U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS.

IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXPERIMENT STATION.

# SOIL SURVEY OF THE SHASTA VALLEY AREA, CALIFORNIA.

BY

E. B. WATSON, OF THE U. S. DEPARTMENT OF AGRICULTURE,
IN CHARGE, AND M. E. WANK AND ALFRED SMITH,
OF THE UNIVERSITY OF CALIFORNIA.

[Advance Sheets—Field Operations of the Bureau of Soils, 1919.]


WASHINGTON:
GOVERNMENT PRINTING OFFICE,
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[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.]

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# SOIL SURVEY OF THE SHASTA VALLEY AREA, CALIFORNIA.

By E. B. WATSON, of the U. S. Department of Agriculture, In Charge, and M. E. WANK and ALFRED SMITH, of the University of California.

## DESCRIPTION OF THE AREA.

The Shasta Valley area lies in Siskiyou County, Calif., within 10 miles of the northern boundary of the State and 75 miles from the Pacific Ocean. It lies between the large Sacramento Valley and the main agricultural valleys in western Oregon. The area surveyed is about 32 miles long and from 10 to 20 miles wide. It contains 512 square miles, or 327,680 acres.

The base map used in plotting the soils was constructed by plane-table traverse by the field party, no published map suitable for the purpose being available.

The Shasta Valley is a broad structural valley with its longest dimension north and south, bordered on the west by a ridge extending north from the Trinity Mountains and on the east by mountains formed by lava flows and constituting a part of the Cascade Range. The main valley basin, which has a width of about 15 miles, has been partly filled and obstructed by sheets and low hills of lava from local flows and minor volcanic eruptions, so that much of it has little resemblance to a valley, but is rough or hilly. (Pl. VII, Fig. 1.) The route of travel follows along the western border of the valley over the better agricultural land. East of this route are extensive lava flows, which have been mapped as Scabland, interspersed with patches of arable land.

FIG. 4.—Sketch map showing location of the Shasta Valley area, California.

The southern end of the valley extends to the pass just south of Weed, which has an elevation of 3,905 feet and separates the Shasta Valley from the drainage basin of the Sacramento River. East of the pass is Mount Shasta, which rises to an elevation of 14,440 feet. It is the most conspicuous feature of the landscape and can be seen from all parts of the valley. Its peak is covered with perpetual snow, and there are several glaciers on its upper slopes.

The main floor of the valley has an elevation of 2,400 to about 2,800 feet, and a general slope northward from the southern point of the valley.

The Shasta River, which receives the drainage from the northwestern slopes of Mount Shasta and from the mountains east and west of the valley, flows north and passes out of the area through a rocky gorge in the northwestern part, where it has a high gradient. It is a tributary of the Klamath River, which empties into the Pacific Ocean. The main tributary of the Shasta River is the Little Shasta River, which comes from the mountains on the east. The eastern part of the area drained by this stream is locally known as the Little Shasta Valley. Both these streams have a moderate fall in their courses in the valley and have cut down very little below the valley floor. The extreme northern part of the area is drained by Willow Creek, which leaves the area on its northern boundary, also a tributary of the Klamath River.

In the northern third of the area and on the western border the topography is erosional. The hills are rounded, the streams are dendritic, and the valleys are filled with alluvial fans. The rest of the area shows its youth very plainly. In the region of the Scabland the small cones or upheaved masses of lava and the lava flows exist to-day almost as they were originally formed. A few alluvial fans exist on the east side, along streams issuing from the mountains.

Settlement of the area began with the discovery of gold in this region in 1851, and was very rapid for a few years. When the gold fever subsided the influx of population ceased, and probably some of the settlers left. But as farming has developed there has been a steady growth of population. Available statistics apply to the county as a whole and not to the area surveyed, so actual figures can not be given.

The population came originally from all parts of the United States. It is predominantly Anglo-Saxon, but there is a small admixture of other nationalities. Most of the people at Hawkinsville are Portuguese. There are a few Germans, Italians, and Chinese scattered over the area. The mill employees at Weed are largely foreigners. About a dozen Indians reside in the area.

In the area surveyed the population outside of the towns is generally scattering. The land holdings are large, grain growing and stock raising being the main industries, and the ranches are few in number. However, there are several comparatively new colonies at Mayten and Grenada, and near Montague, in which the individual holdings run from 10 to 40 acres, and settlement is correspondingly dense.

Yreka, the county seat and chief town, lies in the northwestern part of the survey, and is reached by the Yreka Railroad, a local line connecting with the Southern Pacific main line at Montague. It was

the center of the early settlement and mining development. In 1910 it had a population of 1,134 and in 1920 of 1,277. Montague has about 453 people, Grenada and Gazelle have about 100 each, and Edgewood has about 225. These are trading centers located on the Southern Pacific Railroad. Hawkinsville has about 75 people and is an old mining center. Weed is a sawmill town in the southern part of the area, with a population of several thousand, mainly employees of the sawmill and planing mill and the box and sash factory.

The main San Francisco-Portland line of the Southern Pacific Railroad, which traverses the area north and south, gives an outlet for farm produce. A branch line of the Southern Pacific running northeast from Weed to Klamath Falls, Oreg., is utilized largely for logging purposes.

Most of the live stock is sent to San Francisco. The hay and grain are sold locally.

## CLIMATE.

The climate of the Shasta Valley area resembles that of the Great Interior Valley of California in many ways, but the winter temperatures are lower. There is a rainy season with moderate to low temperatures and a dry season with high temperatures. The rainy season lasts from about October to April. The mean annual rainfall during a period of 30 years is reported by the Weather Bureau station at Yreka as 17.96 inches. The record kept by the United States Forest Service, also at Yreka, gives an average of 14.12 inches for the last 5 years. Some rain falls during the dry season, from one-third to two-thirds of an inch each month.

The mean annual temperature is 51.3° F. During the rainy season it averages about 40° F. It drops to zero at times, and snow falls nearly every winter, but does not remain long on the ground. From May to October, inclusive, the average is 62° F. Summer temperatures above 100° F. are often recorded, although these extremely hot periods do not last long.

The average date of the latest killing frost in the spring is May 11 and the average date of the first killing frost in the fall is September 26. Killing frosts have been recorded at Yreka as late as June 21 and as early as September 6. The great variations in elevation in different parts of the area and differences in exposure to prevailing winds make the local variation in climate very great. On the foot slopes of Mount Shasta, at elevations of 3,500 to 4,000 feet, frosts occur every month of the year and crops are confined almost entirely to grasses.

The climate is well suited to stock raising and grain growing, which are the principal industries. In certain parts of the area the climate appears to be well suited to fruit, although so little fruit is grown

that it is hard to judge. There are a few small orchards that are apparently thriving and productive.

Relatively few fogs occur. High winds are reported frequent, especially in exposed situations.

The accompanying table, giving the normal monthly, seasonal, and annual temperature and precipitation, is compiled from the records of the Weather Bureau station at Yreka:

*Normal monthly, seasonal, and annual temperature and precipitation at Yreka.*

[Elevation, 2,625 feet.]

| Month. | Temperature. | | | Precipitation. | | |
|---|---|---|---|---|---|---|
| | Mean. | Absolute maximum. | Absolute minimum. | Mean. | Total amount for the driest year. | Total amount for the wettest year. |
| | ° *F.* | ° *F.* | ° *F.* | *Inches.* | *Inches.* | *Inches.* |
| December | 34.8 | 62 | −1 | 3.06 | 2.20 | 5.44 |
| January | 34.8 | 59 | −4 | 3.34 | 1.28 | 1.81 |
| February | 38.9 | 67 | −2 | 2.45 | 1.77 | 8.50 |
| Winter | 36.1 | 67 | −4 | 8.85 | 5.25 | 15.75 |
| March | 43.8 | 79 | 12 | 1.75 | .40 | 6.68 |
| April | 48.7 | 85 | 17 | 1.01 | .90 | 2.73 |
| May | 55.8 | 95 | 20 | 1.16 | .60 | .15 |
| Spring | 49.4 | 95 | 12 | 3.92 | 1.90 | 9.56 |
| June | 62.6 | 102 | 26 | .61 | .00 | .50 |
| July | 70.4 | 105 | 34 | .40 | .00 | 1.12 |
| August | 70.1 | 106 | 35 | .25 | .00 | .03 |
| Summer | 67.7 | 106 | 26 | 1.26 | .00 | 1.65 |
| September | 61.3 | 98 | 20 | .41 | .44 | 1.35 |
| October | 52.0 | 95 | 7 | 1.18 | .55 | 1.97 |
| November | 42.0 | 73 | 1 | 2.34 | 1.17 | 1.98 |
| Fall | 51.7 | 98 | 1 | 3.93 | 2.16 | 5.30 |
| Year | 51.3 | 106 | −4 | 17.96 | 9.31 | 32.26 |

## AGRICULTURE.

The earliest settlers in the Shasta Valley came in 1851 to 1853. They found the land covered with native grasses extending over practically all the arable soils of the valley. As in other sections of California upon the discovery of gold, the population increased rapidly, and the area was soon in the position of an isolated region with a considerable population but without any local supply of food. To meet the sudden demand for subsistence, the most available parts of the valley were plowed and planted to grain, chiefly wheat. Coincident with the sudden demand for food arose an equally strong

demand for horses. Miners traveling from the valley to the mountains were willing to pay any price for suitable saddle animals. This demand caused the agricultural members of the community to import and pasture large herds of horses. Range land was at this time unlimited, and the animals were pastured in the hills in summer and driven down to the valley for the winter.

As the mining population increased, cattle, to supply meat to the various camps, were driven into the valley and pastured with the horses. The grain produced was used entirely for human consumption; the grass in the hills in the summer and in the valley in winter provided ample subsistence for live stock.

Between 1851 and 1870 the settlers were primarily miners and agriculture was of secondary importance; its growth took the form of more extensive production of the commodities already being produced, namely, grain, horses, and cattle. The floor of the valley was gradually planted to grain. Large holdings were purchased from the Government; others were homesteaded. The increased production of grain no more than kept pace with the increased demand by the growing population. Beef cattle, on the other hand, exceeded the local demand, and herds were frequently driven across the mountains to Redding, in the Sacramento Valley, where they found a ready market.

In the early seventies agriculture slowly began to develop more intensively. The earliest development took place along the rivers and streams running through the valley, where water was diverted and rude irrigation systems were installed. Alfalfa was introduced about this time and planted on these irrigated lands. As the valley land was gradually put under cultivation, cattle ranchers were forced to find a supply of feed for their stock in winter, so they adopted the growing of alfalfa as a solution for this problem, and began the practice of driving the cattle down from the hills at the first snow and feeding them alfalfa hay during the winter.

In 1888 the Southern Pacific Railroad Co. built a main-line railroad through the Shasta Valley, connecting California and Oregon, thus supplying extensive markets both north and south and giving a decided impetus to agriculture. Since that time the development has continued almost exclusively along the original lines. Grain is sold in the local markets, only the surplus being shipped out. Beef cattle have increased in number, and the Shasta Valley now is one of the large meat-producing sections of California. Sheep and hogs have recently been bred in larger numbers, and the number of dairy cows is increasing.

The farms in the Shasta Valley area have grown fewer in number and larger in acreage during the last 10 years. The original ranch

owners have prospered, and consequently the tendency is to enlarge the holdings. The average ranch contains between 500 and 1,000 acres, and there are several very large ones. Three centers exist about which smaller farms of 20 to 160 acres have been developed—one around Grenada, another in the vicinity of Montague, and a third at Mayten near Big Spring. Each of these districts was formed by real-estate promoters, who supplied the farmers with water necessary for an intensive cultivation of the soil. These farms are devoted mainly to dairying and alfalfa production.

It is impossible to quote actual figures showing production of crops in the Shasta Valley, because the available statistics apply to the entire area of Siskiyou County. Cattle are herded over large areas of mountainous range land in the summer, and many are pastured on the poorer lands on the valley floor. Soils of the Gazelle, Bellavista, and Hovey series are devoted largely to pasture. They are located in and south of the Little Shasta Valley and east of the Southern Pacific Railroad tracks and contain accumulations of alkali salts in spots. (Pl. VII, Fig. 2.) Bunch grass, wire grass, and other wild grasses flourish on such soils. Salt grass is found only in isolated spots where the salts have become concentrated. Cattle ranged in the mountains usually are driven into the valley in November and fed alfalfa hay for about three months. Shipments of live cattle are made the year round, most of them being marketed in central California.

Horses have decreased in importance and are now surpassed by sheep. They are ranged, pastured, and fed in about the same manner as cattle. A ready market is found both locally and to the north and south.

Sheep have only recently been raised extensively in the area. Because of their habit of close cropping the grass, they are not pastured with other domestic animals but are herded separately. The sheep industry is growing, and many of the poorer ranges and pasture lands unsuitable for cattle and horses are now devoted profitably to sheep grazing.

Hogs and mules are not raised extensively in this region. No large droves of hogs are found, but each ranch usually has a few, chiefly to supply meat for home consumption.

Dairying is developing quite extensively around Montague, Grenada, Edgewood, and Mayten. The industry flourishes most where water is available and the soil is suited to alfalfa. According to the estimates of farmers, there are approximately 2,800 dairy cattle in the valley. The majority of these are grade Jerseys and Holsteins. A few of the more progressive dairy farmers are building up herds of registered animals. Figures for the output of the area are not available, but the creamery at Montague produces approximately

42,000 pounds of butter each month. Of this output, 7,500 to 9,000 pounds are used locally and the rest is shipped to outside points. The creamery at Edgewood produces an average of 10,000 pounds of butter a month, besides supplying a large trade in cream and ice cream. Practically all of the butter shipped out is sold in Oregon. Cheese is produced on a small scale by individual ranchers with a surplus of milk. A cheese factory is being built at Grenada.

Where water for irrigation is not available, the valley soils are devoted mainly to grain growing. Wheat is by far the most important grain crop, forming over 60 per cent of the total grain production. Barley, oats, and rye follow as minor grain crops. Barley production has declined in the last few years. This is due to the fact that better returns are obtained with the other grains. Rye is a new crop in the district, and the total production is still small. The methods followed are much the same as have been used for years in all grain-growing countries. Machinery has been steadily supplanting less efficient forms of power and is now in common use. The fields are plowed, usually with tractor-drawn gang plows, then drilled and harrowed. Harvesting is done in almost all cases with tractor-drawn combined harvesters, only a few fields being harvested by binders. Among the more progressive farmers the principles of dry-farming are followed. Fields are summer fallowed every other year. Under this plan the land is plowed in the winter or early spring, left fallow throughout the following summer, and seeded in the fall or early spring for the next year's crop. Most of the seeding is done in the fall, damage from winter killing in the valley being so slight as to be negligible. Grain is grown successfully on both hardpan and nonhardpan soils. The Montague and Lassen soils are given entirely to grain where cultivated. The Elder, Dublin, Vina, Conejo, Hovey, and Bellavista soils are largely used for grain. Yields vary greatly with the soils and the methods used. On the better grades of soils, with the best dry-farming methods employed, yields range from 9 to 13 sacks of wheat per acre, each sack weighing about 130 pounds. On the poorer soils, with less efficient methods, the yields are frequently as low as 3 to 6 sacks per acre. Although summer fallowing gives only one crop every two years, the increased yield makes it the more profitable form of management. Very little grain is cut green for hay, and almost none is fed in the form of grain.

Hay ranks next to grain in importance in the Shasta Valley area. Alfalfa is the most important of the hay crops, but small areas of wild grasses, timothy, clover, and the last two combined are harvested. Alfalfa is grown on the best soils of the valley, where water is available. It is adapted best to the medium-textured types of the Elder, Dublin, Vina, and Conejo series, but does moderately well on the lighter and heavier members of these series. (Pl. VIII, Fig. 1.)

Several hardpan soils have been seeded to alfalfa, with but moderate success; the plant grows well the first year or two, but is restricted in growth in succeeding years by the compacted layer which the roots are unable to penetrate. The most progressive farmers get four cuttings of alfalfa hay each season, but, owing to the short growing season, the average number of cuttings is only three. The first cutting is usually made about the end of May, and if a fourth cutting can be obtained it is made in early September. The more usual practice is to harvest three cuttings and then turn the cattle into the field to pasture on the new growth. Alfalfa is grown primarily for feed for live stock, and only the surplus is baled and shipped. Yields of 1½ to 2 tons per acre per cutting are obtained on the better soils under the best management. The average yield is 1 to 1½ tons, making the season's average yield 3½ to 4½ tons per acre, and 6 to 8 tons per acre under the most favorable conditions. Timothy, clover, and wild and salt grasses are minor crops, occupying mainly the poorly drained trough of the valley, in which the soils contain alkali salts and are underlain by hardpan, and are not adapted to alfalfa. Where labor is uncertain, wild hay is sometimes stacked by means of bull rakes, eliminating the need of a crew of men to stack by the "pitching and hauling" method.

Potatoes and beans are minor field crops. Other vegetables, such as onions, lettuce, radishes, squash, and melons, are grown on a small scale for local use.

A little fruit is grown in the Shasta Valley area in a few family orchards. The local market is supplied almost entirely from outside points. Apples, pears, peaches, prunes, plums, apricots, almonds, and grapes are grown in favorable situations. Most of the plantings consist of old trees in full bearing. A crop is assured almost every year, except of apricots and almonds, the blossoms of which are frequently caught by late spring frosts. The main reason why fruit culture has not developed appears to be the unsuitability of the soils in places where water for irrigation is available. The prevalence of late spring frosts is also a hindrance. It seems probable that fruit could be much more extensively grown, especially on the Elder soils, where water is available.

Poultry raising is carried on only to supply meat and eggs for home use.

The labor supply in the main part of the Shasta Valley is usually sufficient, although by no means abundant or cheap. In the Little Shasta Valley and in regions off the main roads a shortage is frequently felt during the harvesting season. The laborers are of the type so common in California—the transient, traveling with his blankets from place to place. They are not entirely satisfactory, but are the only men available. They are almost exclusively white. During

the harvesting season, from the middle of May until the middle of September, $3 and frequently $3.50 per day is paid, besides board. In the outlying districts $4 and board is sometimes paid. The housing conditions during harvest time are poor; many ranchers do not even provide a bunk house, but allow the men to sleep wherever they can lay their blankets. The more progressive ranchers have taken steps to remedy this, however, and the tendency is to provide bunk houses and shower baths for the farm hands.

Very few of the farms in this area are rented, and renting is confined to the smaller farms. Occasionally a part of a large ranch or an entire small farm is leased, usually for cash, but sometimes for a share of the crops. Nearly all ranches, however, are operated by the owners.

The price of land varies greatly, according to soil conditions and topography. Some land that is barely agricultural may be bought for $5 an acre. The price of the best unirrigated land seldom goes above $50 to $75 an acre. Land supplied with water, on the other hand, commands a much higher price and is in greater demand. Land of poor quality sells for $100 to $125; the average price for irrigated land is from $150 to $175 an acre; and occasionally a preferred piece sells for $250 to $350.

## SOILS.

The Shasta Valley was originally a large structural valley, which received the material that was eroded from the surrounding hills and spread out in broad fans. The material laid down earliest has undergone pronounced changes through weathering and has developed a dense hardpan. This is found only in the northwestern part of the area surveyed, practically all of it west of Oregon Slough and north of a line passing 2 miles south of Yreka. From the standpoint of the soil development this is evidently the oldest part of the valley. The material was derived from the old sedimentary rocks of the ranges to the west. Similar materials must have been deposited in other parts of the valley at the same time, but they are now covered with other deposits or have been eroded away. The main soils here are the Agate soils in the valley floor and the residual Altamont soils in the hills.

East of this is a region of igneous rocks, old, but not as old as those farther west. The rocks have weathered in place to some extent, giving rise to the Lassen soils which cover the rolling hills, and the wash from them extends to the west as far as Oregon Slough, forming the extensive Montague soils on the valley floor.

In the extreme northern part of the area, and within the two regions just mentioned, are small patches of recent-alluvial soils along the streams that flow out of the valley to the northwest.

South of this region of igneous rocks—that is, south of Montague and east of the line passing through Montague, Grenada, and Gazelle—is the great region of recent vulcanism. This part of the valley appears to have been filled by lava flows and eruptions, and is much younger than the other parts. This filling process may have been associated with the vulcanism that produced Mount Shasta, which lies just outside of the area to the southeast.

This recent volcanic region, occupying about one-half of the area, is largely nonagricultural, but includes scattered patches and strips of agricultural land, usually of low value. The region can be divided into three parts: (1) Little Shasta Valley, (2) the Scabland region, and (3) the alluvial-fan and outwash region.

The Little Shasta Valley lies east of Montague and on the eastern edge of the area surveyed. The Little Shasta River, which drains it, is of considerable size and has brought down sediments that have apparently filled up an ancient lake or broad valley, instead of building a typical fan. These sediments, like the rocks of the drainage area on the north, which are all of igneous origin, are very high in lime, which has been concentrated in the subsoil, cementing the soil material into a hardpan. Practically all the soils here have been modified in this manner and are therefore classed with the old valley-filling soils.

South of the Little Shasta Valley is the extensive Scabland region, of recent eruptive origin, occupying probably one-fourth of the entire survey. Scabland itself is nonagricultural, but includes numerous irregular bodies of agricultural land, the largest and best of which is the one at Mayten. The main arable soils in this region are of the Vina series.

Southeast of the Scabland region are the footslopes of Mount Shasta, which have been covered by ice-laid glacial deposits and glacial outwash.

West of the recent volcanic region is a narrow strip lying between the lavas and the foothills of the Coast Range. This strip extends from the neighborhood of Grenada to a point south of Gazelle, and is occupied by recent-alluvial soils composed of material brought down from the hills to the west by moderate-sized streams. These soils form the main body of valuable agricultural land in the Shasta Valley area. The principal soils in this region represent the Elder and Dublin series.

Thus it appears that about 50 per cent of the Shasta Valley is mainly nonagricultural, about 46 per cent is composed of residual, old valley-filling, and glacial soils, many of which are shallow or underlain by hardpan or are of low water-holding capacity, and a very small proportion, about 4 per cent, is free from hardpan and harmful amounts of alkali, of favorable texture, and capable of pro-

ducing good to large crops. Approximately half of this area of first-class land is irrigated and producing maximum crops.

The rocks[1] found in the valley and surrounding it are of many kinds. Those forming the range on the west, and the hills east and southeast of Yreka, are sedimentary rocks, including sandstones, shales, limestones, and conglomerates, with associated intrusive igneous rocks and ancient lavas of various ages, and all more or less metamorphosed. They are part of the Coast Range.

The rocks found in the northeast, east, and southeast, as well as over a large part of the floor of the valley, are lava flows and igneous eruptives of the Cascade Range, chiefly andesite, with some basalt and rhyolite and beds of tuff.

Scattered over Shasta Valley are many small knolls of lava and tuff, which appear to be, in part at least, the products of minor and local eruptions that broke through the overlying beds, each fissure or vent contributing its little pile of material.

The hills and mountains on the west show great age and are deeply eroded, though the hills are mostly rounded and smooth in outline. The hills and mountains on the north and northeast are formed by ancient lavas and show deep weathering and much erosion. The lavas on the floor of the valley and on the eastern and southeastern margin are recent and show very little weathering.

On the basis of differences in the manner of accumulation of the soil material, the soils of the Shasta Valley area fall into four groups: (1) Residual soils, (2) soils derived from glacial materials, (3) soils derived from old valley-filling material, and (4) soils derived from recent-alluvial deposits; in addition, there is a group of miscellaneous materials, mainly nonagricultural.

The residual soils are those derived by the weathering in place of consolidated rocks. They occur mainly on the hills and gentle slopes bordering the valley. Those derived from sedimentary rocks are classed with the Altamont series and those from igneous rocks with the Lassen series. The residual soils in this area, with one exception, are shallow and of relatively little agricultural importance. The exception is the Lassen clay adobe, which is farmed.

The soils derived from glacial materials occupy the foot slopes of Mount Shasta and are of low agricultural value. (Pl. VIII, Fig. 2.) The soils derived directly from the ice-laid till are classed in the Shasta series, and those derived from glacial outwash deposited by glacial streams are classed in the Delaney series.

The soils derived from the old valley-filling deposits have been formed by the weathering in place of unconsolidated material brought down from the surrounding hills by streams. The changes in these soils due to weathering are evidenced by a leached surface soil, a

[1] Bulletin 614, U. S. Geological Survey, Guide Book of the Western United States.

heavier subsoil due to the translocation of finer particles from the surface material, the concentration of lime in the subsoil, and in some cases by the presence of cemented hardpan. The soils in this group are classed with the Corning, Agate, Montague, Pinole, Bellavista, Hovey, and Gazelle series.

The recent-alluvial soils are composed of materials washed down into the valley in times so recent that they have undergone no great change through weathering. They occupy some gently sloping fans and are the best agricultural soils in the area. Those composed of material derived mainly from sedimentary rocks are classed in the Elder and Dublin series; those derived mainly from igneous rocks, in the Sutter, Vina, and Conejo series.

The miscellaneous materials embrace Muck and Peat consisting of cumulose deposits, Tailings, Scabland, and Rough broken and stony land.

The soils of the Shasta Valley area are classed in series on the basis of similarity in origin, color, topography, and structural characteristics. The series are divided into types on the basis of texture, or the proportion of particles of various sizes composing the material. The soil type is the unit of soil mapping.

The soils of the Altamont series vary in color from light brown to dark brown. Rock fragments in varying amounts may occur in the surface soil and subsoil. The subsoil is usually slightly lighter in color than the surface soil, being lighter brown or yellowish brown, and tends to be slightly compact. Generally it rests upon bedrock within 6 feet of the surface, although in places weathering extends to much greater depths. These soils are residual in origin and derived largely from interbedded sandstone and shale. They occupy rolling, hilly, or mountainous areas, including eroded steep slopes with abundant rock outcrop. The Altamont loam, with a shallow phase, is mapped in this area.

The surface soils of the types in the Lassen series are dark brown to brown, usually with a rusty-brown or chocolate tint. The subsoil has a similar or slightly lighter brown or more reddish brown color. Bedrock in most places lies 1 to 3 feet below the surface. The types of this series have developed under conditions of low rainfall, but the surface soils are generally leached of lime. The subsoil in places contains lime-coated rock fragments or light-colored mottlings caused by lime accumulation, but is not everywhere calcareous. The soils are residual, being derived from basic igneous rocks, including basalt, andesite, and tuff. The topography is generally rolling to hilly, with local flatter areas, and the surface is smooth. (Pl. IX, Fig. 1.) Surface drainage is good to excessive, except in small depressions, but the subdrainage is restricted in the flatter and

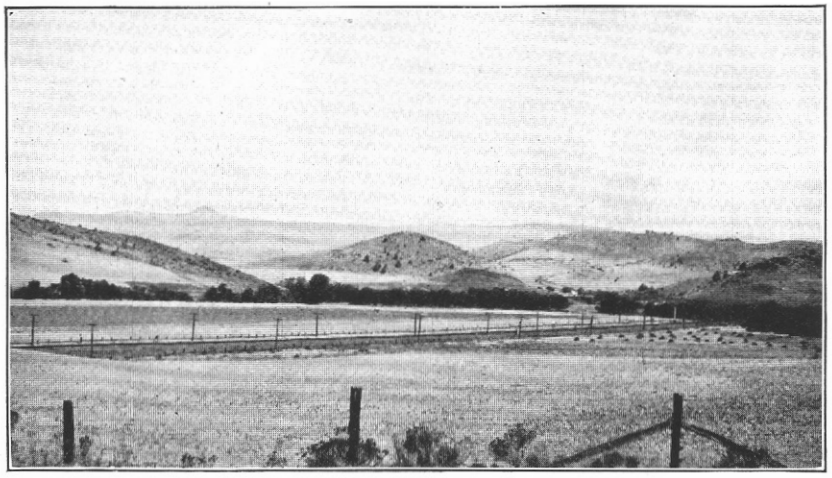


PHOTO FROM UNIVERSITY OF CALIFORNIA.

FIG. 1.—TOPOGRAPHY IN THE NORTHERN PART OF THE SHASTA VALLEY AREA.

Agate sandy loam, gravelly phase, in the valley in the foreground. Hills in the distance occupied by shallow stony soils classified with Scabland.

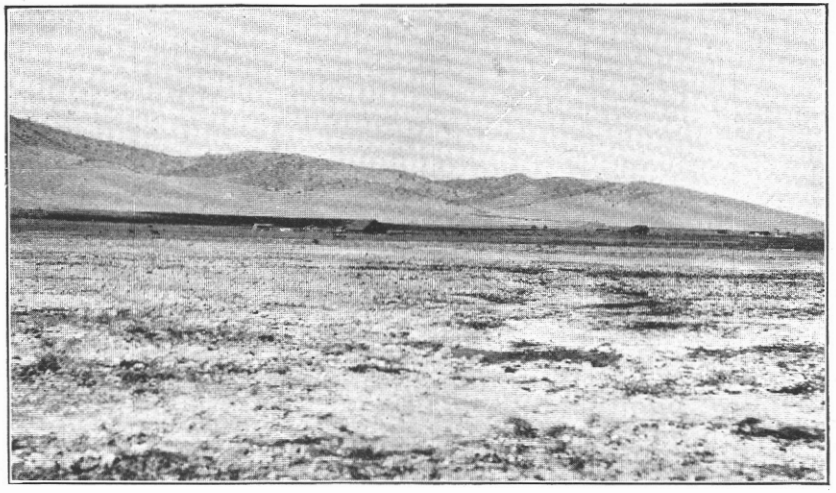


PHOTO FROM UNIVERSITY OF CALIFORNIA.

FIG. 2.—LOCAL ACCUMULATION OF ALKALI SALTS.

Gazelle loam in foreground. The slopes at the base of the hills in the distance are occupied by the soils of the Elder series, which are well drained and free from alkali.

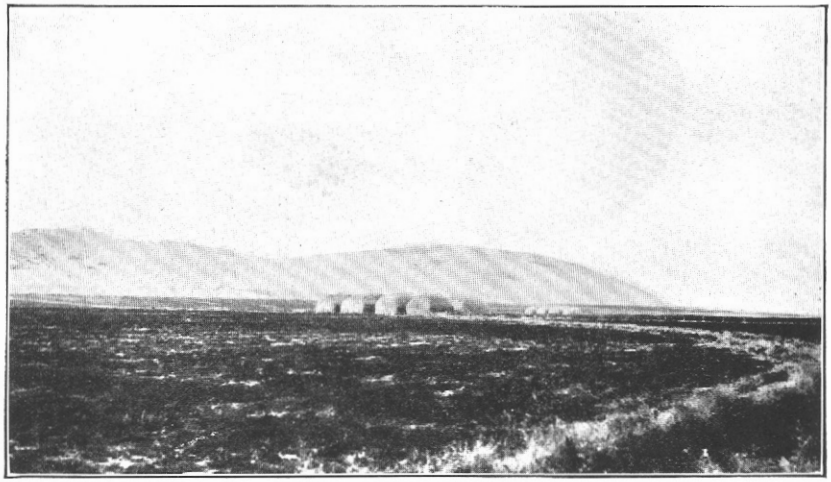


PHOTO FROM UNIVERSITY OF CALIFORNIA.

FIG. 1.—ALFALFA ON SOILS OF THE ELDER SERIES SOUTHWEST OF GRENADA.

PHOTO FROM UNIVERSITY OF CALIFORNIA.

FIG. 2.—TOPOGRAPHY AND NATIVE VEGETATION ON THE GLACIAL SOILS.

Soils of the Shasta and Delancy series in the foreground. Mount Shasta in the distance.

more shallow areas. The Lassen series is represented in this area by the loam, clay loam and its red phase, and clay adobe.

The surface soils of types of the Shasta series are predominantly of light-gray or gray color, modified in places by light-brownish, light-purplish, or pinkish tints. Locally in forested areas the immediate surface consists of a dark-colored layer, 1 or 2 inches deep, resulting from an accumulation of organic matter, but below this the color is typical. The subsoil is similar to the surface soil in texture, structure, and color, except that the pinkish or light-purplish tones are more pronounced. The material of the entire soil section is uniformly coarse, and there are no accumulations of lime, hardpan layers, or compacted horizons. Glacial bowlders and pebbles are embedded in the material, without assortment or stratification, except in occasional pockets or lenses. The bowlders and stones are subangular and consist mainly of fragments of grayish or pinkish andesite and volcanic tuff. The soils of this series are derived from glacial till, which has its origin mainly in andesitic and basaltic rocks, and has apparently been modified very little by weathering since deposition. The soils occur on the foot slopes of Mount Shasta under subhumid conditions. The topography is rather uneven, being sloping and rolling and somewhat hummocky, and in places of morainic character. Both surface and internal drainage are usually excessive. Only one type, the gravelly sand, is mapped in this area.

The soil types of the Delaney series are light gray to light brownish gray in color, with a pinkish or light-purplish tint in places. They are low in organic matter, loose and open in structure, of gritty texture, free from lime accumulations or compact horizons, and lack a distinctive subsoil. They are underlain, normally at relatively shallow depths, by a stratum of porous sand, gravel, and bowlders. The material giving these soils consists of slightly weathered glacial-outwash deposits occupying alluvial fans and slopes. (Pl. IX, Fig. 2.) The topography is gently to steeply sloping, but in most places smooth, except for shallow courses of intermittent streams. Surface and internal drainage are free and the soils are droughty. The Delaney series is represented in this survey by three types—the gravelly sand, gravelly fine sand, and fine sandy loam.

The surface soils of types of the Corning series are pale red to deep red. The subsoil is pale red or red, in places yellowish red, and commonly heavier in texture and more compact than the surface soil. Both surface soil and subsoil are well leached and free from lime accumulations, thoroughly oxidized, low in organic matter, and in places gravelly. In exposed sections stratified beds of cobblestones, gravel, sand, silt, and clay, compact or partly cemented, occur at 4 to 8 feet below the surface. The Corning series is derived from

old valley-filling materials having their source in a variety of rocks. In this survey the parent material appears to consist of old-alluvial fans formed of sediments derived from sandstone, shale, conglomerate, and igneous intrusives of the Coast Range. In origin and mode of formation it is similar to the Pinole series, from which it differs in color. The soils occupy gently sloping to rolling and eroded terraces or benches. The surface is usually smooth, although in some high dissected areas the slopes may be steep. Only the gravelly loam is mapped in this area.

The surface soils of types of the Agate series are brown, ranging in color from light brown to dark reddish brown. They are low in organic matter, generally sticky, and inclined to puddle when wet, and become compact and hard upon drying. The subsoil is normally reddish brown, and heavier and more compact than the surface soil. A hardpan lies at depths ranging from 1 to 4 feet, and outcrops in places where erosion has been active. The hardpan consists of reddish, ferruginous, indurated clay or sandy clay, in most places fissile in character, and incrusted with lime. The origin of this hardpan is not entirely clear, but there is evidence that in places it consists of volcanic tuff material laid down in water and later consolidated. The soil material is derived from old valley-filling deposits, derived from a variety of rocks. The soils occupy level or sloping to undulating treeless plains, in places marked by hog wallows. The level areas and depressions are poorly drained, and subdrainage is restricted throughout the series. The gravelly loam and the sandy loam with a gravelly phase are mapped in this area.

The surface soils of types of the Montague series are very dark brown to black. They are predominantly heavy in texture, compact in structure, moderate to high in organic matter, and generally noncalcareous. The subsoil is yellowish brown, light grayish, or pale yellowish and prevailingly calcareous. It is underlain at a depth of about 3 feet by a yellowish to grayish, rather soft, calcareous hardpan, below which is a stratum of friable material similar to the upper subsoil. The soils of this series are derived from old valley-filling materials consisting of foot-slope and alluvial-fan deposits which had their source mainly in basalt or other basic igneous rocks. The topography is level or gently sloping to gently undulating, the surface being smooth, except for a few hog wallows. Surface drainage is moderately well developed, but subdrainage is somewhat restricted. Only the Montague clay loam adobe occurs in this area.

The surface soils of types of the Pinole series are pale yellow or brownish yellow, with light yellowish brown to light grayish brown variations. The subsoil is of similar or heavier texture, more compact structure, and slightly lighter color. The substratum consists

of interbedded layers of light-colored clay, silt, and fine sand and to some extent of gravel. All these beds are slightly cemented, with seams and coatings of lime. The surface soil and subsoil, however, do not contain sufficient lime to effervesce with acid. The types of the Pinole series occupy terraces or benches with a smooth and level to gently rolling surface. They are derived from old valley-filling deposits coming largely from sedimentary rocks. Drainage is generally well developed. As occurring in this area, the surface soils are prevailingly yellowish brown, the brown being somewhat more pronounced than typical. Only one type, the gravelly loam, is mapped in this survey.

The surface soils of types of the Bellavista series are gray to light gray, highly calcareous, low in organic matter, and compact in structure. They puddle when wet and bake upon subsequent exposure to the sun. A stratum of firmly cemented lime hardpan of gray or grayish color commonly lies a foot or two below the surface. Below the hardpan the material is very similar to the surface soil. The soils of the Bellavista series are derived from old-alluvial deposits coming apparently mainly from basic igneous rocks of high lime content. The origin of the hardpan, however, is not entirely clear. It appears possible that it consists of volcanic material of fine fragmental character laid down by water and later cemented in part by calcium carbonate. If such is the case, the soil consists of weathered tuffaceous material that has not become cemented. The Bellavista soils are closely associated with the soils of the Hovey series, from which they are distinguished by a lighter color and the occurrence of hardpan. The types of this series have a level, gently sloping, or gently undulating topography, with a smooth surface. They are developed under conditions of low rainfall. Subdrainage is arrested by the hardpan, and in local flats the surface drainage also is poorly developed. Two types of this series, the loam and the clay, occur in this area.

The surface soils of types of the Hovey series are very dark brown or dark gray to black, relatively high in organic matter, and calcareous a few inches below the surface. They are predominantly heavy in texture and compact, but are friable under favorable conditions of moisture and have good water-holding capacity. The subsoil is highly calcareous. A compacted or slightly cemented layer, 18 to 24 inches thick, and containing concentrations of lime in the form of soft nodules, crusts, and marly deposits, usually lies at a depth of 2 or 3 feet. The color of this layer is light gray or pale yellowish to yellowish brown. Below this layer the material is brown or yellowish gray, variable in texture, more friable, and of lower lime content. The topography is level to gently sloping or gently undulating, and the surface is smooth. Drainage is usually well developed. The soils of this series occur under conditions of low rainfall. They are derived

from old valley-filling deposits on foot slopes and alluvial fans, the material of which was derived mainly from basic igneous rocks. They resemble the Bellavista soils in origin and mode of formation, but differ in color and in having no hardpan. Only one type, the loam, is mapped in this area.

The surface soils of types of the Gazelle series are dark brown to dark grayish brown or black, the latter in areas of high organic-matter content. On dry field surfaces and in the dry samples the color sometimes fades to a lighter gray. They are commonly mildly to distinctly calcareous. The subsoil is generally lighter in color, usually yellowish or grayish, and contains an irregularly developed lime hardpan, never so very hard or firmly cemented that it can not be penetrated by the soil auger. The hardpan layer probably occurs under more than half the area of these soils. Below the hardpan the subsoil varies in texture, but is normally more friable than the upper subsoil, and of about the same or a slightly lighter color. The soils occupy flat and low valley plains and shallow basins, and most of them are poorly drained during the rainy season. The surface is smooth, though in places traversed by shallow stream ways and sloughs; accumulations of alkali occur here and there. These are old valley-filling soils that have been somewhat modified in profile since deposition, but apparently have not yet attained great age. They are derived in the main from basic igneous rocks. In color and occurrence they resemble the Hovey soils, from which they are differentiated by poorer drainage and the occurrence of a noncontinuous hardpan. The Gazelle series is represented in this area by the loam, with a sandy phase, and the clay loam.

The surface soils of types of the Elder series are brownish gray to dark brownish gray or slate gray. They have a moderate content of humus and good water-holding capacity, and are generally friable. In places they contain gravel, consisting mainly of dark-colored water-worn pebbles. The subsoil closely resembles the surface soil, but in places has a somewhat lighter color and may include variable strata of materials of different texture. No accumulations of lime are apparent in surface soil or subsoil. The soils occupy level to gently sloping areas with a smooth surface. They are recent-alluvial soils, and, in this area, occupy small alluvial fans on the western side of the valley. The parent material is derived mostly from sedimentary rocks, but to some extent from metamorphosed rocks, both of sedimentary and igneous origin. They are related to the soils of the Dublin series, from which they are distinguished by their lighter and browner color and superior drainage. The gravelly sandy loam with a light-textured phase, the fine sandy loam, and the loam with a gravelly phase are mapped in this area.

The surface soils of types of the Dublin series are dark gray or dark brownish gray to black, commonly of moderately high humus content. The subsoil is dull yellow to yellowish brown or grayish brown, similar to or lighter than the surface soil in texture, in places mildly calcareous, and without pronounced compaction or lime cementation. There is, however, little uniformity in the color or texture of the subsoil and substratum. The substratum consists of alternate layers of clay, silt, and loam, with an occasional bed of gravel at lower depths. The surface soil evidently owes its dark color to the high content of organic matter. The Dublin soils occur typically on alluvial fans or in broad basins which have only recently been drained. The surface is gently sloping to nearly level and smooth. These are recent-alluvial soils, derived mostly from the wash of sedimentary rocks. They are associated with the Elder soils, from which they differ in being darker in color and less well drained. Only one type, the Dublin clay loam, is mapped in this area.

The types of the Sutter series are light gray, brownish gray, or gray, the material in places extending without distinctive difference in color, texture, or structure to the depth of 6 feet or more. When of less depth the surface soil is underlain in this survey by a grayish, brownish, or yellowish, heavier textured subsoil. The content of organic matter is low, the soil permeable, and lime accumulations are wanting. Soils of this series are of recent-alluvial origin, derived from basic igneous rocks. They occupy small fans, with gently sloping, smooth surfaces, and prevailingly well-developed drainage. (Pl. X, Fig. 1.) They are distinguished from soils of the Vina series by their lighter grayish color. They generally occur under conditions of low rainfall. The series is represented in the present survey by the Sutter fine sandy loam, with a light-textured phase.

The color of the surface soils of types of the Vina series ranges from light reddish brown or grayish brown in the light-textured members to dark brown or dark reddish brown or chocolate brown in the heavier types. The surface soils are friable, usually free from gravel, generally noncalcareous, and low in organic matter. The subsoil has a similar or slightly lighter color, is generally permeable, and shows no compaction, cementation, or accumulations of lime. It may include stratified layers of variable texture. The soils of this series, which are alluvial in origin, occupy recent-alluvial fans, the deposits of which are derived almost entirely from basic igneous rocks. The topography is smooth and gently sloping and drainage is well developed. Overflows occur in some parts of the fans, but are not serious. These soils are distinguishable from the related Sutter soils by their browner color. The Vina series is represented in this area by the sandy loam with a light-textured phase and the fine sandy loam with a heavy phase.

The surface soils of types of the Conejo series are dark gray or dark brownish gray to black, predominantly of heavy texture and compact structure, and typically noncalcareous. The subsoil is generally brown or dark grayish brown, but the darker color of the surface soil may extend to the depth of several feet. It is variable in texture, but not consistently heavier or more compact than the surface soil, and in places contains mottlings and seams of lime. These soils are of recent-alluvial origin, from parent material derived mainly from basic igneous rocks. They occupy sloping to nearly flat alluvial fans, terraces, and stream bottoms. They are similar in origin and mode of formation to the Sutter and Vina soils but differ from them in their darker color. The soils have a smooth, uniform surface. The Conejo fine sandy loam with a heavy phase, the clay loam with a gravelly phase, and the clay adobe are mapped in this area.

The soils of the Shasta Valley area are described in detail in subsequent pages of this report. Their distribution is shown on the accompanying soil map. The table below gives the actual and relative extent of the soil types mapped.

*Areas of different soils.*

| Soil. | Acres. | Per cent. | Soil. | Acres. | Per cent. |
|---|---|---|---|---|---|
| Rough broken and stony land | 114,048 | 34.8 | Agate gravelly loam | 4,096 | 1.2 |
| Scabland | 54,016 | 16.5 | Vina fine sandy loam | 2,816 | 1.1 |
| Lassen clay loam | 24,000 | 7.4 | Heavy phase | 1,088 | |
| Red phase | 128 | | Bellavista loam | 3,328 | 1.0 |
| Agate sandy loam | 1,472 | 4.1 | Hovey loam | 2,880 | .9 |
| Gravelly phase | 12,096 | | Lassen clay adobe | 2,560 | .8 |
| Gazelle loam | 11,520 | 3.6 | Gazelle clay loam | 2,496 | .8 |
| Sandy phase | 384 | | Delaney gravelly sand | 2,240 | .7 |
| Elder gravelly sandy loam | 10,688 | 3.4 | Conejo clay adobe | 1,536 | .5 |
| Light-textured phase | 384 | | Conejo fine sandy loam | 1,216 | .5 |
| Altamont loam | 5,120 | 3.3 | Heavy phase | 320 | |
| Shallow phase | 5,760 | | Sutter fine sandy loam | 1,152 | .4 |
| Montague clay loam adobe | 9,792 | 3.0 | Light-textured phase | 384 | |
| Vina sandy loam | 8,576 | 2.9 | Bellavista clay | 1,344 | .4 |
| Light-textured phase | 576 | | Dublin clay loam | 1,216 | .4 |
| Shasta gravelly sand | 8,448 | 2.6 | Tailings | 1,152 | .3 |
| Lassen loam | 8,064 | 2.5 | Elder fine sandy loam | 1,088 | .3 |
| Elder loam | 3,520 | 1.8 | Delaney fine sandy loam | 832 | .2 |
| Gravelly phase | 2,432 | | Corning gravelly loam | 576 | .2 |
| Conejo clay loam | 3,904 | 1.6 | Muck and peat | 256 | .1 |
| Gravelly phase | 1,280 | | | | |
| Pinole gravelly loam | 4,736 | 1.4 | Total | 327,680 | |
| Delaney gravelly fine sand | 4,160 | 1.3 | | | |

ALTAMONT LOAM.

The surface siol of the Altamont loam is a brown loam from 10 to 15 inches deep. It is granular, low in lime, relatively easy to cultivate, and retains moisture fairly well. The subsoil is a brown clay

loam, or clay, and, as occurring in this area, is noncalcareous and 8 to 16 inches thick. It rests upon bedrock, usually at 18 to 30 inches below the surface, though in a few places it is somewhat deeper. Here and there the bedrock, which consists of sandstones and shales, is exposed at the surface. Gravel or small rock fragments occur in places in the soil and subsoil. As mapped in this survey the type includes some material of clay loam texture.

This type occurs in fair-sized bodies between the Snowdon and Willow Creek Schools and to the east along Willow Creek; in several small bodies in the neighborhood of Yreka; three small bodies, from 3 to 5 miles south of Montague; and one small body 2½ miles south of Grenada. It occupies the more gentle slopes of the hills, next to the alluvial soils of the valley floor. The surface is sloping to rolling and usually smooth. Drainage is good to excessive and erosion is active in places.

Originally the type was mostly treeless, with some small oaks and low bushes here and there. It is not very important agriculturally. Probably half of the type is in cultivation, wheat being the main crop, but the yields are low. The uncultivated part affords some scant pasturage for stock. The soil seems to be naturally of low productiveness under dry-farming conditions, and water for irrigation is not at present available.

*Altamont loam, shallow phase.*—The shallow phase of the Altamont loam is in places without a distinctive subsoil, the surface soil resting directly on the bedrock, which occurs at an average depth of 12 inches below the surface. Rock outcrops are much more numerous than in the typical Altamont loam. This phase is mapped northwest of Snowdon School, in the neighborhood of Yreka, on the eastern slopes of the Kildall Hills, and in scattered bodies on the eastern slope of the hills extending from Yreka south to Gazelle. The phase, like the typical soil, occurs on the lower slopes of the hills. The topography is rolling to steep, ordinarily steeper than that of the type, and erosion is active in places. Only a small proportion is under cultivation. It is even less valuable for farming than the typical Altamont loam.

### LASSEN LOAM.

The surface soil of the Lassen loam has an average depth of 12 inches and is a brown to dark-brown or dark chocolate brown loam, nearly free from stone fragments. It is rather granular in structure and not difficult to cultivate. It is low in organic matter and has only a fair amount of lime. It retains moisture only fairly well. In places there is no distinctive subsoil and the soil is very shallow, the plow often striking bedrock. Outcrops occur here and there. The subsoil, where developed, is a brown or yellowish-brown loam or

clay loam extending from the surface soil to bedrock, which normally occurs at depths of 24 to 36 inches, though on the steeper hillsides it may lie within a few inches of the surface. It contains more lime than the surface soil, sometimes effervescing with dilute hydrochloric acid, and in places contains grayish mottlings and seams or incrustations of lime.

The parent rock is a basic igneous formation, but differs somewhat in character from that giving the Lassen clay adobe. The upper part of the rock is well decayed and functions much the same as the soil. Seams in this disintegrating rock are coated with lime.

Large areas of this type are found in the northeastern part of the area in the neighborhood of Hovey Gulch School and the Foothill School. One small area is located about 3 miles south of Montague and another 4 miles east. The type is rolling to hilly, most of the slopes being gentle enough for plowing. The surface is smooth, except where broken by rock outcrops. Drainage is good to excessive.

There is good evidence that all this type was originally treeless. More than half of it is cultivated, wheat being the crop grown, but the yields are light and barely pay the cost of production. The usual practice is to fallow the land every other year. The uncultivated parts are used for pasture. This type has very limited possibilities, and the present system of farming is probably the one best suited to the conditions. It is sparsely settled, and land holdings are large. Most of this type is held at prices ranging from $10 to $25 an acre.

### LASSEN CLAY LOAM.

The surface soil of the Lassen clay loam is a brown to dark-brown clay loam averaging about 6 inches in depth, but varying in depth from 2 or 3 inches to 1 or 2 feet. Most of it is shallow and filled with angular rock fragments. In places these are present in sufficient quantities to constitute a stony clay loam. The soil has a rather granular structure when dry, but when wet it is sticky and plastic. It is low in organic matter, and is moderately well supplied with lime. The color varies from a dull brown to a reddish brown. As mapped in this survey, the texture also varies, some of the included material being a clay or a clay adobe and small areas approaching a loam in texture. Most of this type has no distinctive subsoil, the shallow surface soil resting directly on bedrock. Where a distinctive subsoil is present it is a brown heavy clay loam, generally calcareous. Bedrock occurs at depths ranging from a few inches to 1 or 2 feet, and outcrops in many places. Most of the rock surface is hard, but in places the upper part for a few inches is soft and disintegrated. It is a basic igneous rock.

The Lassen clay loam is extensive in the northeastern, eastern, and central parts of the survey, and a few small areas are scattered in

other parts of the valley. It occurs on the more moderate slopes of the mountains and is closely associated with the Rough broken and stony land, which occupies the higher and more rugged situations. It is rolling and hilly in topography. The surface is smooth, except where broken by rock outcrops or an occasional eroded gully. Drainage is good to excessive, but erosion is not very severe.

In the main this type was originally treeless; in places it now supports a few junipers and some brush. In the Willow Creek neighborhood, in the northern part of the area, considerable of this type is used for growing wheat. Yields are light to moderate. In the other parts of the area the type is mostly untilled and is used for pasture. On account of the shallowness of the soil, the topography, and the quantity of rock fragments present, this is not a very promising type for improvement. Apparently its present use is about all that can be expected of it under present agricultural conditions. It has a market value of $10 to $20 an acre.

*Lassen clay loam, red phase.*—The surface soil of the Lassen clay loam, red phase, is a red to dull-red clay loam, 12 to 24 inches deep, in places containing some gravel or small stone fragments. It is low in organic matter and is fairly retentive of moisture. It is seldom sufficiently calcareous to effervesce with dilute acid. The subsoil, where developed, is a red clay loam, plastic, and somewhat compacted, but in places it is wanting, and the surface soil rests directly on bedrock, which lies 12 to 36 inches below the surface. In this area it is a metamorphosed rock, mostly of igneous origin, but apparently including some rocks of sedimentary origin.

Only two small bodies of this phase are mapped in this area, one near Snowdon School and one at Forest House on the road to Scott Valley. These really represent areas of the Aiken clay loam, a type closely related to the Lassen clay loam, but differing from the Lassen in its predominantly red color. They occupy foot slopes or low hills and are sloping or gently rolling, with a smooth surface. Drainage is good to excessive. About half of this phase is under cultivation and gives medium to low yields.

The table below gives the result of mechanical analysis of a sample of the surface soil of the typical Lassen clay loam:

*Mechanical analysis of Lassen 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.* |
| 575324..... | Soil..... | 1.5 | 4.2 | 3.1 | 17.9 | 16.4 | 26.9 | 30.3 |

### LASSEN CLAY ADOBE.

The surface soil of the Lassen clay adobe is a clay of uniform texture and very decided adobe structure. It is sticky and plastic when wet, and when dry it checks and cracks, and under cultivation breaks down into small granules. This peculiarity is a decided advantage in cultivation. The color is a dark rich brown or dark rusty brown, almost a reddish brown, and is quite uniform. The depth varies from 1 foot to 3 feet, and averages about 2 feet. It is relatively low in organic matter. It is high in lime, all except the first 6 or 8 inches effervescing with dilute hydrochloric acid. There is no subsoil differing materially from the surface soil, and the soil may be said to rest directly upon the bedrock. The top few inches of the bedrock is usually weathered and soft, but below this it is hard. The bedrock outcrops in places.

A few spots were included with this type, as mapped in this area, in which the soil material is black, but otherwise has the same characteristics as the rest of the type. These were too small to show on the map, but if larger they would have been mapped as a different soil, on the basis of color. These spots occur in seepy places on the hillsides and apparently owe their color to the accumulation of more organic matter in the soil, where moisture conditions have been favorable.

The Lassen clay adobe is found in the northeastern part of this survey in several small areas in the Willow Creek Valley, and also east and northeast of Montague. It occurs on the gentle slopes of hills composed of basic igneous rocks and is closely associated with the Lassen clay loam, which usually occupies the more rolling parts of these hills. It is sloping to rolling in topography, with a smooth surface. Erosion affects it only slightly. Surface drainage is good, but subsoil drainage is restricted.

This type was originally treeless. Most of it is under cultivation, wheat being the sole crop. Under very favorable conditions during a season of maximum rainfall it may produce 20 bushels of wheat per acre, but 12 bushels is generally considered a good crop. This type is the most productive of the Lassen soils in this area, but it is not extensive. The best of it is valued at about $25 an acre.

No radical change is necessary in the management of this soil. It is essential that the farmer understand the characteristics of the soil and be prepared, when the favorable time comes, to put it into condition for grain without loss of time. Heavy teams and farming equipment are required.

In the following table is given the result of mechanical analysis of a sample of the surface soil of the type:

*Mechanical analysis of Lassen clay adobe.*[1]

| 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.* |
| 575313 | Soil | 1.2 | 1.4 | 1.6 | 4.4 | 13.7 | 30.1 | 48.2 |

[1] Analysis by University of California.

SHASTA GRAVELLY SAND.

The Shasta gravelly sand is a gray or light brownish gray sand containing very little silt and clay, and considerable gravel. In places there are numerous stones ranging in size from small cobblestones to bowlders several feet in diameter. The surface soil may be said to extend to a depth of 6 feet and more, for there is no distinctive subsoil or change in character of material in the lower depths. The lower part, however, has in places a characteristic pinkish or light-purplish color. Under the virgin forest there is a superficial layer, 1 or 2 inches thick, of brown material which is mostly leaf mold. Other than this there is extremely little organic matter in the soil. Owing to its porous nature, the soil is droughty. The gravel and stone content consists of igneous rock, much of it tuffaceous in character, and found at all depths, usually without assortment or stratification.

This type is mapped in several large areas between Weed and Delaney and one small area south of Weed. It occupies high, sloping ground and terminal moraines on the foot slopes of Mount Shasta. The surface is rolling and hummocky. In places a few gullies have been cut by erosion. Both surface and underground drainage are excessive.

This type is barely within the class of agricultural soils, but where water for irrigation is available, grass is grown for hay and pasturage. The high elevation, ranging between 3,000 and 4,000 feet, climatically limits the choice of crops to a narrow range. Probably not more than 2 per cent of the soil is under cultivation.

The table below gives the result of a mechanical analysis of a sample of this soil:

*Mechanical analysis of Shasta gravelly 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.* |
| 575372 | Soil | 7.4 | 19.3 | 10.7 | 34.4 | 15.1 | 9.0 | 3.5 |

DELANEY GRAVELLY SAND.

The surface soil of the Delaney gravelly sand is a light-gray or light brownish gray sand containing considerable coarse sand and

gravel. A few bowlders are also present. Both the gravel and stones are more or less rounded by water action. The soil is very loose and porous, low in organic matter, and retains moisture very poorly. The subsoil is similar to the surface soil, being a gray or brownish-gray gravelly sand of rather coarse texture, loose and incoherent. In a few places there are some compacted or slightly cemented layers from 3 to 6 feet below the surface, but most of the type is underlain by a porous gravelly stratum. The gravel and stone are of igneous rocks and largely tuffaceous.

This type occurs in a single large area 2 miles southwest of Delaney, on a large outwash plain on the lower foot slopes of Mount Shasta. It has a sloping surface, which is smooth or marked by meandering deserted stream channels. Both surface drainage and underdrainage are excessive. It is subject to overflow during heavy rains, but the floods very soon subside.

This soil has little agricultural value. Several settlers have attempted reclamation on the lower end of this fan, where the soil is most nearly level and the best, but their claims are now deserted. A well about 40 feet deep was curbed up all the way, indicating the loose nature of the material to great depths. The well was dry, showing that at this season of the year (July) the water table drops very low. If irrigation water were obtainable the soil would probably be quite productive. The range of crops would be limited mainly by a short season. The elevation ranges from about 3,000 feet to 4,000 feet. This land has practically no market value.

### DELANEY GRAVELLY FINE SAND.

The surface soil of the Delaney gravelly fine sand is a light-gray or light brownish gray fine sand, about 2 feet deep, containing considerable gravel and a few stones. The gravel and stones show considerable rounding by water action. They are of igneous origin and largely tuffaceous. The soil is loose and porous, easy to cultivate, low in organic matter, and retains moisture poorly. The subsoil is very similar to the surface soil in texture and color, except that the color may be a little lighter and nearer a neutral gray. Stones are found in places in the subsoil. Both surface and subsoil are without compaction, cementation, or accumulations of lime. A small included area adjoining Weed on the northeast is of somewhat lighter texture, and according to field tests the surface soil in this locality is slightly acid, the only instance of this kind observed in the Shasta Valley area.

This type is mapped at Weed and Edgewood and for a few miles north of these towns, in one small body south of Weed, and in a fair-sized body just east of the Shasta View School. The soil areas occupy alluvial fans or outwash plains near the foot of Mount Shasta.

They are level to sloping and have a smooth or nearly smooth surface, dissected by an occasional stream channel. Drainage is good and in places excessive.

Probably half of this type, including only the land for which irrigation water is available, is under cultivation, and is used for pasture and hay. The elevation ranges from 2,800 to 3,500 feet, and this limits the choice of crops materially. The uncultivated part supports a second growth of pine and fir.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Delaney gravelly 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.* |
| 575358 | Soil | 4.8 | 14.3 | 9.3 | 37.5 | 17.8 | 12.4 | 3.8 |
| 575359 | Subsoil | 5.2 | 14.9 | 9.4 | 36.7 | 17.7 | 13.3 | 2.7 |

### DELANEY FINE SANDY LOAM.

The surface soil of the Delaney fine sandy loam is a light brownish gray or light-gray fine sandy loam, 15 to 30 inches deep. It is low in organic matter and does not retain moisture very well. It is granular in structure and easy to cultivate. The subsoil is a brownish-gray fine sandy loam or sandy loam, which in places contains considerable gravel at the lower depths. Coarse gravel may be encountered below the depth of 4 feet. Some variations of heavier, silty texture are included.

The type occurs in a fair-sized area around Shasta View School and a small area 3 miles north of Weed. The topography is level to gently rolling, and the drainage is good. Irrigation water is obtainable for about half the land. Irrigated crops give fair yields; no attempt is made to farm the land without irrigation.

### CORNING GRAVELLY LOAM.

The surface soil of the Corning gravelly loam is a dull-red or brownish-red loam carrying a large percentage of gravel, and from 12 to 36 inches deep. It is low in organic matter and not very retentive of moisture. The subsoil, which is not always distinctively developed, is a red clay loam, 2 or 3 feet thick, also containing much gravel. The substratum consists of beds of large cobblestones, embedded in a matrix of loam and clay. The cobblestones are composed of many kinds of rock, but are largely of metamorphosed sedimentaries and quartzites. The texture of the soil varies somewhat, some of the material being a gravelly fine sandy loam.

This type is mapped only in small bodies in the vicinity of Hawkinsville and Yreka, on remnants of old alluvial fans. The parent materials came from gold-bearing rocks in the mountains to the west and were found to be rich in gold. They have largely been worked over in the processes of mining and much of the area is mapped as Tailings, the Corning gravelly loam representing only small remnants of the original areas. The drainage is good and erosion is active in places.

About one-third of this type is under cultivation. It produces low yields of grain, and owing to its small extent the soil has very little importance.

### AGATE GRAVELLY LOAM.

The surface soil of the Agate gravelly loam is a brown to dark-brown loam containing considerable gravel, enough at all times to influence the cultural requirements of the soil. The depth varies from 6 to 12 inches and averages about 8 inches. The soil is low in organic matter and retains moisture only fairly well. It has a somewhat granular structure, but it is rather difficult to cultivate, owing to its heavy texture. The subsoil is a brown, compact clay loam forming a layer about 12 inches thick between the surface soil and a hardpan layer. Like the surface soil, it contains considerable gravel, which consists of hard fragments of metamorphosed sedimentary and igneous rocks and shows considerable rounding and wear by running water. The hardpan, occurring at depths of 18 to 20 inches, consists of a cemented layer of gravelly clay loam. The cementing material apparently is mainly iron salts, but streaks and coatings of lime carbonate are present. The upper part of the stratum lying beneath the hardpan is usually similar to the surface soil. Below this occur compact volcanic tuffs and clay, with bowlders.

This type occurs to a moderate extent in the neighborhood of Montague. One fair-sized body borders Oregon Slough, another lies just north of Steamboat Butte, and three smaller ones occur in the same neighborhood. The surface is level to gently sloping and where not cultivated is marked with slight hog wallows. The mounds are not as numerous or as large as those on the Agate sandy loam, gravelly phase, and in cultivated fields they have largely disappeared. Very little erosion takes place on areas of the soil. Surface drainage is sufficient, but subdrainage, owing to the heavy subsoil and the hardpan, is inadequate.

This type was originally covered with grasses and other herbaceous plants. About half of it is under cultivation, wheat being the main crop. Light to medium yields are obtained. The uncultivated part is used for pasture and supports only a light stand of grasses. Water for irrigation is obtainable for a very small proportion of it, and here

alfalfa is grown, with moderate yields. Under present conditions, with water unavailable, the soil is apparently being used in the most practicable way. Holdings on this type are large. The market value of this land is from $10 to $25 an acre.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the type:

*Mechanical analyses of Agate gravelly 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.* |
| 575318 | Soil | 6.5 | 7.6 | 3.6 | 15.5 | 19.7 | 30.5 | 16.4 |
| 575319 | Subsoil | 5.8 | 7.5 | 3.4 | 14.2 | 16.9 | 27.7 | 24.5 |

AGATE SANDY LOAM.

The surface soil of the Agate sandy loam is a brown sandy loam, from 16 to 24 inches deep. It contains in places some gravel, but not enough to affect cultural requirements, and most of the type is gravel free. In structure it is fairly granular and is cultivated easily. It is low in organic matter and in places contains slight accumulations of lime. The subsoil, where present, is a yellowish-brown loam. It is usually not more than 6 or 8 inches thick and contains here and there thin seams or mottlings of lime accumulation. In places the distinctive subsoil is absent and the surface soil rests directly on a hardpan, generally 16 to 30 inches below the surface. It is a brown loam material, well cemented, apparently with iron salts, but containing coatings and seams of calcareous material. It has an average thickness of 1 foot and is underlain by material very similar to the surface soil and subsoil, or by volcanic deposits. As mapped some soil with a texture approximating loam is included.

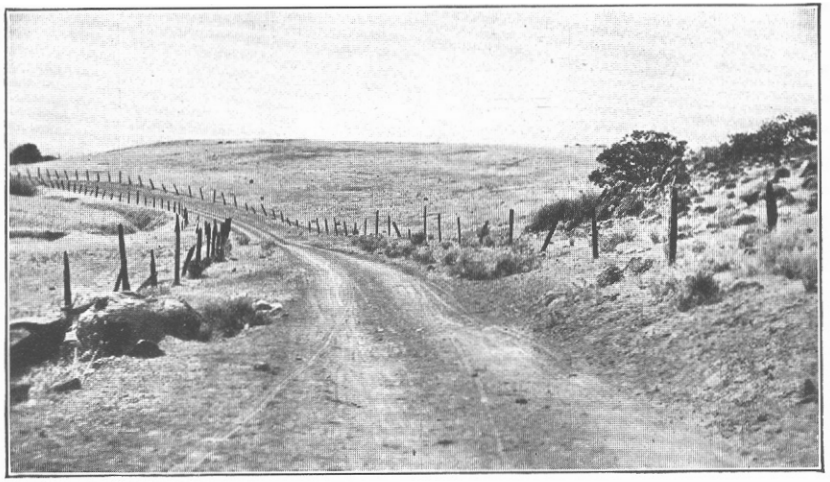
This is a minor type, occurring in a few small areas lying east, south, and southwest of Montague, and one very small body 1½ miles northeast of Snowdon. The surface is gently sloping to nearly level and smooth. Surface drainage is good, but the subdrainage is restricted. The type is treeless and apparently was originally covered with grasses. Most of it is under cultivation. About half of the cultivated area is in grain, which under dry-farming methods gives moderate yields. The other half is irrigated. Alfalfa is the main irrigated crop, and up to the present time (1919) fair crops have been obtained. However, the alfalfa is only 2 or 3 years old, and it remains to be seen how long lived it will be. This soil is considerably more valuable than its gravelly phase, but on account of the hardpan layer it is still a soil of only moderate productiveness.

*Agate sandy loam, gravelly phase.*—The surface soil of the Agate sandy loam, gravelly phase, is a brown sandy loam containing con-

siderable gravel and in places numerous cobblestones and larger bowlders. The depth varies from 4 to 15 inches and averages about 10 inches. The soil is low in organic matter and commonly also in lime. It retains moisture poorly. The gravel and stone content is derived mostly from metamorphosed rocks, but a considerable proportion is of quartz. A little of the soil material is yellowish brown in color and locally some of it shades off into a dark grayish brown. This is true especially in places next to the hills on the west, and is apparently due to a deposit of relatively recent overwash of darker colored material. The subsoil is a brown to yellowish-brown or reddish-brown heavy loam, clay loam, or clay containing considerable gravel; and where the surface soil is stony, the subsoil is also stony. It is low in lime and organic matter. The subsoil layer is only 2 to 6 inches thick and in places is entirely lacking, the surface soil resting directly upon the hardpan. Hardpan occurs at depths ranging from 4 to 24 inches, but is commonly encountered at 10 to 16 inches below the surface. It is brown to yellowish brown in color, and moderately hard to hard. The cementing material seems to be mainly iron salts, but seams and incrustations of calcareous material occur. The hardpan is apparently a cemented gravelly sandy loam. The layer is 12 to 16 inches thick and is underlain by more friable material very similar to the surface soil or by compact and more or less indurated volcanic tuffs.

This phase is developed only in the northwestern part of the survey. One large area extends from near Snowdon School southwest about 11 miles to a point between Yreka and Montague. Two small bodies are in and near Yreka, one is halfway between Yreka and Grenada, and another is in the eastern part of the Kildall Hills. The surface is level or gently sloping. Where uncultivated, as much of this phase is, the surface is invariably covered with low mounds or hog wallows. These mounds are from 8 to 15 feet in diameter and from 1 to 2 feet high, and are thickly scattered over the surface. The hardpan does not follow the contour of the surface; it lies deeper under the mounds and less deep under the depressions. There is practically no erosion of the soil. Surface drainage is good, but subdrainage is very poor on account of the hardpan.

The gravelly phase of the Agate sandy loam in its natural condition is covered with a scant growth of grasses and weeds. Only a very small proportion of the phase is cultivated—the areas where the soil is deepest and water is obtainable for irrigating alfalfa. The greater part of the phase is used for pasture, for which it has a low value. Some of it is not even fenced and no returns are obtained from it. The crops grown give very light yields. The low agricultural value is due to the hardpan found so near the surface, and



S. 10,663.

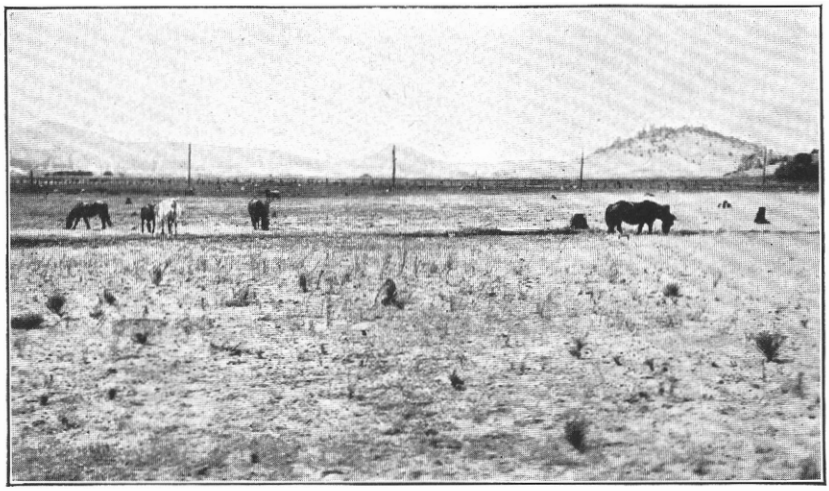
FIG. 1.—SOILS OF THE LASSEN SERIES.

Showing characteristic topography of the lower rolling hills near Redd School.

PHOTO FROM UNIVERSITY OF CALIFORNIA.

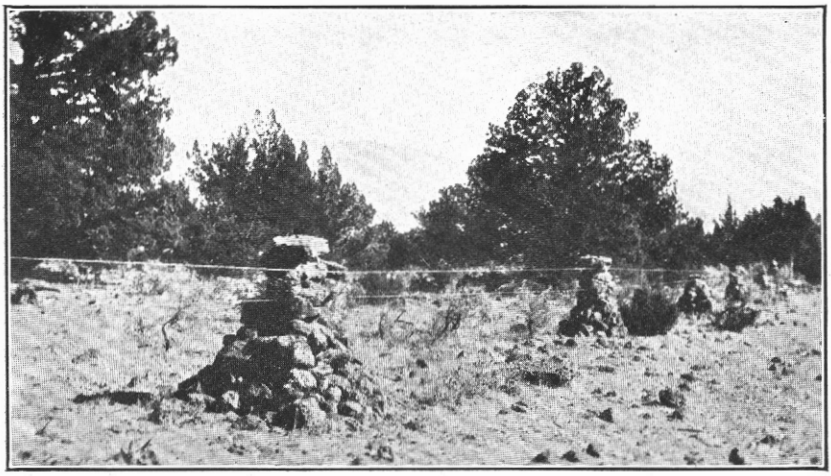
FIG. 2.—EXPOSED SECTION OF THE DELANEY GRAVELLY FINE SAND AT WEED.

Showing gravelly and imperfectly assorted glacial-outwash material.



S. 10,644.

FIG. 1.—SOILS OF THE SUTTER SERIES IN USE AS PASTURE LAND.



S. 10,404.

FIG. 2.—SMOOTH AREA OF SCABLAND.

Showing characteristic shallow stony surface soil with scattering growth of juniper. The stone fence posts are built of loose basaltic fragments.

the possibility of marked improvement in this condition would seem very remote. It is possible that the hardpan could be blasted and the soil made suitable for a greater variety of crops. However, if this were economically feasible, which is doubtful, it would still be necessary to have an abundance of water for irrigation in order to produce crops.

The table below gives the results of mechanical analyses of samples of the surface soil of the typical Agate sandy loam and of the gravelly phase:

*Mechanical analyses of Agate sandy loam.*

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---|---|---|---|---|---|---|---|---|
| Typical soil: | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 575337 | Soil | 9.0 | 11.2 | 4.1 | 14.1 | 20.9 | 28.1 | 12.4 |
| Gravelly phase: | | | | | | | | |
| 575314 | do | 10.9 | 13.0 | 6.3 | 20.2 | 18.7 | 25.1 | 6.7 |

MONTAGUE CLAY LOAM ADOBE.

The surface soil of the Montague clay loam adobe is a clay loam of adobe structure, from 1 to 3 feet deep. In color it is a dark grayish brown, which may shade to a dark brownish gray or to black, especially when the soil is wet. The adobe structure is pronounced, the soil being very sticky and plastic when wet, but cracking and dividing into small cubes during the dry season. It retains moisture well. It is rather low in organic matter, but is well supplied with lime. It contains a variable proportion of gravel; over most of the type there is only a small scattering of pebbles, but in a few places there is nearly enough to make it a gravelly type. The subsoil is a yellowish-brown or yellowish to grayish heavy clay loam or clay, for the most part highly calcareous. In places there is no distinct color change from surface soil to the hardpan layer commonly reached about 3 feet below the surface. In a few places this layer may be within 2 feet of the surface. It is brown or grayish brown in color, of medium hardness, and highly calcareous.

This type is of moderate extent. A large area extends from Montague northeast about 8 miles. A small body lies 4 miles east and two bodies lie west and southwest of Montague. The type, with the exception of one body west of Montague, which is higher and gently rolling, occupies low, gently sloping old-alluvial fans and foot slopes. Its surface under cultivation is smooth, but in the virgin state there are a few low hog-wallow mounds on it. Surface drainage is generally good, but the lowest lying part next to Oregon Slough has rather poor drainage. The large body of the type could be readily irrigated, if water were made available.

From an agricultural viewpoint this is an important soil, and it is practically all under cultivation. At present wheat is the only crop, and the average yield is reported to be 12 to 20 bushels per acre. The land is summer fallowed, a crop being grown every other year. The holdings are very large, and roads and houses are infrequent. Very little of this type has changed hands lately, but it is reported that $40 an acre has been offered for some of it.

The table below gives the result of a mechanical analysis of a sample of the soil of this type:

*Mechanical analysis of Montague clay loam adobe.*

| 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.* |
| 575340..... | Soil..... | 3.1 | 10.1 | 5.8 | 18.0 | 14.5 | 27.5 | 21.1 |

PINOLE GRAVELLY LOAM.

The surface soil of the Pinole gravelly loam is a rather friable yellowish-brown loam, about 2 feet deep, containing a large proportion of gravel. The soil is low in lime, but is not acid in reaction. The texture of the material included with this type varies somewhat, being in places a gravelly sandy loam or a gravelly fine sandy loam. The subsoil is a yellowish-brown or grayish-yellow clay loam containing considerable gravel. It is commonly somewhat mottled with iron stains, especially in the more poorly drained places. As a rule it is compacted, but does not contain a cemented hardpan. It carries a moderate quantity of lime and in places effervesces readily with dilute hydrochloric acid. The gravel in the soil and subsoil is generally less than an inch in diameter and consists largely of waterworn pebbles of sandstone and metamorphosed sandstone and shale. The gravel is rather unevenly distributed, but nowhere is it entirely absent.

The Pinole gravelly loam is found south and southeast of Yreka, patches occurring along the highway nearly to Gazelle. It occupies terraces lying only a little above the level of the recent stream washes and adjacent to the hills bordering the area of the survey on the west. In several cases it extends up narrow valleys into these hills. It is level to gently sloping and has for the most part a smooth surface, though it is slightly eroded in places. It lies from 1 foot to 10 feet above the associated more recent alluvial soils. Drainage is in the main good. In a few places less well drained the subsoil is heavier and more mottled, and there is less gravel.

Most of this soil was originally in forest, consisting of a fair stand of pine, oak, and small trees, and much of it still is uncleared. The

cleared part is used mostly for small grains, the yields of which are light. A very small part is irrigated. Here alfalfa is grown, with fair to good yields. The soil is not well adapted to dry farming, as it does not hold moisture well, but if irrigation water were abundant it would probably be a productive type.

### BELLAVISTA LOAM.

The surface soil of the Bellavista loam is a gray to light-gray loam from 6 to 20 inches deep. It is highly calcareous, but low in organic matter and retains moisture poorly. There is usually no well-defined subsoil, the surface soil resting directly on hardpan. This is a gray or yellowish-gray, highly calcareous layer, quite firmly cemented by lime and from 6 inches to 2 feet thick. In places two or more hardpan layers are present, with soft, uncemented material between. Underneath the hardpan the material is friable and similar to the surface soil.

A fair-sized body of this type lies 4 miles east of Montague. Another occurs in the southwestern part of the Little Shasta Valley; in this body the soil is lighter than the typical loam, much of it being a sandy loam. Other bodies also vary somewhat in texture, some having sandy loam spots in them, and some probably including spots of the darker colored Gazelle loam. Several smaller bodies are situated in flats and depressions in the hills south of the areas mentioned above. Some of them are well drained and some are not. The poorly drained bodies are impregnated with alkali in spots.

Grass is the native covering. The poorly drained parts are used for pasture. Grain is grown on some of the well-drained land, but yields are very light. The soil has a low agricultural value and possibility of more extensive use appears remote.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the type:

*Mechanical analyses of Bellavista 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.* |
| 575330 | Soil | 3.4 | 6.2 | 3.1 | 18.1 | 21.2 | 26.7 | 21.5 |
| 575331 | Subsoil | 3.8 | 8.6 | 3.9 | 20.6 | 17.5 | 24.1 | 21.6 |

### BELLAVISTA CLAY.

The Bellavista clay is a gray to light-gray or white, very heavy clay, from 6 to 24 inches deep. It is compact in structure, low in organic matter, very high in lime, and seems to retain moisture well. The surface soil rests directly upon a hardpan, which is a light-gray or yellowish-gray clay loam or clay material firmly cemented with

lime and from 1 foot to 2 feet thick. The material beneath the hardpan is similar to the surface soil. This type as mapped is somewhat variable in texture and includes local spots that have the texture of clay loam. Some areas of this type contain alkali salts, which are concentrated in spots.

This type is of small extent. It is mapped east of Gazelle, southwest of Big Spring, northwest of Mayten, and south of Gazelle. It occurs as flats between the hills. The general topography is level, but the surface is more or less hummocky, and some of the small mounds consist of lighter textured material than the main part of the soil. Erosion does not affect the type. Drainage, both surface and internal, is poor.

The native vegetation consists of grasses, with sedges and tule in a few places. This soil is used for pasture exclusively, and apparently is not suited to any other purpose. A considerable part of it is irrigated and supplies fair grazing, but the unirrigated part affords very scant pasturage.

Below is given the result of a mechanical analysis of a sample of the surface soil of this type:

*Mechanical analysis of Bellavista 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.* |
| 575307 | Soil | 0.2 | 1.2 | 0.7 | 5.3 | 2.8 | 15.7 | 74.0 |

HOVEY LOAM.

The surface soil of the Hovey loam, as typically developed, is a friable dark brownish gray to black loam, from 10 to 24 inches deep. It is relatively high in organic matter and has a high percentage of lime, the material a few inches below the surface effervescing with dilute hydrochloric acid. The type as mapped is rather variable in texture and includes small areas ranging from a fine sandy loam to a clay loam or even clay. In places east of Little Shasta Church, and also in the body lying 3 miles northeast of Mayten, the surface soil is mainly a sandy loam rather than a loam. The upper subsoil is a gray or yellowish-gray calcareous loam or clay loam. It is from 1 to 2 feet thick and is compacted or slightly cemented by lime and contains nodules, seams, and incrustations of lime. The lower subsoil is a brown or yellowish-gray material, usually lighter in texture than the surface soil and without marked concentrations of lime. The surface soil has been removed in places by erosion, leaving the lighter colored subsoil exposed, which gives rise to gray spots that show up plainly when the fields are plowed.

This is a type of small extent. It occurs in small bodies in Hovey Gulch, near Hovey Gulch School, in a similar gulch 1½ miles west, and in the narrow gulches just south of Table Rock. Other small bodies are located east of Grenada, near Montague, and 3 miles northeast of Mayten. The type occurs as an old valley-filling soil in small valleys located in the region of recent lava flows. The surface is sloping and the soil has been more or less eroded and in places somewhat gullied. Drainage is good to excessive.

Most of this soil is under cultivation. Grain is the only crop grown and the yields are low to medium.

### GAZELLE LOAM.

The surface soil of the Gazelle loam is a loam from 12 to 30 inches deep and dark grayish brown or dull brown to dark gray in color, but having some lighter gray inclusions. It has a compact structure and retains moisture only fairly well. It has a moderate content of organic matter and a good supply of lime, usually effervescing vigorously with dilute hydrochloric acid. Part of this soil at the western end of Little Shasta Valley is grayish brown. The subsoil is a loam or clay loam, brown or yellowish brown or yellowish gray in color, and carrying a moderate amount of lime. Under about two-thirds of the type there is a hardpan which is a light-gray or yellowish-gray clay loam very highly calcareous and usually cemented to a moderate hardness. It is from 12 to 24 inches thick, and generally lies 30 to 40 inches below the surface. The soil may extend down to the hardpan, or a distinctive subsoil may be developed above the hardpan. Below the hardpan is a loam or clay loam, brown or yellowish brown in color, and carrying only a moderate amount of lime. Where the hardpan is absent, the subsoil extends to a depth of 6 feet or more. In the region north of Gazelle, where there are large bodies of this type, little of it has a cemented hardpan, and much of it has a highly calcareous uncemented layer in this part of the profile. Occasional streaks of gravel or sand are encountered in the lower depths.

This type is mapped in large bodies in the Little Shasta Valley, where it is the prevailing type, and in poorly drained areas between Gazelle and Grenada. A few small isolated bodies lie in depressions within the areas of Scabland, and a fair-sized body is situated southwest of Big Spring. It occurs in the lowest parts of these valleys and has a level surface marked by occasional small hog wallows. It is subject to overflow during the rainy season, and both surface and internal drainage are rather poor. Much of this type contains accumulations of alkali salts, usually localized in the surface foot and concentrated in spots.

The Gazelle loam is used for pasture and hay land exclusively, and is of considerable importance on account of its extent. Water for irrigation is obtainable over most of it, and the land is flooded to increase the growth of grasses. Without this irrigation it becomes exceedingly dry in summer and produces very little grass. This type is owned in large tracts by stockmen. Its present use seems to be the best under existing conditions, as the soil is not suited to intensive cultivation.

*Gazelle loam, sandy phase.*—The surface soil of the Gazelle loam, sandy phase, is typically a dark-brown to dark-gray sandy loam, 8 to 24 inches in depth. As mapped in this survey, however, it includes some material of lighter grayish color. It has a low content of organic matter and in places contains some gravel. It contains considerable lime, and commonly effervesces vigorously with dilute hydrochloric acid. In most places a cemented hardpan occurs directly under the surface soil. This hardpan is from 12 to 24 inches thick, is soft to moderately hard, and highly calcareous. The substratum is similar in appearance to the surface soil, but may be heavier in texture. There are traces of alkali salts in the soil, which are usually concentrated in spots, segregated mainly in the surface foot. This soil is not very uniform, varying especially in texture, and evidently has been modified in places by recent deposits laid down by Shasta River.

This phase of the Gazelle loam is mapped in three small bodies in the Little Shasta Valley. It occurs on low-lying bottom land subject to overflow in winter and to drying out in summer. The drainage is poor. Most of it is irrigated as long as water is available. This phase is used for pasture in connection with adjoining soils, and appears to be best suited to its present use.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Gazelle loam and of the Gazelle loam, sandy phase:

*Mechanical analyses of Gazelle loam.*

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---|---|---|---|---|---|---|---|---|
| Typical soil: | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 575367 | Soil | 2.9 | 2.8 | 1.6 | 13.9 | 22.4 | 38.6 | 17.8 |
| 575368 | Subsoil | .9 | 2.0 | 1.5 | 15.6 | 23.2 | 33.8 | 23.0 |
| Sandy phase: | | | | | | | | |
| 575370 | Soil | 1.0 | 7.2 | 9.6 | 49.8 | 11.2 | 11.3 | 9.9 |
| 575371 | Subsoil | 1.0 | 5.0 | 7.3 | 41.6 | 13.3 | 12.4 | 19.4 |

GAZELLE CLAY LOAM.

The surface soil of the Gazelle clay loam is a dark-brown to dark-gray or black clay loam, from 1 to 2 feet deep. It has a fair supply of organic matter and a good supply of lime. The subsoil is a clay loam or clay, yellowish brown or gray in color and highly calcareous. Most of the subsoil carries a layer of hardpan, usually in the upper part and from 12 to 24 inches thick. This hardpan is highly calcareous, of medium hardness, and grayish-brown color. The subsoil below the hardpan contains occasional streaks of sand or gravel in the lower depths. The type as mapped includes small spots of clay or clay adobe.

Alkali is found in varying quantities in this type, but it is concentrated mainly in the surface foot. It consists mostly of the so-called white alkali, but black alkali also is present in smaller quantities in most of the areas.

This type is found in the Little Shasta Valley, in a fair-sized body east of Grenada, and in a small area on the Shasta River, 5 miles north of Edgewood. Several small areas are surrounded by larger bodies of the Gazelle loam. The type occurs in flat, poorly drained areas in the lowest parts of the valleys. The surface is level, with occasional very low hog wallows. These hog wallows are associated with the parts of the type that have the most pronounced hardpan, the surface being smooth and a little lower in the parts in which the calcareous layer is less pronounced and not cemented.

This soil is subject to overflow during the rainy season, and surface and internal drainage are very poor. During the summer it becomes very dry, except where irrigated. Some of the included spots of heavier texture are covered with water for several months during the rainy season and are devoid of vegetation. This type is closely associated with the Gazelle loam, and has about the same agricultural value.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the type:

*Mechanical analyses of Gazelle 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.* |
| 575309 | Soil | 10.2 | 12.3 | 4.6 | 14.0 | 9.8 | 29.6 | 19.6 |
| 575310 | Subsoil | 3.1 | 7.3 | 4.2 | 13.8 | 11.3 | 28.3 | 32.2 |

ELDER GRAVELLY SANDY LOAM.

The surface soil of the Elder gravelly sandy loam is a dark grayish brown to dark brownish gray sandy loam, from 12 to 24 inches deep,

and containing a large amount of gravel. As mapped in this survey it includes some rather pronounced dark-brown variations which approach in color and may include some material of the related brown soils of the Yolo series. It is friable, has no apparent accumulations of lime, is low in organic matter, and retains moisture poorly. The subsoil to a depth of 6 feet or more is a brown or dull grayish brown to dark brownish gray permeable sandy loam or fine sandy loam, containing gravel and showing little or no cementation. The gravel in this soil type is waterworn and derived from sandstones and shales, which include some igneous and metamorphosed rocks.

This soil occurs along the western border of the valley. Important areas are situated 2 or 3 miles south of Gazelle and west and south of the Wheatfield School, and a smaller one 2 miles southwest of Gazelle. Another large body lies at Grenada, from which village it extends 2½ miles south. A few small areas are mapped south and southwest of Yreka, north of Gazelle, and west of Grenada. The type occupies the upper parts of recent-alluvial fans built up by streams flowing from the hills of sedimentary rocks that border the valley on the west. It is gently sloping to nearly level and has a smooth surface. Drainage is good, but erosion is not active. The type is not subject to overflow and is well suited to irrigation. The native vegetation was mainly herbaceous, with a growth of willows along the stream channels.

This is an important type of soil, not so much on account of its extent, which is not great, as on account of its productiveness. It is practically all under cultivation. The land at Grenada is irrigated, and here alfalfa is the main crop. Other irrigated areas are devoted to grain. When well managed, the soil gives very good yields. Probably more than one-half of the type, however, is not irrigated, and this has been cropped to grain for many years under dry-farming methods. The yields are now light, and some of the land has been abandoned because cropping has become unprofitable. With water for irrigation this would without doubt all be very productive. The roads across this type are good and are easily kept smooth and solid. On the unirrigated part the holdings are large and the ranch houses scattering. Some of the irrigated areas have recently been subdivided into 10 and 20 acre tracts, and settlement here is much more dense. Irrigated land is selling at $150 to $250 an acre. Unirrigated land can be bought for $50 to $100 an acre.

The principal requirements for the improvement of this soil include irrigation water, an increased supply of organic matter, which may be obtained by growing and turning under legumes, and better cultural methods.

*Elder gravelly sandy loam, light-textured phase.*—The surface soil of the Elder gravelly sandy loam, light-textured phase, is a dark

brownish gray coarse sand containing considerable gravel. It is loose in structure and does not retain moisture well. It has a low to moderate content of organic matter. No concentrations of lime are apparent. The surface soil is from 1 to 2 feet deep and grades with very little change into the subsoil, which extends to a depth of 6 feet or more. The subsoil may be somewhat lighter in texture than the surface material, but is normally of the same color. The gravel consists of waterworn pebbles derived from sandstone and shale and intruded metamorphosed igneous rocks.

This phase is mapped in a few small areas along the channel of Willow Creek, which flows past Gazelle, and in one small area at Hawkinsville. The surface is level and smooth, except where marked by shallow stream channels. It is subject to overflow during the winter rains, but drains quickly when they are over, owing to its open porous nature. Most of it is included in one large ranch and forms parts of large fields used in the production of grain and alfalfa. Both grain and alfalfa give light yields on this phase even under abundant irrigation, and without irrigation cropping is practically impossible.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Elder gravelly sandy loam:

*Mechanical analyses of Elder gravelly 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.* |
| 575320 | Soil | 7.4 | 17.9 | 8.3 | 26.0 | 16.1 | 16.4 | 7.9 |
| 575321 | Subsoil | 8.4 | 17.4 | 8.7 | 22.9 | 14.2 | 17.8 | 10.7 |

ELDER FINE SANDY LOAM.

The surface soil of the Elder fine sandy loam is a dark grayish brown or dark-brown fine sandy loam, from 1 to 3 feet deep. It has a moderate content of organic matter, and though friable retains moisture fairly well. As mapped in this survey it is variable in texture, some of the included material being heavier and some of it being lighter in texture than typical. In places there is some gravel. The color also is in places a lighter brown, approaching that of the related Yolo series. The subsoil is typically a dull-brown fine sandy loam, it varies in texture even more than the surface soil and includes material ranging from sand to sandy loam and loam. In places the subsoil shows some compaction and the surface is slightly eroded, both being evidence of age, but hardly sufficient to place the soil in the class of old valley-filling soils.

Small bodies of this type are found 2 miles south of Willow Creek School, near the Shasta River School, 2 miles south of Yreka, 3 miles

south of Montague, 3 miles south of Grenada, and 1½ miles northeast of Grenada. It comprises narrow strips of recent-alluvial material along stream courses. The surface is nearly level, but marked in places by old stream channels. The part that lies along the Shasta River is poorly drained, as it is only a few feet above the water in the stream.

That part of the Elder fine sandy loam lying along intermittent streams is dry-farmed to grain and gives very satisfactory yields. That lying along the Shasta River is used for pasture.

ELDER LOAM.

The surface soil of the Elder loam is a dull-brown loam, in places of silty texture, from 2 to 3 feet deep. As mapped in this area it includes some variations of rather pronounced brown color which approach in character the soils of the Yolo series. It is friable and easy to cultivate, has a moderate to low content of organic matter, and retains moisture only fairly well. A small quantity of gravel is present in a few places. The subsoil is a dull-brown or a yellowish-brown loam extending to a depth of 6 feet or more. Where this soil occupies the alluvial fans of small intermittent streams the subsoil shows some compactness, giving evidence of age. The areas of the type that occur in and just north of Yreka have been worked over for gold by the early miners and are very uneven in texture, both in surface soil and subsoil.

The Elder loam is mapped in several small bodies in the neighborhood of Willow Creek School, in one body at Yreka, one 4 miles north and two others 3 miles east of this place, several near Grenada and north and south of Gazelle, and one very small body west of Edgewood.

It is associated with the lighter members of the Elder series, being situated below them and on the outer edges of the alluvial fans on the west side of the valley, and also on the flood plains of streams in the northwestern part of the area. It is nearly level, with a smooth surface. Drainage is deficient in only a few places. The land is well suited to irrigation.

Though of only moderate extent, this is a very valuable soil. About half of it is irrigated and produces moderate to high yields. The unirrigated land is used for the production of grain or for pasture. Returns under dry-farming methods are equal to or better than those on any other soil in the area.

Where water for irrigation is not obtainable the land is valued at $50 to $100 an acre. Land under irrigation is valued at $200 or more an acre.

*Elder loam, gravelly phase.*—The surface soil of the Elder loam, gravelly phase, is a dull-brown to dark brownish gray loam from 12

to 24 inches deep containing a large proportion of gravel. It is friable and easily worked, but is low in organic matter and retains moisture poorly. The subsoil, to a depth of 6 feet or more, is very similar to the surface soil, though in places it may be yellowish brown in color. It is not noticeably compacted. No accumulations of lime appear in surface soil or subsoil. The gravel is waterworn and an inch or less in diameter, and is derived mainly from sandstone or shale, much of it metamorphosed.

This phase is developed in a fair-sized area northwest of Gazelle, and in small areas southwest of Gazelle on the alluvial fan of Willow Creek, in the vicinity of Wheatfield School, northeast of Grenada, and north of Yreka. It is closely associated with the Elder gravelly sandy loam, being situated next below it on the alluvial fans. The surface is smooth and very gently sloping to nearly level. This phase is a highly prized soil, although of limited extent. It is well drained and well suited to irrigation and about one-third of it is irrigated. It is devoted to the same crops and has about the same productiveness and selling price as the Elder gravelly sandy loam, though considered a stronger soil. None of it has been abandoned on account of low yields of grain under dry farming.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Elder loam:

*Mechanical analyses of Elder 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.* |
| 575362 | Soil | 1.5 | 3.1 | 1.6 | 8.3 | 17.8 | 50.8 | 17.1 |
| 575363 | Subsoil | 1.1 | 3.1 | 2.4 | 16.5 | 22.2 | 36.3 | 18.4 |

DUBLIN CLAY LOAM.

The surface soil of the Dublin clay loam is a dark-gray to black clay loam, from 12 to 24 inches deep. It has a good supply of organic matter and enough lime to make it decidely alkaline in reaction. It retains moisture fairly well, but is sticky when wet and bakes hard upon drying. A little gravel is found, and in a few spots the included material is a clay in texture. The subsoil is a brown or yellowish-brown or drab-colored clay loam. It includes occasional black layers, and gravel strata may occur in the lower depths.

This type is mapped in small bodies 1 mile north of Snowdon School and 4 miles east of it, 3 miles southwest of Montague, 1 mile west of Vineland School, 2 miles southwest of Gazelle, 4 miles south of Gazelle, and 3½ miles southwest of Edgewood. It occurs on small recent-alluvial fans, commonly on the outer margins or edges. It is gently

sloping to level in topography, and has a smooth surface. Most of it is well drained, but some is poorly drained.

This type is farmed in conjunction with adjoining soils. Part of it is irrigated, and most of this is devoted either to alfalfa or grasses, a very little being used for grain growing. The yields are very satisfactory. The unirrigated land is used for pasture.

Below is given the result of mechanical analysis of a sample of the surface soil of the type:

*Mechanical analysis of Dublin clay loam.*[1]

| 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.* |
| 575334 | Soil | 4.0 | 3.2 | 2.6 | 5.7 | 17.9 | 38.0 | 29.3 |

[1] Analysis by University of California.

SUTTER FINE SANDY LOAM.

The surface soil of the Sutter fine sandy loam, where typically developed, is a light-gray or brownish-gray fine sandy loam from 15 to 36 inches deep. As mapped in this survey, however, some of the included material is of rather pronounced brownish color and has somewhat the character of the Vina soils. It is loose and friable, low in organic matter, and does not retain moisture well. As developed in this area a distinctive subsoil is absent, the soil resting directly upon igneous rocks.

The type is mapped in a body of moderate extent 3 miles northeast of Mayten and an area of irregular outline west and northwest of Shasta View School. It occurs on small recent-alluvial fans deposited by intermittent streams. It has a level or gently sloping topography, a smooth surface, and good drainage.

Most of this soil near Shasta View School is irrigated, and grain, alfalfa, and potatoes are grown. Fair crops are obtained where the soil is the deepest, but on the shallow parts the alfalfa fails to do well after two or three years. The other body is dry-farmed and gives very light crops of grain. Rye does better than the other small grains.

*Sutter fine sandy loam, light-textured phase.*—The light-textured phase includes parts of the fine sandy loam near Shasta View School and two areas at and near Delaney, which are lighter in texture than the typical soil, being a sand or loamy sand. The soil material is slightly lighter in color, lower in organic matter, and more porous. The surface is in part hillocky, the wind having drifted the sand into small drifts in places. The phase is droughty and is less productive than the typical soil.

Below is given the result of a mechanical analysis of a sample of the surface soil of the typical Sutter fine sandy loam:

*Mechanical analysis of Sutter 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.* |
| 575373..... | Soil..... | 0.9 | 3.8 | 3.8 | 27.7 | 21.8 | 27.3 | 14.7 |

VINA SANDY LOAM.

The surface soil of the Vina sandy loam is a grayish-brown to reddish-brown sandy loam ranging from a few inches to 3 feet in depth. Some light-grayish variations occur where the type grades into the related Sutter soils. The type also is somewhat variable in texture, ranging from fine to coarse. It is friable, has a rather low percentage of organic matter, and does not hold moisture well. It contains considerable lime. A distinctive subsoil is usually lacking, the surface soil being shallow and resting directly on basaltic bedrock. In places there is a brown clay subsoil layer a few inches thick and in others a small amount of gravel just above the bedrock, which lies nowhere at depths greater than 3 feet and protrudes from the soil in spots. Fragments of the rock are scattered over the soil. Along the margins of the areas of this type, where the soil is the shallowest, it is often difficult to establish the boundary between the agricultural land of the type and the nonagricultural Scabland.

This soil is mapped in many small patches and several fair-sized areas within the large area of Scabland in the eastern part of the survey. It occurs as alluvial accumulations filling small rock basins or depressions in the relatively level Scabland, and also as gently sloping alluvial fans lying below the higher rocky hills included within the Scabland and Rough broken and stony land. Some of the higher fans reach well up the slopes of the mountains. The type has a smooth surface and good drainage and is fairly well adapted to irrigation. This soil is composed mainly of recent-alluvial material, but the compact and heavier textured subsoil found in places shows evidence of age, indicating that these parts are related to the old valley-filling soils, and the closeness of the rock to the surface suggests that some of the material may be residual in origin.

This is the most extensive of the Vina soils in this area, but its shallow depth limits its usefulness, and in its natural state it has so much lava outcrop and loose rock that much of it is nonarable. Originally much of it supported a stunted growth of juniper. Small grains, grown

by dry-farming methods, give very light yields. Rye has been found to give better results than wheat, oats, or barley. Most of the land that can not be irrigated is uncropped. At Mayten, where water for irrigation from the Big Spring is obtainable, the land has been subdivided into small holdings and is cleared of stones and planted to alfalfa. Fair crops are being obtained, but the stand probably will not last long after roots have reached the rock. This land under irrigation has been selling for $125 to $200 an acre. Where water is not obtainable the land is valued at $10 to $50 an acre.

*Vina sandy loam, light-textured phase.*—The soil material of the Vina sandy loam, light-textured phase, is somewhat lighter in texture than the typical Vina sandy loam and consists mainly of rather coarse sand, only slightly loamy, containing a little gravel and a few bowlders. It is somewhat deeper than the type, but on account of its coarse texture, low content of organic matter, and loose open structure, it is even more droughty and less productive. It is represented by a small area east of Mayten, and an area 2 miles northwest of Delaney. It is covered with a scant growth of sagebrush, juniper, and weeds, and is not cultivated.

Below is given the result of a mechanical analysis of a sample of the surface soil of the typical Vina sandy loam:

*Mechanical analysis of Vina 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.* |
| 575385½..... | Soil..... | 1.6 | 9.7 | 9.3 | 32.5 | 11.8 | 20.2 | 14.7 |

VINA FINE SANDY LOAM.

The surface soil of the Vina fine sandy loam is a brown or slightly reddish brown fine sandy loam, 18 to 30 inches deep. It is loose and friable, easy to cultivate, and retains moisture fairly well. It has a rather low content of organic matter and apparently a good supply of lime. The subsoil, which normally extends to a depth of 6 feet or more, is of open friable structure. It is brown, but lighter than the surface soil, or it may be yellowish brown. Where the type occurs as alluvial deposits along streams the substratum is usually loose gravel, but in the general region of the Scabland the type is underlain at variable depths by bedrock.

In the area 4 miles southeast of Mayten the texture is a little lighter than typical, and in places the sandy material is somewhat drifted along fences. An area of about 300 acres southwest of Mayten has considerable gravel in both soil and subsoil.

This type occurs on Willow Creek in the northern part of the survey, on the Shasta River in the extreme southern part, at Mayten, 4 and 6 miles southeast of Mayten, at Edgewood, and in the southern part of Little Shasta Valley. It occupies the flood plains of fair-sized streams, as on Willow Creek and Shasta River, and the smooth and nearly level fans of intermittent streams, as at and east of Mayten. It has a smooth, level to gently sloping surface, and is well situated for irrigation. Most of it is well drained, but the areas on the flood plains of streams are subject to overflow.

This is not a type of large extent, but it is of considerable agricultural importance on account of its productiveness. Nearly half of the soil is irrigated. Alfalfa is the main crop and yields are high. The part utilized under dry farming is used for grain. Here the yields are low to medium. If water were available for irrigation, the land would all be highly productive, except the gravelly variation near Mayten, which is more leachy than the typical material.

Land of the Vina fine sandy loam at Mayten, which has been subdivided into small holdings and is under irrigation, is valued at $200 to $300 an acre. Land without water is valued at $25 to $75 an acre.

*Vina fine sandy loam, heavy phase.*—The surface soil of the Vina fine sandy loam, heavy phase, is a brown fine sandy loam to loam from 12 to 20 inches deep. It averages somewhat darker in color than the typical Vina fine sandy loam, being when wet a very dark brown. It is friable and comparatively easy to cultivate, has a moderate content of organic matter, and retains moisture fairly well. The subsoil is dark brown to lighter brown in color, and variable in texture, ranging from a sandy loam to a clay. In places the materials are stratified. The area on the north side of Little Shasta Valley has a hardpan substratum, which is a continuation of that occurring in the Gazelle soils farther out in the valley. The hardpan in the Vina soil ordinarily lies below a depth of 5 feet.

The main area of this phase occupies an alluvial fan on the north side of Little Shasta Valley. One small area occurs on the flood plains of the Shasta and Little Shasta Rivers, 2 miles south of Montague, and another on an alluvial fan 3 miles northeast of Edgewood. The surface is level to gently sloping. Drainage is mostly good, though the part situated in the flood plains is subject to overflow. The land on the fans is under irrigation and is very highly prized. Yields of wheat run from 15 to 30 bushels per acre. These areas constitute part of larger holdings of land, and none has changed hands lately.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of the typical Vina fine sandy loam:

*Mechanical analyses of Vina 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.* |
| 575338 | Soil | 3.2 | 8.8 | 5.6 | 26.5 | 22.3 | 24.6 | 8.5 |
| 575339 | Subsoil | 7.5 | 11.2 | 6.4 | 24.0 | 21.0 | 24.2 | 6.0 |

CONEJO FINE SANDY LOAM.

The surface soil of the typical Conejo fine sandy loam is a dark-gray or dark brownish gray to black fine sandy loam, from 16 to 30 inches deep. It is loose and friable, high in organic matter, and retentive of moisture. The soil in some areas contains variable quantities of gravel, sufficient in some cases to modify its structure. The more gravelly areas are indicated on the map by gravel symbols. The subsoil is a brown or dark-brown fine sandy loam, loam, or clay loam, extending to the depth of 6 feet or more. Locally it also contains gravel.

One area of this type lies 4 miles east of Mayten. Small gravelly areas occur 1 mile north of Edgewood, 4 miles northeast of Gazelle, 4 miles east of Gazelle, where Park Creek leaves an area of Scabland, and on the flood plain of Boles Creek in the vicinity of Weed.

The type occupies the slopes of recent-alluvial fans, and alluvial flats and flood plains, over which the material has been distributed by intermittent streams having their source in Scabland or in other regions occupied by basalt or similar rocks. The surface ordinarily is gently sloping and smooth, although in some of the gravelly areas it is slightly irregular. Drainage is well developed in most places. The type is generally well adapted to irrigation, but the supply of water for this purpose is limited.

The area on Boles Creek is utilized mainly for pasture and hay, with a few small home gardens. Other areas are dry-farmed to grain, and give light to moderate yields. Where irrigated, grain and alfalfa are grown, and crops are very satisfactory considering the limited amount of water available for irrigation.

*Conejo fine sandy loam, heavy phase.*—The surface soil of this phase of the Conejo fine sandy loam is a dark-gray to black loam from 1 to 2 feet deep. It is high in content of organic matter, has a favorable amount of lime, and retains moisture well. The subsoil is variable in color, but is usually a drab or brown loam or clay loam. It usually has sufficient lime to effervesce with dilute hydrochloric acid.

This phase is mapped in small bodies 3 miles southeast of Willow Creek School, near the Shasta River School, 1½ miles southwest of Montague, 1½ miles southeast of Grenada, 1½ miles north of Gazelle, and 1½ miles west of Edgewood. It occurs on the flood plain of the

Shasta River and on the outer margins of the alluvial fans of some of the small streams entering the valley from the west, and doubtless includes some materials derived from sedimentary rocks. It is level or nearly level, and is subject to overflow during the rainy season, and most of it is poorly drained. Nearly all of it is used mainly for pasture. The small part that is cultivated gives fair yields of grain.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Conejo fine sandy loam:

*Mechanical analyses of Conejo 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.* |
| 575303 | Soil | 0.9 | 4.1 | 4.4 | 30.1 | 22.4 | 35.4 | 2.9 |
| 575304 | Subsoil | .5 | 4.3 | 5.4 | 36.8 | 24.9 | 22.4 | 6.1 |

CONEJO CLAY LOAM.

The surface soil of the Conejo clay loam is a very dark brown or dark brownish gray to black clay loam from 2 to 3 feet deep. It is sticky and plastic when wet, inclined to be hard and cloddy when dry, and is rather difficult to cultivate. It has a very good supply of organic matter and, if properly handled, retains moisture very well. It is usually well supplied with lime, and frequently effervesces with dilute hydrochloric acid. The subsoil is a brown or grayish clay loam or clay and extends to a depth of 6 feet or more. It contains sufficient lime to be alkaline in reaction, and is in places decidedly calcareous. Some of this soil type has harmful accumulations of alkali salts in spots.

A little of the material included with this type is lighter in texture than typical, being a loam, which is underlain by a loam or clay loam subsoil. This is true of some small bodies near the Redd School and also of parts of the type on the Shasta River, both north and south of Edgewood. Some of the included material is of rather pronounced brown color and resembles the material of the Vina series.

This soil type is mapped on the flood plains of the Shasta River and Parks Creek in the southern part of the area, on the southern margin of the Little Shasta Valley, 4 miles east of Montague, and in a few scattering small bodies in the drainage basin of Willow Creek in the northern part of the area. Besides occurring as flood-plain deposits, the type also occupies parts of small alluvial fans. It is nearly level to gently sloping, with a smooth surface and generally poor drainage, and much of it is subject to overflow.

Most of this soil is used for pasture and hay land and is valuable for these purposes. The body in Little Shasta Valley is cropped to grain and gives moderate yields.

*Conejo clay loam, gravelly phase.*—The Conejo clay loam, gravelly phase, which is shown on the map by gravel symbols, has a rather wide range in color and texture in the surface soil and subsoil, and some small included areas represent material of soils of the Dublin series, with indefinite gradations between these and the typical soils of the Conejo series. The surface soil is predominantly of somewhat lighter texture than the typical Conejo clay loam, and usually is a dark brownish gray to black loam containing considerable gravel. It is generally from 12 to 30 inches deep, of granular structure, retentive of moisture, and moderately easy to cultivate. Some of the included areas are, however, of heavier texture and compact structure, and more nearly resemble in physical character the typical Conejo clay loam. The subsoil is predominantly yellowish brown or brownish gray in color, highly calcareous in places, and dries out to a light-gray color where exposed. It is variable in texture, ranging from a clay loam to a loam, with an occasional light sandy loam streak. The gravel occurring in most of the phase consists mainly of water-worn pebbles, less than an inch in diameter, of shales and sandstones, many of them metamorphosed. In the area 3 miles east of Gazelle, however, which is typical Conejo material, the gravel consists of fragments of hard, dark-colored igneous rocks.

A small body of this phase occurs at Vineland School, two small bodies occur at Gazelle, and two more are located about 3 miles west of Edgewood. These represent mainly inclusions of Dublin material or of gradations of the Dublin into the Conejo soils. An area representative of the Conejo material occurs 3 miles east of Gazelle. The phase occupies small alluvial fans, mainly at the foot of the hills on the western side of the area surveyed. The surface is gently sloping and smooth, and drainage is sufficient.

A little of this phase is irrigated, but most of it is dry-farmed to produce grain or is used for pasture. Yields of dry-farmed crops are medium to light.

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

*Mechanical analyses of Conejo 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.* |
| 575322 | Soil | 2.9 | 8.0 | 4.1 | 15.5 | 18.1 | 27.7 | 23.8 |
| 575323 | Subsoil | 3.2 | 8.9 | 4.4 | 15.0 | 14.1 | 25.7 | 28.8 |

### CONEJO CLAY ADOBE.

The surface soil of the Conejo clay adobe is a very dark brown to black clay, of adobe structure, 20 to 36 inches deep. The soil is well supplied with organic matter and contains sufficient lime to make it alkaline in reaction. It retains moisture well if properly cultivated. Ordinarily the subsoil to a depth of 6 feet or more is a dark-brown or dark-gray clay. In places in the present survey it includes layers of Muck, and in other places it is a compact yellowish clay. It is generally calcareous and may contain accumulations of lime.

This type occurs in small bodies in the northern part of the area on Willow Creek, in the flood plains of Parks Creek east of Gazelle, about 2 miles south of Edgewood, and south of Montague. It is level and has a smooth surface. Much of it is poorly drained and subject to overflow during the winter season. This soil is mainly of recent-alluvial origin. A little of it in the northern part of the area appears to be residual from shale. This, if it were in areas large enough to map, would be classed with another series.

The Conejo clay adobe is used almost exclusively as pasture and hay land. It gives fair yields of hay. The area at Montague is irrigated and produces fair crops of alfalfa.

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

*Mechanical analyses of Conejo clay adobe.*

| 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.* |
| 575328 | Soil | 0.5 | 1.9 | 1.3 | 9.0 | 14.4 | 30.8 | 42.1 |
| 575329 | Subsoil | .4 | 1.8 | 2.0 | 18.7 | 23.2 | 27.1 | 27.0 |

### MUCK AND PEAT.

Muck and peat are mapped together in this area, as they are both small in extent and are so intermingled that it is impracticable to separate them on a map of the scale used.

Muck and peat consist in large part of organic materials, accumulated from the growth and decay of water-loving plants, in this area mostly grasses and sedges, with an admixture of a small amount of mineral material. Muck is black, thoroughly decomposed material, which has lost all traces of fibrous structure of the plants forming it. Peat is less thoroughly decomposed, has a more or less fibrous structure, and is brown to black in color. The material typically is 6 feet or more deep, but some deposits, especially in the areas south of Weed, are only 12 to 24 inches deep, and underlain by loam or clay loam material.

One area of Muck and peat occurs 2 miles south of Weed, one at Edgewood, one 4 miles northeast of Edgewood, and two 5 miles east of Gazelle. These areas are all small and occur in poorly drained depressions. They are level, but the surface is irregular because the grasses grow in clumps. Muck and peat affords fair grazing and is used exclusively for pasture.

TAILINGS.

Tailings comprise the débris in dredge, placer, and hydraulic mining. In the early mining days the gold-bearing gravels in the alluvial soils in the neighborhood of Yreka and Hawkinsville were worked by placer mining and later by hydraulic mining. In these operations the finer materials found in these deposits were largely washed into the streams, and the land was left scored and gullied and covered with gravel and cobblestones. At the present time a gold dredger is working on Greenhorn Creek.

Some of the old placer diggings have become grass covered and afford some pasturage. Aside from this the material mapped as Tailings is unfit for any form of agriculture.

SCABLAND.

Scabland is essentially nonagricultural land, consisting of or derived from recent lava flows from local volcanic fissures and cones and including only small patches of shallow soil material. Between Montague and Mayten there is a large body of Scabland, about half of which consists of low hills, 50 to 200 feet high, which are very stony and have scant vegetation. Between these hills the character of the material varies. There are low ridges of rough stony land, bodies of comparatively smooth stony sand, and some coarse-textured sandy loam or loamy sand. This finer material forms only a shallow cover over the bedrock, contains much outcrop, has a very low agricultural value, and is covered with a stunted growth of juniper. Farther east and south, extending to the foot slopes of Mount Shasta, the Scabland consists of broad expanses of lava flows that lie in low ridges and are very rough and stony. (Pl. X, Fig. 2.) The vegetation here is mostly juniper. Included are small patches of fine sandy loam, too small to map, which occupy possibly 5 per cent of the Scabland in this region. The soil in these patches is very shallow, but when irrigated they have some value as farm land.

Besides the two large regions already mentioned, Scabland occurs in small bodies in the extreme northern part of the survey, as numerous small isolated hills south of Grenada and in the neighborhood of Gazelle, and as a long, broad sheet lying east of Gazelle, a tip of which extends south to the southern boundary of the survey.

Table Rock, a conspicuous landmark northeast of Little Shasta Valley, is mapped as Scabland. This is a butte with precipitous

sides rising about 800 feet above the flood plain of the Little Shasta River flowing at its base, and is an isolated remnant of an old lava flow.

While Scabland includes some rough stony hills and buttes, it differs from the Rough broken and stony land, which is also non-agricultural, in not being conspicuously mountainous, but relatively level, though in places the surface is extremely rough and irregular. Scabland is extensively and typically developed in the lava beds of northeastern California and the adjoining part of Oregon.

### ROUGH BROKEN AND STONY LAND.

Rough broken and stony land includes land that is predominantly too rough and steep or eroded and broken for tillage. Such land occupies the more hilly and mountainous parts of the survey. A few small local patches of tillable land are included, but these are mostly inaccessible.

The area of Rough broken and stony land is relatively large; it forms a nearly complete rim or margin around the agricultural part of Shasta Valley. It is mapped in a large area south and southwest of Big Spring, includes some large hills southeast of Yreka, known as the Kildall Hills, and occupies several small scattered bodies in the valley.

The Rough broken and stony land lying on the west side of the valley occupies part of the Coast Range, which here is formed from old sedimentary and igneous rocks in large part metamorphosed. That on the north, east, and south consists of more recent lava flows and igneous intrusions, some of them so recent that they are very little altered by weathering. The southeastern part of the survey includes the foot slopes of Mount Shasta. Most of this land is covered by brush and timber. Its only agricultural value lies in the scant pasturage it affords.

### ALKALI.

Alkali salts exist in harmful quantities in several parts of the Shasta Valley area. Such accumulations are indicated by symbols upon the soil map. They occur mainly in the Little Shasta Valley and in the low-lying land east of Grenada and Gazelle. Smaller areas lie in the flood plains of the Shasta River and Parks Creek along their courses through the Scabland areas, and in other parts of the area. The accumulations are not as serious as would appear at first glance. During the summer months white salt crusts appear on the surface in abundance and there is seemingly much alkali. However, a study of the distribution of alkali salts in the soil profile shows that the greatest concentration is in the surface foot and that in many cases most of this is localized in the surface inch. Moreover, the alkali

accumulations occur in spots, usually only a few feet across, and the rest of the field may not have alkali in harmful amounts. For this reason the alkali indicated on the map is all classed as spotted. This means that the average alkali content in any body of soil large enough to show on the map is not strong enough to render it unfit for growing crops if uniformly distributed through the 6-foot section, but the alkali is concentrated in spots too small to be individually shown upon the map, and on these spots ordinary crops will not grow.

The alkali areas are, however, sufficient in extent and in salt concentration materially to lessen crop production and the value of the land where they occur. The alkali salts are mostly of the kinds usually called white alkali, and consist mainly of the sulphates and chlorides of sodium, calcium, and magnesium. Black alkali or sodium carbonate, however, is present in small amounts in practically all of the alkali areas in this survey.

A representative alkali spot was tested in the field by the electrolytic-bridge method with the following result:

| | | |
|---|---|---|
| Surface inch | Sandy loam | More than 3 per cent alkali. |
| 0 to 12 inches | Loam | 0.54 per cent alkali. |
| 12 to 24 inches | Hardpan | Less than 0.2 per cent alkali. |
| 24 to 36 inches | do | Do. |

Below 36 inches the hardpan was too hard to bore through.

A test was also made one-half mile from the location of the above sample, in a place which represents the average alkali conditons of the soils in this locality, with the following result:

| | | |
|---|---|---|
| 0 to 12 inches | Loam | 0.3 per cent. |
| 12 to 24 inches | Clay loam | Less than 0.2 per cent. |
| 24 to 36 inches | Loam hardpan | Do. |

Wet gravel below 36 inches would not come up on the auger. The hardpan was gray and cemented with lime. Black alkali was found in both the first and the second foot. The vegetation was largely salt grass. An adjoining spot was bare of vegetation.

It can be seen from the above data that if the alkali salts were evenly distributed throughout the 6-foot section there would not be enough to injure crops, but as they have accumulated near the surface and have been concentrated in spots, the conditions are troublesome and have to be reckoned with.

The areas of alkali accumulation in this survey are usually associated with hardpan soils. The soils are used for pasture or occasionally for hay land. With the circumstances, this appears to be the

best use that can be made of these areas. Most of the alkali is found in the Gazelle soils, but small quantities occur in the Bellavista and Conejo soils, and very little in the Vina, Elder, and Montague soils.

## IRRIGATION.

As the mean annual precipitation in this region is only about 18 inches, of which more than 60 per cent occurs in the 4 months November to February, inclusive, it is evident that irrigation is necessary to secure maximum crops, and under some conditions even profitable crops. Grain can be and is grown without irrigation, but as a rule yields are light, and in many cases a crop is grown only once in two years. Lack of moisture is the limiting factor, and when irrigation water is applied yields are greatly increased. The most easily obtainable supply of water has been used for many years. Practically all the water of the Little Shasta River during the summer season is used for irrigation in the Little Shasta Valley. Water is taken from this stream by a number of ditches. Some large springs at the head of this valley also form a source of water for irrigation. Most of this water is used on the lower lying pasture and hay land of native grasses, mainly on the soils of the Gazelle series, but a little of it is used on the better drained soils situated around the margin of the valley. These soils are devoted to the growing of grain and alfalfa.

The old Yreka ditch, built by the gold miners in 1856 for use in conducting water to the gold diggings at Yreka and Hawkinsville, and now used mainly to supply water on a large ranch at Gazelle, takes its water from the Shasta River in the southern part of the area and supplies from 25 to 35 cubic feet per second. Numerous small irrigation systems in the southeastern part of the area utilize springs or gravity water from the Shasta River and Parks Creek. At Big Spring near the center of the area, a number of springs, which are probably fed by underground streams coming from Mount Shasta, have a large combined flow. Some of this water is pumped for irrigation, and some flows out into the Shasta River.

Measurements made by the State Water Commission of California in 1918 give the following interesting data: Flow of Big Spring at outlet, 32 second-feet; Little Springs near outlet, 6 second-feet; Shasta River, above junction of flows from these springs, 23 second-feet; Big Spring Creek at junction with Shasta River, 103 second-feet. The results of these measurements show that there is a considerable increase in the flow between the outlet of Big Spring and the main Shasta River. This increase amounted to 65 second-feet and is derived mainly from springs in the bed of the stream below Big Spring. It is therefore seen that the water in Shasta River below this point is mainly from the flow of springs.

N. M. Stover, in a report[2] regarding the irrigation waters used in 1912 in the Shasta and Little Shasta Valleys, states that 12,319 acres were irrigated in that year, the water being used almost entirely for hay and pasture lands. He also states that the duty of the water used was low. Since that time irrigation with water from Big Spring has been extended and about 2,200 acres additional are now under irrigation at Mayten.

About 1,800 acres are irrigated at Grenada and 2,250 acres near Montague, by pumping from the Shasta River. The land recently brought under irrigation near Montague, Grenada, and Mayten, has mostly been sown with alfalfa, which is used largely as feed for dairy cows. The projects in these districts are cooperative, the holdings are small, and settlement is relatively dense, in all these ways contrasting strongly with the type of farming practiced under the earlier irrigation systems.

At the present time (1919), therefore, about 18,500 acres are irrigated in the area of the survey, or about 11 per cent of the agricultural land. Very little more expansion is possible unless new sources of water are developed. Much of the land classed as agricultural is hilly and shallow and not well suited to irrigation. But there are some areas, notably on the large alluvial fans along the hills on the west and lying between Gazelle and Wheatfield School, that are well adapted to irrigation and would be very productive if farmed under this system.

## SUMMARY.

The Shasta Valley area is a broad structural valley in Siskiyou County, in the extreme northern part of California. It lies between a ridge extending north from the Trinity Mountains, composed largely of sedimentary rocks, and a part of the Cascade Range, in which part the rocks are of recent volcanic origin.

Mount Shasta, just outside the area to the southeast, is a very prominent feature of the landscape.

The survey covers an area of 512 square miles, or 327,680 acres.

The area was first settled by gold seekers in 1851. The population is predominantly Anglo-Saxon. There are no large towns in the area. Yreka is the county seat. The main San Francisco-Portland line of the Southern Pacific Railroad passes through the area.

The climate is semiarid, the mean annual rainfall being less than 18 inches. The first efforts of the farmers in the area were to supply the pressing needs of the gold miners. Wheat was the principal crop, and raising cattle the main live-stock interest. This same type of agriculture prevails at present. The average ranch is large, and the houses are far apart. An extensive system of agriculture

[2] Irrigation resources of California and their utilization, by Frank Adams. U. S. Dept. Agr., Office of Experiment Stations, Bul. 254.

prevails, but small farms are now being developed about Montague, Grenada, and Mayten.

The area surveyed includes a large amount of nonagricultural land, nearly as much agricultural land of a low value, and only a small proportion of first-class land.

The residual soils are represented by the Altamont and the Lassen series.

The soils derived from glacial materials are represented by the Shasta and Delaney series.

The old valley-filling soils are represented by the Corning, Agate, Montague, Pinole, Bellavista, Hovey, and Gazelle series.

The recent-alluvial soils are represented by the Elder, Dublin, Sutter, Vina, and Conejo series.

In addition the following types of miscellaneous materials are mapped: Muck and peat, Tailings, Scabland, and Rough broken and stony land.

The Altamont loam covers a considerable area, but it is a shallow soil of low value.

The most valuable of the Lassen soils is the clay adobe type, which is devoted to wheat growing.

The Shasta gravelly sand occurs on the foot slopes of Mount Shasta. Very little of it is farmed.

The Delaney gravelly sand occurs on outwash fans from Mount Shasta. Without irrigation it has little crop-producing value. The Delaney gravelly fine sand is found associated with the Shasta gravelly sand. About half of it is under cultivation.

The Agate gravelly loam is of moderate extent, and about half of it is farmed. The Agate sandy loam, with its gravelly phase, is an extensive hardpan soil of such low value that much of it is not farmed.

The Montague clay loam adobe is an extensive type, valued for grain growing by dry-farming methods.

The Pinole gravelly loam is a minor type, and most of it is unfarmed.

The Bellavista loam and the Bellavista clay are of moderate extent and of low value.

The Hovey loam is of small extent, but most of it used in the production of grain.

The Gazelle loam is an extensive type with an intermittent hardpan and some alkali. It is used as pasture and hay land. The Gazelle clay loam is an unimportant type associated with the loam.

The Elder gravelly sandy loam is a valuable soil, being very productive under irrigation. The Elder fine sandy loam is not extensive, but produces good crops where cultivated. The Elder loam is of moderate extent, but it is a highly prized soil.

The Dublin clay loam is of small extent, but yields on it are very satisfactory.

The Sutter fine sandy loam is a minor type, and is fairly productive.

The Vina sandy loam is well distributed, but in small bodies. It is shallow and has only a moderate crop-producing value. The Vina fine sandy loam is inextensive, but is somewhat deeper and more productive.

The Conejo fine sandy loam is inextensive, but is in part irrigated and utilized for the production of grain, alfalfa, and hay. The Conejo clay loam and the Conejo clay adobe are small in extent, and are used mostly for pasture.

Areas mapped as Muck and peat have a small total extent. They are used as pasture.

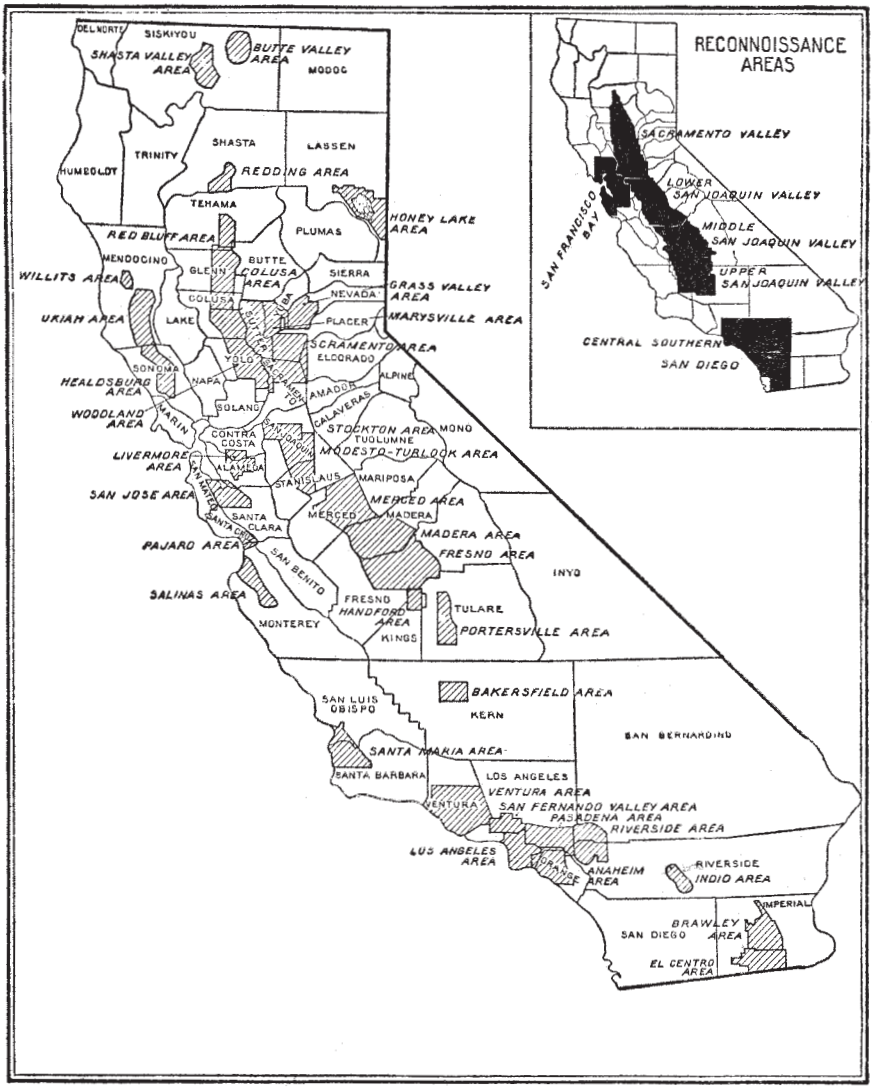
Scabland is an extensive type. It consists mainly of lava flows, with only small areas of shallow soil material.

Rough broken and stony land occupies rocky areas of rough topography about the margin of the survey.

Alkali is found in relatively small amounts, but owing to concentration at the surface and in spots is a factor to be reckoned with.

Irrigation is confined mostly to pasture and hay lands on the large ranches, and to alfalfa fields on the small ranches.

○




Areas surveyed in California, shown by shading

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