, constituting the lower part of the Rio Grande project and lying south of the limits of this area, was in cultivation at the time of the inauguration of the Rio Grande Federal irrigation project. In 1915, just before the storage works were completed, 33,876 acres were under irrigation. In 1926 the extent of irrigated land had increased to 142,523 acres, an increase of more than 400 per cent in 11 years. In the Rincon area the proportionate increase has probably been even greater.

Until the construction of the dam, practically the same primitive methods of irrigation followed by the Indians and early white settlers were practiced, but since that time much improvement has taken place in irrigation methods. To obtain the best results from the use of irrigation water, fields must be properly leveled and diked. In many places this is very expensive, sometimes costing as much as $50 an acre. Some new settlers with limited means prepare only a few acres each year but prepare that well. Others roughly prepare a much larger acreage but obtain a smaller acre yield on account of lack of preparation.

In extensive experiments carried on by the New Mexico College of Agriculture to determine the most economic use of irrigation water, it was found that for alfalfa the best duty was obtained from about 50 inches applied in 5-inch irrigations and for wheat from 15 to 20 inches applied in 4-inch irrigations. For miscellaneous crops the duty varied widely with the crop.[8]

For chilies, cabbage, tomatoes, and other crops requiring intensive cultivation, frequent light irrigations have proved best.

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[6] BLOODGOOD, D W, and CURRY, A S, NET REQUIREMENTS OF CROPS FOR IRRIGATION WATER IN THE MESILLA VALLEY, NEW MEXICO. N. Mex Agr Expt Sta Bul. 149: 4. 1925.

[7] WALKER, A L, and CURRY, A. S, THE STATUS OF LAND AND CAPITAL IN THE ELEPHANT BUTTE IRRIGATION PROJECT. Jour. Land & Pub Utility Econ 4: 77. 1928

[8] BLOODGOOD, D W, and CURRY, A S Op. Cit.

With increase in the acreage of irrigated land and the use of larger quantities of water, the problem of drainage has become important and in places is a serious one. The deep subsoil in such places becomes saturated and the ground water is gradually raised until it comes so near the surface that it interferes with the deep rooting of plants, and rapid evaporation results in an accumulation of alkali in the surface soil. This condition is most pronounced in the lower-lying areas, during the spring and summer seasons when irrigation water is used most freely. During the progress of the soil-survey work, which was carried on in the winter, ground water or saturated soil was reached at a depth of less than 5 feet in many low-lying parts of the area but in very few places in the higher irrigated parts.

Throughout much of the Rincon area thin layers of silt or clay occur at varying depths in the subsoil. In many places these are cross-bedded, forming lenses and pockets, and in soils of light or sandy texture may be beneficial because they are more retentive of moisture and plant food than are open, sandy subsoils. They may also be harmful through the checking or stopping of the downward movement of ground water, and probably in places they cause the establishment of temporary, or false, water tables.

Much of the surface accumulation of alkali in the higher-lying irrigated sections and those supplied with deep drainage ditches is believed to be due to this subsoil condition. A high water table not only causes an accumulation of alkali in the surface soil but also checks the growth of alfalfa and other deep-rooting plants. Such conditions can best be improved by open lateral ditches or tile drains.

In the Rincon Valley, drains have been installed and improvement in drainage and alkali conditions made, but much more reclamation work is necessary. In the Palomas Valley and throughout that part of the area extending from the vicinity of Plemons Mill northward, no drainage ditches have as yet been constructed. Surface accumulation of alkali is most prevalent in the lower-lying areas, especially those having a high water table, and in areas recently cleared and brought under irrigation, the soils of which have not yet been thoroughly leached. Where the water table is permanently 6 feet or more below the surface and the soil has an open sandy subsoil, the land may be reclaimed from alkali by leveling it, throwing up dikes, and keeping it flooded for various lengths of time. It should then, as quickly as possible, be cultivated and seeded. Sweetclover and alfalfa, where once established, so that surface evaporation is stopped or checked, are among the more desirable alkali-resistant crops. The loamy and sandy loam soils are the more readily reclaimed, but, on the other hand, the same quantity of alkali in such soils is more harmful than in soils of heavier texture. A concentration of white alkali between 0.2 and 0.4 per cent in a soil of light sandy texture has proved as harmful as a concentration between 0.8 and 1 per cent in a heavy silt or clay soil.[9] Alkali is also much more harmful in the surface soil, where it delays or prevents germination, than at a greater depth. It has a toxic effect in that it checks or prevents

[9] SWEET, A. T. SOIL FACTORS INFLUENCING CROP PRODUCTION IN THE ARKANSAS VALLEY, COLORADO. U. S. Dept. Agr. Circ. 55, 25 p., illus. 1928.

germination and plant growth and it may also deflocculate the soil, causing it to crust at the surface and to form hard clods, especially if cultivated when wet.

In its effect on the soil structure, black alkali, or sodium carbonate, is much more harmful than the white alkali salts which occur in this region. White alkali, however, under irrigation and cultivation, does influence soil structure, the surface crusting of the soil, the formation of clods, the absorption of irrigation water, and, where present in excessive quantities, the germination of seed and growth of crops. Even after seeds begin to germinate, alkali in small quantities retards germination and thereby causes a poor stand.

For the reclamation of alkali land, lowering of the water table to a depth of at least 6 feet is necessary. A crop should be established either by leveling, flooding, cultivating, and planting the land or by planting the crop without first flooding, after the land has been well prepared. If one crop fails, the soil should again be cultivated and another planted. Sweetclover is the most alkali-resistant useful crop of this region. Alfalfa, if it can once be established, withstands rather large quantities of alkali. Barley, millet, sorghum cane, and some other crops may be of use in reclaiming alkali land, not through the removal of appreciable quantities of salts but because they check surface evaporation and loosen the surface soil and subsoil so that the salts may be more readily leached out.

As alkali is freely soluble in water, it moves readily through the soil and tends to accumulate in certain places and disseminate from others within a short time if there has been a free movement of ground water and soil moisture. For this reason alkali determinations by means of the electrolytic bridge or by laboratory methods are of value in determining general conditions only at the particular spot from which the sample was taken and at that exact time. A sample taken but a few rods or a few feet away or taken at the same point after a heavy rain or period of irrigation may show very different results.

In the Rincon area a number of alkali determinations were made, using the electrolytic bridge. The soil was taken, for the most part, from spots where a surface crust, bare spots, or a growth of alkali-resistant plants indicated a high concentration. The determinations represent, therefore, about the maximum concentration at that particular place rather than the general average for that locality. They give, however, an indication of the quantity which might accumulate under poor drainage and a high water table. The result of these determinations is indicated on the accompanying soil map in the form of a fractional number in red. The upper number represents the concentration of salts in the surface soil to a depth of 1 foot and the lower number the average quantity between depths of 1 and 3 feet, expressed in percentage of total salts in the air-dry soil.

In the vicinity of El Paso, Tex., rather extensive work has been done in the reclamation of alkali land by means of leveling, diking, and flooding.[10] Data collected on the costs of reclamation from alkali on 11 farms and the profits and losses of crops produced show a cost ranging from $10 to $46 an acre, the average cost being about $25. The quantity of water used ranged from 2 to 5 acre-feet. Alfalfa was the crop most extensively grown following the flooding.

[10] CURRY, A. S. N. Mex. Agr. Expt. Sta. Bul. (Unpublished data.)

On five farms where alfalfa was grown this crop showed a profit ranging from $16.75 to $49 an acre, the average profit being $33.47. Other crops showing a profit were cotton, sorghum cane, and barley. Corn showed either a loss or only a very small profit.

In the Rincon area injury from alkali is not a serious problem on the higher-lying soils which have been under cultivation for a number of years, except in small spots. On the lower-lying soils and those which are at present being brought under cultivation, it is a very serious problem. On some fields in which the soil was well prepared and put in crops the past year less than half a stand was obtained, this poor stand being caused very largely by an accumulation of alkali in the surface soil (Pl. 2, A.) On the very low lying shallow soils with a high water table, where attempts are being made to grow crops by subirrigation, injury from alkali is especially acute or may become so. Livestock pastured on the land compact the soil, which tends to increase evaporation and the accumulation of alkali in the surface soil. Land with a permanently high water table can be of but little value for cultivated crops, and areas in which the water table rises to within 3 feet of the surface for any length of time may accumulate alkali in dangerous quantities.

EROSION

Control of erosion in the Rincon area and throughout the Rio Grande Valley in New Mexico is an important problem. The greatest injury to the farm lands of the valley arises, however, not from direct erosion but from deposition, the result of erosion.

Entering the valley from both sides at short intervals are numerous deep, broad arroyos with steep gradient. These are entirely dry except following torrential rains which occur with varying intensity. At such times deep, swift currents of water rush through the arroyos and carry out into the main valley large masses of rounded bowlders, gravel, sand, and in places red clay. So deep and swift are the streams at such times that, for the safety of travelers, even the smaller ones are provided along the highways with broad concrete " dips " marked by concrete posts on which the depth of water is indicated.

In the river valley good agricultural lands have in many places been deeply covered by débris, much of which is of low agricultural value. Irrigation and drainage ditches are filled, siphons become choked, and in places even the course of the river is diverted. Valuable farm lands are ruined, and expensive construction work becomes useless.

In low places, especially in old river channels, heavy red clay is deposited, changing fairly friable tillable soil into one much more refractory. In other places, especially in the lower valleys of the arroyos where tillable soils have developed, the land becomes so gullied that it is of very little value, even for pasture land.

Injury from erosion, however, is not confined to that done by waters from arroyos. Throughout its length, the flood plain of the Rio Grande, on which the best agricultural lands have developed, is bordered by steep hill slopes or slopes of old high alluvial terraces. Along the foot of both there is a progressive movement of

soil, sand, and gravel from above. Much of this material is non-agricultural, or nearly so, on account of its loose open structure and also because it is above the irrigation ditches. This border of unproductive land increases from year to year. From some slopes, soils highly impregnated with alkali are carried into the valley, and by them existing alkali conditions are made worse.

As a result of erosion and deposition, the channel of the river itself is being filled, the stream bed raised, and the general level of ground water brought nearer the surface. The whole scheme of storage, irrigation, and drainage is becoming less stable and effective.

SOILS AND CROPS

Soils of the Rincon area may be divided into three fairly well defined groups, depending somewhat on the stage of weathering or of soil development.

The first, which may be called the Gila group, includes soils of recent alluvial formation which have weathered only slightly. They consist of alternating layers of sand, silt, and clay caused by deposition, not due to weathering. They include soils of the Gila series, which are brown or reddish brown in color and, in this area, light in texture; soils of the Pima series, which are darker brown in color and tend to be heavier in texture; and soils of the Brazito series, which are light brown or light gray in color and sandy in texture.

The second, which may be called the Anthony group, includes soils formed on the lower slopes, old outwash fans, and deltas where arroyos enter the main valley, and in the small higher valleys. They have a wide range in source and character of parent material and in stage of development. Some of the material has been assorted by water and slightly weathered, showing faint zones of development. Much of it, however, is an unassorted, unweathered mass of sand, gravel, and bowlders with an admixture of some finer soil material The mass lacks uniformity and includes areas of very low agricultural value.

The third group, which may be called the Pinal group, includes old soils developed on the high, nearly level, terraces or mesas. They are old in stage of development, the soils of the Pinal series having a highly developed lime hardpan and those of the Mohave series having a heavy accumulation of lime in spots in the subsoil, but not a true hardpan.

In the Rincon area nearly all crops are grown on soils of the first group. This is owing in part to the fact that these soils are the best suited to the crops grown in the area and also to their position in the river flood plain where they can be more easily irrigated.

The principal crops of the area are cotton, alfalfa, corn, and various truck, garden, and fruit crops. These are all grown under irrigation and almost entirely on soils of the first group.

Cotton makes the largest growth and gives the better yield on soils of medium or heavy texture when not injured by frost, but such injury more frequently occurs on such soils than on the sandier soils. The fine sandy loams, loams, and silt loams are also the best soils for alfalfa and corn. For garden and truck crops, which require intensive cultivation and frequent irrigations, the loams, fine sandy loams, and very fine sandy loams are best.

A few small areas of Anthony soils are used for corn and for alfalfa, but yields, owing to lack of water supply, are low. In other areas of the West these soils are used extensively for growing alfalfa and other crops. In this area they support a scant growth of grama, mesquite, and chamiza, which afford forage for livestock.

The soils of the Pinal group in this area are high above the irrigation ditches and therefore are not farmed. In other regions the Mohave soils, where they can be irrigated, are rather important for cultivated crops.

The soils of the Rincon area are described in detail in the following pages, and their present and potential utilization for agriculture is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in the Rincon area, N Mex*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Gila silt loam	5,440	9 6	Pima silty clay, shallow phase	448	0 8
Gila silt loam, heavy-subsoil phase	384	.7	Brazito fine sand	512	9
Gila silt loam, shallow phase	256	.4	Anthony gravelly sandy loam	8,832	15 5
Gila loam	3,712	6 5	Anthony sandy loam	2,368	4 2
Gila loam, heavy-subsoil phase	448	.8	Anthony sandy loam, hummocky phase	1,024	1 8
Gila very fine sandy loam	11,648	20.4	Anthony loam	768	1 3
Gila very fine sandy loam, shallow phase	832	1.5	Anthony loam, red phase	1,088	1 9
Gila very fine sandy loam, heavy-subsoil phase	1,024	1 8	Anthony clay loam	3,008	5 3
Gila fine sand	1,472	2 6	Mohave loam	960	1 6
Pima clay adobe	1,920	3 4	Pinal sandy loam	3,264	5 7
Pima clay adobe, red phase	896	1.6	Total	56,960	.....
Pima silty clay	6,656	11 7			

SOILS OF THE GILA GROUP

Soils of the Gila group are characterized by their light-brown, dark-brown, or slightly reddish brown color, by thin layers of widely differing texture owing to their deposition from flood waters, by soil of lighter texture in the deeper part of the subsoil, and by their abrupt changes and lack of uniformity over large areas. On account of their position they are the principal agricultural soils of the Rincon area.

The Gila series includes the fine sand, very fine sandy loam, loam, and silt loam members. The very fine sandy loam has a shallow phase and a heavy-subsoil phase. The loam has a heavy-subsoil phase, and the silt loam has a heavy-subsoil phase and a shallow phase.

Soils of the Pima series, which are darker in color and of heavier texture than the Gila soils, have been divided into a silty clay and a clay adobe. The silty clay has a shallow phase and the clay adobe a red phase.

Only one member of the Brazito series, the fine sand, has been recognized.

Gila silt loam.—The surface soil of Gila silt loam consists of light-brown or light grayish-brown silt loam, in many places having a pale-pink tint. In the virgin condition, or where uncultivated for some time, this soil has in places a thin finely granular slightly

crusted surface layer. In other places the surface soil shows thin flaky layers of recent deposition. Below the thin surface layer, the soil is light grayish-brown silt loam, in many places containing white specks along cleavage planes and root channels. The irregular clods are fairly easily crumbled and in places show thin flakes of recent deposition. Below an average depth of about 15 inches this material grades into a very fine sandy loam or fine sand subsoil. Areas of this soil vary greatly in depth and in texture. In places, especially in low-lying, poorly drained areas, the soil material is darker, heavier, and deeper than the typical soil.

Gila silt loam is easier to cultivate than are the Pima soils. It is well suited to alfalfa, cotton, and other crops of the area. It is well distributed throughout the area but as a rule occupies somewhat lower-lying positions near the river channel than do the Pima soils, and therefore as a whole it has a higher water table.

Gila silt loam, heavy-subsoil phase.—The heavy-subsoil phase of Gila silt loam consists of areas of Gila silt loam in which thin interstratified layers of silt loam, silty clay loam, or clay occur in the sandy subsoil at depths ranging from 15 to 30 inches. Soil of this phase has a higher water-holding capacity than the typical soil, is somewhat less subject to drought, and is slightly more productive. Areas having a high water table or an accumulation of alkali are less easily drained and reclaimed than areas of the typical silt loam. This soil occurs in only a few small bodies, mainly in the southern part of the area.

Gila silt loam, shallow phase.—The shallow phase of Gila silt loam consists of a 6 to 8 inch layer of silty soil underlain by river sand. It has a high water table, supports a growth of salt grass or tornillo, and is of but little agricultural value.

This soil occupies low-lying situations in the vicinity of the river channel. It occurs in only a few small bodies in the southern part of the area.

Gila loam.—Gila loam has the light chocolate-brown or reddish-brown color characteristic of soils of this region. The thin granular surface layer is only moderately developed. The surface soil extends to an average depth of about 12 inches, below which is the lighter-brown subsoil.

To a depth of about 12 inches the soil is light, fine-textured loam, the sand particles being of the fine and very fine grades, giving the soil a slightly lighter or coarser texture than Gila silt loam. Below a depth of 12 inches, the material grades into very fine sandy loam, and this, below a depth ranging from about 24 to 30 inches, into very fine sand.

Under cultivation this soil breaks up into irregular clods which are not hard and can be easily broken down.

In cultivated fields this soil appears to be of nearly the same color as Pima silty clay, but it is lighter in texture, more easily cultivated, and produces slightly earlier crops than that soil. As a whole it has accumulated less alkali than has Gila silt loam.

The most extensive development of this soil is in the region between Salem and the river bridge above Garfield, where it is the predominant soil under cultivation. It is a soil well suited to cotton and alfalfa and also to garden and truck crops requiring intensive

cultivation and frequent irrigations, such as tomatoes, beans, cantaloupes, chilies, and cabbage.

Gila loam, heavy-subsoil phase.—The heavy-subsoil phase of Gila loam is represented by a few small areas of Gila loam, in which thin stratified layers of silt and clay occur in the lighter-textured subsoil materials.

Gila very fine sandy loam.—Gila very fine sandy loam is light-brown fine sandy loam or very fine sandy loam faintly crusted at the surface where exposed for a long time to weathering. The soil section, or profile, is stratified, the thin layers of heavier-textured and lighter-textured soil materials in places being well marked. In general the thin heavier layers are nearer the surface, decreasing in number and thickness downward. Below an average depth of 15 or 18 inches the soil grades into fine sand or very fine sand.

As mapped this soil includes a few very small areas in which the soil is very light and sandy, the sand being coarser in texture than in the typical soil and containing rather large quantities of small waterworn gravel. This included soil has been deposited in or near old overflow stream channels and is of but little agricultural value. Such areas are indicated on the soil map by gravel symbols.

Gila very fine sandy loam is the most extensive soil in the Rincon area. In general it occupies the lower-lying positions near the river, but it also occurs in extensive tracts in other parts of the valley. Even within areas of the heavier-textured Pima soils are small bodies of Gila very fine sandy loam too small to be shown on the soil map but of much importance in handling the land.

This soil tends to blow and drift badly and in many places contains alkali salts in injurious quantities. (Pl. 2, A.) Under cultivation and irrigaton, especially where used for alfalfa, it becomes, on account of higher organic-matter content, somewhat darker in color and heavier in texture and through proper handling may be made into a highly productive soil. It produces alfalfa moderately well and gives an early-maturing crop of cotton (pl. 2, B), although the yield is not so large as on soils of heavier texture, provided the season is sufficiently long for cotton on the heavier soils. It is also well suited for chilies, cantaloupes, tomatoes, beans, and other crops requiring intensive cultivation.

Gila very fine sandy loam, shallow phase.—Gila very fine sandy loam, shallow phase, consists of a thin layer of very fine sandy loam, only a few inches deep, underlain by river sand. This soil is of low water-holding capacity and of very little agricultural value. It occurs in only a few very small bodies, mainly in the southern part of the Rincon Valley.

Gila very fine sandy loam, shallow phase, as mapped in the Rincon area, corresponds to Gila very fine sandy loam, shallow-subsoil phase, of the Socorro and Rio Puerco areas.

Gila very fine sandy loam, heavy-subsoil phase.—In the heavy-subsoil phase of Gila very fine sandy loam, thin layers of silt or clay occur at different depths in the subsoil and tend to check the downward movement of irrigation water. These light-textured soils, in which such layers occur in the subsoil, may in places develop an accumulation of alkali in the surface soil more readily than the same soil with an open subsoil, but they are as a whole more productive.

A, Cotton on Gila very fine sandy loam showing poor stand due to an accumulation of alkali in the surface soil B, Acala cotton on Gila very fine sandy loam near Rincon

Profile of heavy soil of the Anthony series, showing a feebly developed horizon of lime accumulation to point indicated by pick

An area covering about one-half square mile occurs about 1 mile north of Las Palomas. Other bodies are in the vicinities of the Garfield flume and Salem School and in the Rincon Valley in the southern part of the area.

Gila fine sand.—Gila fine sand is light grayish-brown or light-brown loose incoherent fine sand which in places is slightly stratified and contains very thin layers of fine sandy loam or silt loam. In places where it has remained stationary and supports a growth of grass or shrubs, the surface soil to a depth of a few inches is slightly darker gray and contains small quantities of organic matter. In many places the surface is bare and the soil blows and drifts badly. Small bodies of this soil occur within areas of the heavier soil types, causing increased expense for leveling.

Gila fine sand is of low water-holding capacity, is subject to drought, and is less productive than the other soils of the Gila series. It occurs in a number of areas scattered throughout the valley, mainly in the vicinity of the river channel. A long narrow and conspicuous body occupies part of an abandoned river channel in the vicinity of Heathden in the southern part of the area.

Pima clay adobe.—Pima clay adobe is a dark dull-brown, dark grayish-brown, or dark chocolate-brown soil. In the virgin condition or in areas not cultivated for a few years, a surface layer 1½ or 2 inches thick of fine sharp granules of clay is present. This is well crusted over at the surface. Below this layer the dark-colored clay extends to a depth of about 12 inches. When wet it is very sticky, and when dry it assumes an adobe structure and bakes and cracks into small irregular very hard clods, many of which have a thin white coating of salts. The same material occurs along old root channels.

Below a depth of about 12 inches the soil becomes slightly lighter brown or purplish brown, somewhat lighter in texture, and breaks into clods from 1 to 2 inches in diameter. This material gradually becomes lighter in color and more massive in structure with increasing depth. At a depth of about 24 inches it grades into gray or pinkish-gray fine-textured loam and this, in turn, below a depth of 30 inches grades into light-brown fine sand or very fine sand stratified with thin layers of heavier texture, in places mottled with rust brown. This material, in turn, is underlain at various depths by fine sand or sand.

Pima clay adobe is a fairly productive soil, best suited for alfalfa and cotton, but it is difficult to handle. It is not extensive but is widely distributed throughout the valley.

Pima clay adobe, red phase.—This phase of Pima clay adobe is deep dull red in color, becoming dull reddish brown or rich chocolate brown when dry. It is very heavy and tenacious, and the subsoil when wet is exceedingly stiff and plastic. This red soil is, as a rule, deeper than the typical soil, the heavy red plastic clay in many places extending to a depth of 30 or more inches.

Typical Pima clay adobe has developed very largely from heavy sedimentary material deposited from overflow of the Rio Grande, modified by decay of water-loving plants and by exposure. The red phase of this soil consists partly of the same material, but it is modified by red clay washed from adjacent slopes.

The red phase of Pima clay adobe is used for the production of alfalfa, cotton, and other crops, all of which return fair yields, but, on account of the difficulty in handling the soil, it is not considered so desirable as typical Pima clay adobe, or Pima silty clay. It occurs principally along the outer edge of the valley and in old abandoned stream channels, mainly west of Hatch and in the lower end of Rincon Valley.

Pima silty clay.—Pima silty clay is dark, slightly reddish, brown or light chocolate-brown silty clay. In the virgin condition or in areas which have not been cultivated for a few years, a surface crust and mulch layer, 1½ or 2 inches thick, develops. This, when dry, is made up of small somewhat angular fragments having the appearance of ground coffee The thin well-developed surface crust is easily broken.

Below the granular layer, the surface soil extends to an average depth of about 12 inches. When dry the material forms hard irregular clods, from one-half inch to 2 inches in diameter, which can be broken only with difficulty. In places a light-gray coating covers the surface of the clods and also occurs in old root channels. When moist this soil is very sticky and plastic.

At an average depth of about 12 inches, the darker-colored heavy layer grades into one of lighter, more grayish-brown, color which in many places shows a pinkish-brown tint, and in the lower part, especially if near the water table, slight mottlings of rust brown are present.

In texture this layer ranges from light micaceous silt loam to very fine sandy loam. At an average depth of about 30 inches this material grades into, or may be underlain abruptly by, light-brown or light grayish-brown fine sand or sand.

This soil is well supplied with lime, both surface soil and subsoil effervescing freely on application of dilute hydrochloric acid.

As occurring in the Rincon area, this soil is subject to wide variations in color, texture, and depth. In places it has received recent deposits of red clay from flood waters or washed from adjacent slopes. Such areas are in general not only redder but also heavier than the typical soil and in some places of greater depth. In low, poorly drained places, as in the old abandoned river channels, the soil is in many places dark brown and heavy, approaching in color and texture Pima clay adobe. In some places the deep subsoil consists of medium-textured very light brown river-laid sand.

Areas of this soil are distributed throughout the Rincon area. In general they occupy the more level higher parts of the river bottoms, which have been under cultivation for a long time. Although this soil is more difficult to cultivate than soils of lighter texture, probably a higher percentage is under cultivation than of any other soil type. It is the most productive alfalfa and cotton soil of the area and is used to considerable extent for other crops. It is well developed around Hatch and Rodey, between Salem and Garfield, west of Heathden, and in many other places. It typically contains a high percentage of silt and is commonly referred to in this region as silt.

Pima silty clay, shallow phase.—The shallow phase of Pima silty clay is represented by a few small areas, in which the silty clay

surface soil is only a few inches thick and is underlain by river-laid sand and fine sand. These areas, which occur near the river channel, are long and narrow.

This shallow soil is more permeable than typical Pima silty clay and will be more rapidly and easily leached of alkali salts. It is, however, of lower water-holding capacity, will require more frequent irrigation, and is generally somewhat less productive than the deeper soil.

Near Tonuco a small area of this soil consists of fine sand and fine sandy loam deposited by the river and covered by a layer of red clay ranging from 3 to 8 inches in thickness.

Brazito fine sand.—Brazito fine sand consists of loose incoherent nearly white fine sand which has been blown into hummocks, low ridges, and dunes. It tends to accumulate in favorable situations near the river channel, along old stream channels, at the corners and sides of fields, and in many other places.

It occurs in small bodies associated with the soils of the Gila series and is widely distributed over the area surveyed.

Land of this kind is of practically no agricultural value and causes much damage in places where it blows onto areas of heavier-textured soil and into cultivated fields. Injury caused to growing crops by blowing sand is, at times and in certain places, serious.

SOILS OF THE ANTHONY GROUP

Soils of the Anthony group are characterized by a light grayish-brown or brown color, by loose open consistence, and by the presence of masses of sand, gravel, and bowlders in the subsoil. They include areas in which there has been some weathering and slight development of a soil profile. They also, in this area, include masses of clean sand, gravel, and bowlders, which might be considered river wash. Most of the soils of the group are between these extremes. None of them is under irrigation, on account of lying above the irrigation ditches, and even if irrigated the land would be of rather low agricultural value.

Anthony gravelly sandy loam.—Anthony gravelly sandy loam is largely a mass of unassorted soil material rather than a true soil. It may be described as light-brown or gray sandy loam of very light texture, in which the sand ranges from fine and smooth to coarse and sharp. Mixed with this material are varying quantities of rounded waterworn gravel and bowlders. At a depth ranging from only a few inches to more than 12 inches the subsoil consists almost entirely of waterworn gravel.

Included with areas of this soil are numerous bodies consisting almost entirely of gravel, and the deep, broad, arroyo channels are so filled with such gravel that they might be regarded as river wash. Along the outer limits of the alluvial fans there is an accumulation of sand and finer material in places, but this is apt to be removed or covered during the next flood period.

This soil supports a growth of mesquite, tornillo, creosote bush, popotillo, chamiza, buckthorn, yucca, and here and there bunches of buffalo grass and grama. A few scattered areas might be used for cultivated crops. The greater part of the land, however, is not only too high for irrigation under the system now installed but the soil

and especially the subsoil are too open and porous for profitable irrigation.

Narrow belts of material of this kind are almost continuous along the outer edges of both sides of the valley, and bodies occupy the arroyo valleys, deltas, and alluvial fans extending far out into the main valley.

Anthony sandy loam.—The surface soil of Anthony sandy loam consists of reddish-brown or light purplish-brown medium or fine textured sandy loam. At the topmost part of this layer is a 2 or 3 inch layer of loose fine sand, below which the soil grades into light sandy loam or fine sandy loam. In places the soil material is more or less stratified with thin layers of materials of variable texture. But little profile structure due to weathering has developed. Below an average depth of about 2 feet, sand and stream gravel are reached.

This soil has developed principally from sandy material carried into the river valley by tributary arroyos. The sand has been more or less assorted from the gravel and deposited at the outer edge of the alluvial fans. The red color is inherited from the parent material from which much of this soil material has been eroded. As mapped, the soil includes several small undifferentiated areas which are light brown or light grayish brown rather than red.

Some of the land is under cultivation and is used for alfalfa, cotton, and other crops.

Areas of this soil are widely distributed through the valley, the larger ones occurring in the vicinities of Tonuco, Santa Teresa, and Caballo.

Anthony sandy loam, hummocky phase.—The hummocky phase of Anthony sandy loam is pale reddish-brown or pale-red sand blown into hummocks and low dunes, in most places collected around clumps of mesquite. The principal area of this phase extends along the south side of the valley southwest of Salem. A smaller but conspicuous area occurs at Rincon. The soil is of slight agricultural value.

Anthony loam.—Anthony loam is light grayish-brown loam of light texture. Where well weathered it has a thin finely granular or flaky surface mulch which is slightly crusted. Below this, and extending to a depth of about 10 inches, is a layer consisting of light-brown fine-textured loam which grades into very light textured loam or fine sandy loam in the lower part. Below a depth of 10 inches the material is fine sandy loam and gravel, and below a depth ranging from 24 to 30 inches waterworn gravel, stratified with thin layers of fine sand, occurs.

This soil is mainly of recent alluvial accumulation, deposited in the flood plain of some of the larger arroyos. A small area at Las Palomas is under irrigation, the water being obtained by pumping. A few small bodies, in which the moisture supply is obtained from flood waters in the arroyo valleys, are under cultivation. Corn is the principal crop grown.

Anthony loam, red phase.—The surface soil of the red phase of Anthony loam consists of a pronounced reddish-brown loam having a well-crusted thin granular surface layer. The surface soil extends to a depth of about 12 inches, below which is more or less stratified gravel and sand. This red soil occupies slopes adjacent to the

valley, and the red color is due largely to the influence of red parent material. The principal area lies along the north side of the valley east of Salem. Land of this kind is above the level of gravity irrigation water, and even if it could be irrigated would not be of high agricultural value.

Anthony clay loam.—Anthony clay loam has a highly developed finely granular dark grayish-brown well-crusted surface layer about 2 inches thick. Below this layer and continuing to a depth of about 15 inches is dark grayish-brown clay loam which when dry breaks into hard irregular clods. (Pl. 3.) Below this depth the material grades into a lighter, more reddish, brown clay loam of slightly lighter texture. This layer extends to a depth of about 5 feet where the soil is underlain by sand and waterworn gravel.

When moist, this soil is very sticky and nearly free of sand or any gritty material. It contains a moderate quantity of alkali. It is of alluvial origin and occupies areas in the arroyo valleys and on alluvial-fan slopes marginal to the main valley. In places varying quantities of gravel have washed on the surface from adjacent areas. The land supports a grass growth almost entirely, and in places it is very badly gullied. None of it is under cultivation.

SOILS OF THE PINAL GROUP

Soils of the Pinal group are brown or reddish brown in the surface soil and deeper reddish-brown in the upper part of the subsoil. The lower subsoil layer contains much light-gray or nearly white limy material which in the Mohave soil occurs in spots and lumps and in the Pinal soil as a firmly cemented lime hardpan, or caliche. The deep subsoils of many bodies of the soils of this group consist of thick beds of waterworn stream gravel.

In the Rincon area, these soils have developed on nearly level old high terraces which are above the level of irrigation water. The Mohave soils here are also somewhat less highly developed than in some other areas where they have been mapped in the Southwest. This is indicated by the freedom with which the surface soil effervesces with acid, which is not true of the well-weathered soils of this series.

Mohave loam.—Mohave loam is a dull reddish-brown soil with well-developed horizons, or layers. The surface soil is characterized by a finely granular mulch layer, an inch or slightly more in thickness, with a slight surface crust. On account of blowing of loose sand, this layer is in many places covered by sand. Below this and extending to a depth of about 10 inches is reddish-brown loam which breaks along exposed surfaces into somewhat regular clods ranging from 1 to 2 inches in diameter. In this layer are light-gray, nearly white, spots of lime accumulation, which increase in number with depth, the material in the lower part of the layer being very light gray and easily crumbled. Below this layer is sand and waterworn gravel, the latter heavily coated with lime.

This soil occupies high level old alluvial terraces lying from 60 to 75 feet above the river flood plain. Water for irrigation is not available, and the soil is utilized only for the scant grazing it affords. The principal growth is creosote bush. Bodies of this soil occur on

both sides of the Arroyo Seco and east of Percha Creek School in the northern part of the area.

Pinal sandy loam.—This soil occupies old high terraces and uplands in the northern part of the area. It has a reddish-brown sandy and gravelly shallow surface soil and a gravelly subsoil, the upper part of which is cemented into a well-developed lime-carbonate hardpan, or caliche. The land is practically nonagricultural and of very little value for grazing purposes.

SOILS AND THEIR INTERPRETATION

The Gila and Pima soils, which are the predominant agricultural soils of this area, are of recent alluvial deposition, very largely from flood waters of the Rio Grande. This stream for ages past, and until the construction of Elephant Butte Dam, meandered across the valley from side to side many times. At intervals the entire valley was flooded. Each change of channel and each flood period left its impress on the soils. Where the currents were swift, sand and gravel were deposited; where the water moved gently, silt and very fine sand were laid down; and in basins and abandoned stream channels, the principal deposits were silt and clay. The different grades of soil material carried by the river are more or less uniform. There are, however, certain factors which tend toward lack of uniformity in the soils.

The most important of these factors is difference in the character of materials carried into the valley by the tributary arroyos. Each of the arroyos carries material of local origin eroded from the adjacent high alluvial terraces, from the hill slopes, and some from the mountains near by. This material varies widely in color, in texture, and in character of the parent rocks from which it is derived.

The second cause of lack in uniformity is modification of material by the wind. Strong winds sweep from the mountains on the west and follow down the valley. When the river flood plain is dry, as it often is, immense quantities of sand are carried by wind action to the adjacent soils, in places covering them to considerable depths. In cultivated fields, especially of the lighter-textured soils, sand is blown from the surface and accumulates along fences and ditch lines. In places it is blown from sandy uplands into the valley.

Irrigation with water, at times carrying large quantities of silt, has changed the character of the soil, making it heavier in texture. Where much water is used, as in growing alfalfa, and its use continued for several years, the soil texture becomes heavier than soil in which cotton or other cultivated crops are grown. Changes in texture have also been caused in leveling the land for irrigation. Sand ridges have been pulled down and low spots of heavy soil deeply covered. On account of recent deposition and of these changes which are constantly taking place, structural or profile development of the alluvial soils through agencies of weathering has been but slight. The most rapid and pronounced development has been that of the surface mulch. In Pima clay adobe and Pima silty clay the mulch is well developed to a depth of 1½ or 2 inches, and it is moderately or strongly crusted. On the lighter-textured Gila soils the surface mulch is much less pronounced.

Thus it may be seen that the soil profile is dominated by geological stratification of the soil materials as laid down, rather than by developed horizons due to leaching or to accumulation of either lime or the finer colloidal or mineral particles as a result of weathering agencies.

The soils of the Gila and Pima series are calcareous and effervesce freely in dilute hydrochloric acid. The lime is uniformly distributed throughout the soil profile, except in the lighter-textured open sandy strata, in which the material may or may not effervesce.

The heavier-textured soil material has naturally a darker or more pronounced color than the light-textured soil material. This is most noticeable in nearly level areas of Pima silty clay and Gila loam, in which there is a development of chocolate-brown or dark chocolate-brown color, which continues to an average depth of 10 or 12 inches below the surface. The very dark brown color of Pima clay adobe is believed to be caused in large part by organic matter, and the reddish-brown color of the red phase of this soil by the red color of the parent material. The heavy-textured Pima soils show a pronounced, irregular, small cloddy structure to a depth of about 12 inches, below which are irregular clods of larger size. In the silt loam, loam, and very fine sandy loam of the Gila series, a thin platy structure of deposition is marked in the surface soil and especially in the subsoil.

In the soils of the Anthony series, especially those of lighter texture, weathering has had but little influence on soil development. These soils, like those of the Gila and Pima series, represent a very recent stage in soil development. In the arroyo valleys and on the alluvial fans and slopes where these soils occur, there is an almost constant movement of soil material, owing to action of water, of gravity, and of wind, so that but little opportunity has existed for soil profile development. In the case of Anthony clay loam, however, a soil of comparatively heavy texture has developed. Accumulation and penetration of moisture have been favorable, and under a grass vegetation a soil with fairly definite profile characteristics has developed. These are a well-crusted surface mulch, a darker grayish-brown or darker-brown layer extending to a depth of about 15 inches below the surface, and underlying this a slightly lighter brown layer. The material in the surface layer, below the mulch, breaks into small hard irregular clods, and the lighter-brown layer below breaks into larger clods which are more easily broken.

The soil is decidedly calcareous throughout, the soil materials effervescing vigorously in dilute acid. There is, however, a tendency toward accumulation of the lime in the upper part of the subsoil (pl. 3), and in many places layers of gravelly material occur in which the gravel are lightly incrusted with lime, and root holes and insect cavities may be lined with this material. In the lighter-textured soils, however, in which penetration of moisture is much more rapid and free, evidence of accumulated lime is less frequent or is lacking.

The Mohave soils are much more maturely developed. They have developed on a smooth nearly level surface under a less than 10-inch rainfall, rapid evaporation, high temperature, and scant vegetation. The surface soil is dull reddish brown or pale reddish brown. The

finely granular surface layer is moderately developed and crusted even in the lighter-textured soils. The entire soil profile is calcareous, and there is a high development of lime accumulation at a slight depth. In the upper part of the subsoil, lime has accumulated in light-colored spots, the number of which increase with depth. The deep subsoil of lighter color, which is reached at a slight depth, is sandy and gravelly, the gravel being coated with white incrustations of lime.

The Pinal soils differ from those of the Mohave series in their still more advanced stage of development. In them, carbonate of lime has accumulated at the upper limit of a gravel subsoil and has formed a well-cemented lime hardpan.

SUMMARY

The Rincon area extends as a narrow strip from 1½ to 2½ miles wide along the valley of the Rio Grande for a distance of about 50 miles southward from the vicinity of Hot Springs, south of the Elephant Butte Dam. The total area surveyed is 89 square miles.

The principal irrigated soils are included in the Gila and Pima series. They range in texture from clay to fine sand. The more important agricultural soils for cotton and alfalfa are Pima silty clay, Gila silt loam, and Gila loam. Soils of lighter texture are extensive, and they tend to become heavier under cultivation and irrigation.

Many areas of these soils, especially those which are low lying and have a high water table, contain injurious quantities of alkali. They can best be reclaimed by lowering the water table by drainage and by leveling and flooding the land to wash the alkali down or carry it out. In many places this is an expensive process.

Cotton, alfalfa, and corn are the most important crops grown, cotton being the leading money crop.

Soils of the Anthony and Brazito series, for the most part, lie above the level of the irrigation ditches and are used to only a very slight extent for cultivated crops.

Soils of the Mohave and Pinal series show a more advanced stage of soil weathering. They are high above the level of the irrigation ditches, and in this area no soils of either series are under cultivation

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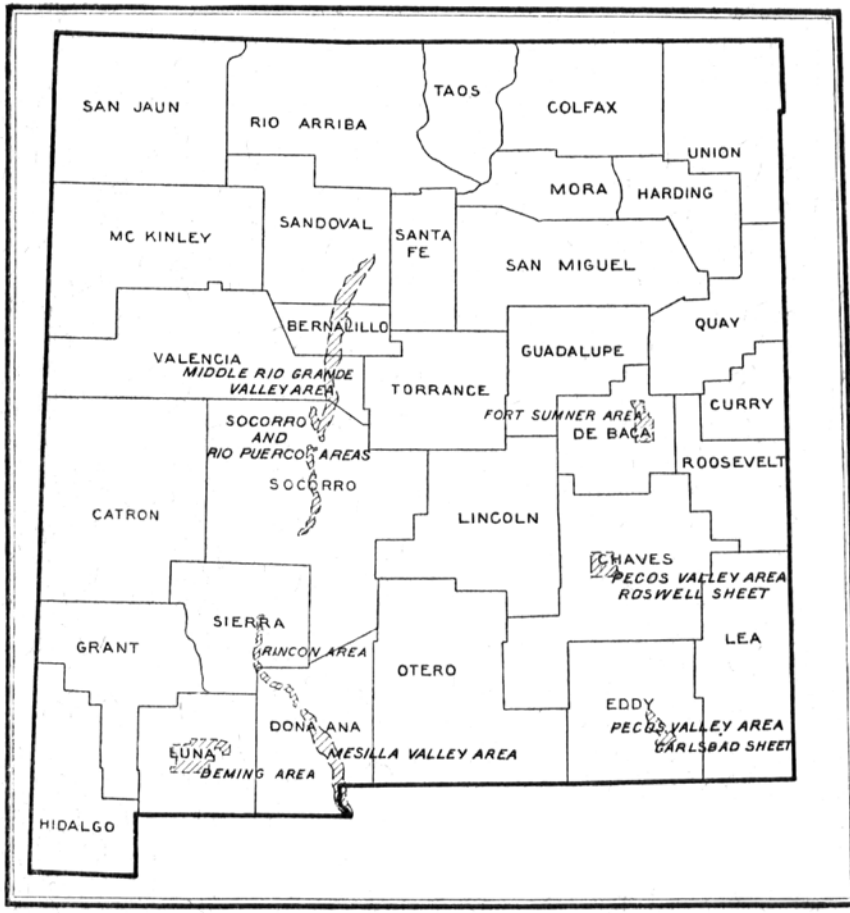

Areas surveyed in New Mexico, shown by shading. Detailed surveys shown by northeast-southwest hatchings

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