

# RECONNAISSANCE SOIL SURVEY OF TUOLUMNE COUNTY, CALIFORNIA

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*The authors are Kenneth D. Gowans, Extension Soils Specialist, Davis, and Harry S. Hinkley, Farm Advisor, Tuolumne County.*

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# Reconnaissance Soil Survey of Tuolumne County, California

A reconnaissance soil survey of the Tuolumne area was made by the University of California Agricultural Extension Service to provide basic information about the soils and their distribution. The area covered in the survey is that portion of the county outside of the Stanislaus National Forest, an area of about 300,000 acres. Standard procedures used in soil surveys<sup>4</sup> in other parts of California were used in this soil survey.

This reconnaissance survey differs from some of the more detailed soil surveys in the valley portion of California in the scale of the map and the number of soil observations made. The scale in this reconnaissance map is 1/2 inch to the mile, while the scale of detail soil survey maps is 2 to 3 inches to the mile. Most of the soil observations made in this soil survey were made along roadcuts and other exposures of soil. Since no attempt was made to separate soils that occurred together in a natural unit, many of the mapping units contain more than one soil series. Nor was any attempt made to separate soil mapping units on the basis of surface soil texture, slope, drainage, or erosion, as done in detailed soil surveys.

## DESCRIPTION OF THE AREA

The portion of Tuolumne County surveyed is in the foothills of the Sierra Nevada Mountains, with elevations ranging from about 500 to 5,000 feet. Sonora, the county seat of Tuolumne County, is located on California Highway 49 and 108, about 114 miles southeast of Sacramento and 133 miles east of San Francisco.

## CLIMATE

The climate throughout the area varies from west to east and is related to the elevation. On the west side of the county at the lower elevations, rainfall is near 20 inches. The winters are moist and cool, while the summers are often hot and dry. Daytime temperatures may rise above 100° F during the summer. On the eastern edge of the area near Twain Harte, the average annual rainfall is near 45 inches. The winters are cold and wet, with some snow; the summers are warm and dry. The rainfall distribution through the mapped area is shown in figure 1<sup>6</sup>. The mean annual temperature and rainfall at Sonora are shown in table 1<sup>9</sup>.

Footnotes are listed on page 22.

TABLE 1. Monthly temperature and rainfall recorded at Sonora by the U.S. Weather Bureau over a period of years.

MONTH	TEMPERATURE			RAINFALL		
	Average Degree F.	Highest Degree F.	Lowest Degree F.	Average Inches	Driest Year (1923-24) Inches	Wettest Year (1905-06) Inches
January	44	71	14	6.13	4.65	13.63
February	48	75	21	5.96	.40	5.82
March	51	82	23	6.73	.50	15.92
April	56	91	29	2.59	6.74	4.50
May	62	100	31	2.36	.14	5.42
June	70	103	35	.26	.13	.83
July	77	109	46	.02	.00	.00
August	75	107	44	.02	.00	.00
September	70	101	35	.34	.00	.20
October	60	96	28	1.78	.97	.00
November	51	84	23	3.24	5.91	2.85
December	45	76	19	5.50	9.98	1.95
Average Annual Rainfall				32.94		

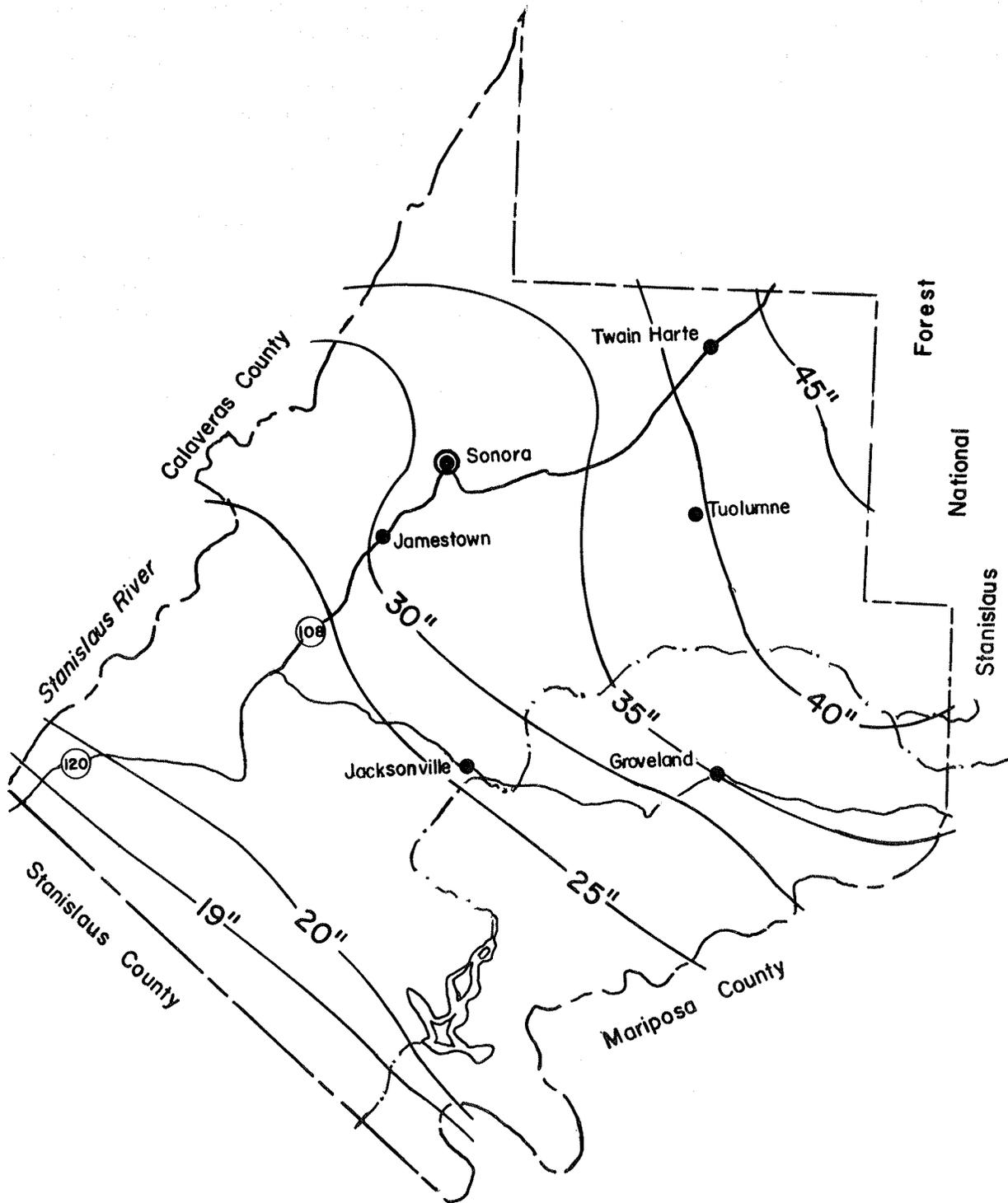


FIGURE 1. Average annual rainfall in part of Tuolumne County.

## GEOLOGY

The rocks in the various geologic formations throughout the area have a very strong influence upon soil formation. It was possible to use the geologic map<sup>2/7/8/</sup> to a great extent in locating and defining the limits of the various soil units within the mapped area. Hard rocks underlie all of the soils. The rocks, however, vary considerably in composition, structure, and age. The manner in which the rocks are exposed to weathering also varies considerably. Many of them are tilted on edge, although some are more or less horizontal. These characteristics of the rocks influence the rate of weathering to soil materials. The rock formations in this part of the Sierra Nevadas are tilted upward on the east side. The tilting varies considerably within the formations; some are nearly vertical; others are at a much lower angle. Volcanic flows were deposited over part of the area. There is very little, if any, tilting in these formations, so they are more or less horizontal beds.

The oldest rocks in the area are in the Calaveras formation. These are in the Carboniferous Period, more than 300 million years old. The rocks in this formation are dominantly metamorphic mica schist. They are very platy, and most of them are tilted nearly on end so that rock weathering has been downward through the ends of the various strata in the formation. Most of these rocks occur in the eastern portion of the mapped area.

A large area of greenstone or metamorphic volcanic rock is exposed in the western portion of Tuolumne County. These rocks are in the Carboniferous and Jurassic Periods, and range in age from about 150 million to more than 300 million years. The rocks in this formation are somewhat massive and greenish in color. The dominant mineral is chlorite, which is a magnesium-iron-aluminum silicate.

A fairly large area of granitic rock occurs on the eastern edge of the area, as well as in two other relatively small areas. The rocks in this formation are very hard and crystalline. The dominant minerals in these rocks are feldspar and mica, with a small amount of quartz and hornblende. These rocks were intruded in the other

formations before the mountains were uplifted, probably during the Cretaceous Period which was about 150 million years ago.

About the same time, another group of rocks also was intruded into the surrounding formations—the serpentine rocks. A fairly large area of them occurs in the center of the mapped area. These rocks are very massive, hard but highly fractured, greenish in color, and have a rather soapy appearance. These are dominantly magnesium silicates. The balance of plant nutrients in the soils weathered from these rocks generally is not favorable to most plants, due to the high percentage of magnesium and the low percentage of calcium.

Some time after the formation of the Sierra Nevada Mountains, and after the rocks of the formations we have just mentioned had partly eroded away, volcanic flows moved over the land surface. Most of them followed existing canyons and stream channels, more or less filling them with either volcanic flow rock or broken volcanic rock cemented with volcanic tuff. The surrounding rock formations continued to erode away, while the volcanic formations remained. The tabletop ridges that are now seen throughout the county are a result of this geologic erosion. The volcanic rocks vary considerably in composition, but are all rather massive. The tuff material generally is the softest, while the volcanic flow rocks (basalt) are the hardest. These volcanic flows occurred some time during the Pliocene Age, or about 60 million years ago.

There has been very little or no deposit of materials in the county since the Pliocene Age with the exception of a very small area in the northwest portion near Highway 120.<sup>1</sup> This area is too small to show on the small scale of this survey.

## NATURAL VEGETATION

The location of the various natural vegetation types within the county is closely related to the kind of climate, which, in turn, is related to the elevations. At the lower elevations, annual grasses and forbs are dominant; in the middle elevations there is a combination of annual grasses and forbs with shrubs, hardwoods, and conifers; in the upper elevations on the eastern edge of the mapped area, conifers are

dominant, with some hardwoods and shrubs. The dominant vegetation is listed in the description of each of the soil mapping units.

The natural vegetation has changed considerably over the years as man has used the areas. Many of the grasses and forbs now growing on the ranges are not native to California, but were accidentally introduced species from the Mediterranean region. These are such plants as the bromes, clovers, oats, and filarees. Many of the hardwoods, which are dominantly oaks, have been cut for firewood over the past 100 years, but in many instances they have grown back. Many of the brush fields have been burned over a number of times. Most of the conifers growing in the area today have regrown since man came into the area.

Most of the vegetation growing in the county is natural; that is, not a cultivated crop as is found in the central part of the San Joaquin Valley, for instance. Certainly, more acreage was cultivated in the past for hay and cereals. Due to the shallow soils, uneven topography, and lack of water, it is doubtful whether very many acres ever will be intensely cultivated within the county. For some time, the principal agricultural use of the land will be for cattle range and timber.

## SOILS

Twenty-seven different soil series were mapped in this reconnaissance soil survey.<sup>5</sup> These soil series differ from one another in one or more soil characteristics, such as depth to hard rock and the color, reaction, texture, structure, and thickness of major horizons within the profile. A horizon of a soil profile is a horizontal layer in the soil; a profile of a soil is the vertical slice through the soil to the underlying parent material. The differences in the characteristics of these soil series are related directly or indirectly to the factors of soil formation.<sup>3</sup> These factors are the parent material from which the soil developed, the kinds of vegetation growing on the soil, the climate of the area, length of time during which soil formation has taken place, and the shape of the land surface.

The difference in the composition of the various geologic formations in the area was described in the section on geology. As these

rocks weather, various kinds of chemical reactions take place. For instance, rocks relatively high in iron weather to soils which are reddish in color. Rocks relatively high in crystalline quartz produce sandy soils.

The kinds and amount of vegetation growing on the soil are reflected in the amount and kinds of organic matter within the soil. The organic matter in the soil has a strong influence upon soil structure and, to a certain degree, in the storage and release of plant nutrients. For instance, the soils in the grass oak areas, such as the Dorado, Argonaut, Toomes, some of the Auburn, Exchequer, Hideway, Pence, and White-rock soils, have a rather massive, porous structure which is hard when dry and friable when moist. This is common of many of the soils in the Central Valley of California. Soils which commonly have a rather dense brush cover, such as the Ahwahnee, some of the Auburn, Goulding, Los Gatos, Maymen, Permanente, Sacata, some of the Sierra, Stonyford, Supan, and some of the Trabuco, have a weak granular to a fine subangular blocky structure in the surface soils and are generally slightly acid throughout. At the higher elevations under the conifer vegetation, the soils have a strong granular to subangular blocky surface structure and a subangular blocky to nearly massive structured subsoil. Soil reaction will range from slightly acid surface soil to moderately acid subsoil. The soils in this group are the Boomer, Cohasset, Holland, Josephine, Mariposa, and Musick soil series.

The depth of rock weathering is related somewhat to the climate. The deepest soils to hard unweathered rock are found in the area of highest rainfall. However, if we were to continue up the slope of the Sierras beyond our mapping area, we would find that the soil depth would decrease even though rainfall increases. This can be shown to be related to temperatures—the temperature decreases when elevation increases. The greatest degree of weathering in the Sierra Nevada Mountains usually is found in a belt ranging in elevation from about 2,000 to 5,000 feet. In this zone the deep soils of the Cohasset, Holland, and Musick series are found. A good example is the deep road cut in the Musick soil series at Twain Harte.

Most of the soil profiles in the mapped area show very little profile development and can be said to be relatively young. A greater degree of profile development is expressed by contrasting differences in horizons. Soils with little or no differences in soil characteristics with depth are said to have little or no development. For instance, the Dorado, Exchequer, Hideway, Maymen, Pence, Toomes, and Whiterock soils have profiles with little or no development, whereas the Auburn, Ahwahnee, Delpiedra, Fallbrook, Los Gatos, Mariposa, and Permanente soils have slight development because there is a slight increase in clay with depth. The Boomer, Cohasset, Henneke, Josephine, Sierra, Stonyford, and Supan have moderate amounts of soil development because of the very noticeable change in soil texture from the surface soil to the subsoil. A few soils, such as the Argonaut, Musick, Sacata, and

Trabuco series, have considerable profile development because of the sharp contrast from the loam surface horizons to the clay subsoils. Often the transition between these two horizons is abrupt.

Topography influences soil formation by drainage and soil loss through erosion. All of the soils in Tuolumne County occur on slopes so that water does not stand in the profile of the soils for any length of time. All of the soils can be considered well drained. On the steepest slopes, such as those along the canyon walls of the Tuolumne and Stanislaus Rivers, there is a very gradual but continual movement of soil down the slopes, so that the soils in these areas are probably losing soil as fast as it is being formed from the rocks. A brief description of each of the series mapped in the county is given in table 2.

TABLE 2. Some characteristics of the soils mapped in the reconnaissance soil survey of Tuolumne County outside Stanislaus National Forest.

SOIL SERIES		TEXTURE	COLOR	Reaction	Soil Depth (Feet)	Parent Material	Most Common Slopes
Argonaut	Sur:	Loam	Brown	Sl. acid	2 to 4	Greenstone	Less than 30%
	Sub:	Clay	Red brown	Sl. acid			
Ahwahnee	Sur:	Sandy loam	Brown	Sl. acid	1 to 3	Grano-diorite	Slopes up to 70%
	Sub:	Sandy loam	Brown	Sl. acid			
Auburn	Sur:	Loam	Red brown	Sl. acid	1 to 3	Greenstone	Less than 30%
	Sub:	Loam		Sl. acid			
Boomer	Sur:	Loam	Red brown	Sl. acid	4 to 5	Greenstone	Less than 30%
	Sub:	Clay loam	Red brown	Mod. acid			
Cohasset	Sur:	Loam	Brown	Sl. acid	4 to 5	Andesitic breccia	Less than 30%
	Sub:	Clay loam	Red brown	Mod. acid			
Delpiedra	Sur:	Stony loam	Red brown	Sl. acid	1 to 2	Serpentine	Less than 30%
Dorado	Sur:	Gravelly loam	Red brown	Sl. acid	1 to 2	Mica schist	Slopes up to 70%
Exchequer	Sur:	Loam	Brown	Sl. acid	1	Greenstone	Less than 30%
Fallbrook	Sur:	Sandy loam	Brown	Sl. acid	2 to 4	Grano-diorite	Less than 30%
	Sub:	Sandy clay loam	Reddish brown	Sl. acid			
Goulding	Sur:	Stony loam	Brown	Sl. acid	2 to 3	Gabbro	Slopes up to 70%
	Sub:		Brown	Sl. acid			
Henneke	Sur:	Stony loam	Brown	Neutral	2 to 3	Serpentine	Slopes up to 70%
	Sub:	Stony clay loam	Reddish brown	Neutral			
Hideway	Sur:	Stony loam	Brown	Sl. acid	1	Basalt	Less than 30%
Holland	Sur:	Sandy loam	Gray brown	Sl. acid	more than 5	Grano-diorite	Less than 30%
	Sub:	Sandy loam	Yellow brown	Mod. acid			
Josephine	Sur:	Loam	Reddish brown	Sl. acid	more than 5	Mica schist	Less than 30%
	Sub:	Clay loam	Reddish brown	Mod. acid			

NOTE: Sur = Surface      Sub = Subsoil

TABLE 2. (continued)

SOIL SERIES		TEXTURE	COLOR	Reaction	Soil Depth (Feet)	Parent Material	Most Common Slopes
Los Gatos	Sur:	Loam	Brown	Sl. acid	2 to 3	Mica schist	Slopes up to 70%
	Sub:	Clay loam	Reddish brown	Sl. acid			
Mariposa	Sur:	Loam	Brown	Sl. acid	2 to 3	Mica schist	Slopes up to 70%
	Sub:	Clay loam	Reddish brown	Mod. acid			
Maymen	Sur:	Stony loam	Brown	Sl. acid	1 to 2	Mica schist	Slopes up to 70%
Mined land	Hydraulically mined areas; quite variable						
Musick	Sur:	Sandy loam	Reddish brown	Sl. acid	more than 5	Grano-diorite	Less than 30%
	Sub:	Sandy clay	Red	Mod. acid			
Pence	Sur:	Sandy loam	Brown	Sl. acid	1	Volcanic tuff	Less than 30%
Permanente	Sur:	Loam	Reddish brown	Sl. acid	2 to 3	Hard limestone	Less than 30%
	Sub:	Clay loam	Reddish brown	Sl. acid			
Rockland	Outcrops of rock covering more than 50 per cent of area						
Sacata	Sur:	Loam	Brown	Sl. acid	3 to 4	Mica schist	Less than 30%
	Sub:	Clay	Reddish brown	Sl. acid			
Sierra	Sur:	Loam	Reddish brown	Sl. acid	2 to 4	Grano-diorite	Less than 30%
	Sub:	Clay loam	Reddish brown	Sl. acid			
Stonyford	Sur:	Loam	Reddish brown	Sl. acid	2 to 3	Greenstone	More than 30%
	Sub:	Clay loam	Reddish brown	Sl. acid			
Supan	Sur:	Loam	Brown	Sl. acid	2 to 3	Andesitic breccia	Less than 30%
	Sub:	Clay loam	Brown	Sl. acid			
Toomes	Sur:	Stony loam	Brown	Sl. acid	1	Andesitic breccia	Less than 30%
Trabuco	Sur:	Loam	Brown	Sl. acid	2 to 3	Grano-diorite	Less than 30%
	Sub:	Clay	Reddish brown	Sl. acid			
Whiterock	Sur:	Gravelly loam	Gray brown	Sl. acid	1	Slate	Less than 30%

NOTE: Sur = Surface      Sub = Subsoil

## SOIL MAPPING UNITS

Each area within a soil boundary on the soil map is a mapping unit, defined by the map symbol or number it contains. A brief description of the soil series referred to by the numbers is given in the tables on the map. A more complete description is given in the following paragraphs.

### *Map Symbol No. 1 – Exchequer, Auburn, Argonaut*

The area with map symbol No. 1 occurs in the low, rounded hills on the western edge of the county (see cover and figure 2). There are approximately 50,000 acres in this area, with elevations ranging from 300 to 1,500 feet. Several short streams drain the area toward the west.

Natural vegetation growing in the area is grasses and forbs, with a few blue oaks. There is evidence that some of the area was cultivated some time in the past, although there is little or no cultivation at present. Winter and spring range is the dominant use. Land holdings are relatively large.

No water has been developed for this area, except small stock water ponds. As a result, water is scarce during the hot, summer months, except near a few small springs and along Tuolumne and Stanislaus Rivers.

Exchequer, Auburn, and Argonaut soil series are the dominant soil series in the area, with map symbol No. 1. The Exchequer and Auburn soils are similar. Exchequer soils are shallow to rock (less than 15 inches) and often rocky and stony, whereas the Auburn soils are shallow to rock (15 to 36 inches) with a few stones. The grasses and forbs often grow better on the Auburn than on either the Exchequer or Argonaut. This is due primarily to the greater depth of favorable soil in the Auburn soil series for the storage of water and plant nutrients. The Argonaut soil series often is 30 to 48 inches to rock, with about 15 inches of loam over a clay subsoil. Roots and water penetrate this clay very slowly.

### *Map Symbol No. 2 – Auburn, Argonaut*

Of the five areas with map symbol No. 2, two are relatively large. They extend across the western half of the county from northwest to southeast and cover approximately 28,000 acres.

These mapping units are composed of many rounded hills and small valleys with many slopes less than 30 per cent. Slopes into the larger drainages are steep—some over 50 per cent. The areas are drained by many small streams. Elevation range is from 500 to 3,000 feet.

Natural vegetation is dominantly annual grasses and forbs, with a few blue oaks. Around Tuttletown, the northernmost unit, there is a large percentage of interior live oaks, manzanitas, ceanothus, and toyon. Some of the steeper slopes along the larger streams also have a greater percentage of evergreen woody vegetation.

Cattle range is the dominant use. A few of the gently sloping valleys are cropped to barley and hay.

Water has not been developed to any extent for these areas. There are very few wells and springs. The available water in the Tuttletown area is being used for urban development.

Auburn and Argonaut soil series occur in a rather complex pattern through these areas. The Auburn soil ranges in depth to weathered greenstone from 15 to 36 inches. It is a reddish brown loam throughout. Some areas have a few rocks or stones. Argonaut soils range in depth to weathered rock from 30 to 48 inches. The surface soil to about 15 inches is a brown to reddish brown loam. The subsoil is a reddish brown clay. Under natural conditions, plant growth appears to be slightly better on the Auburn soils.

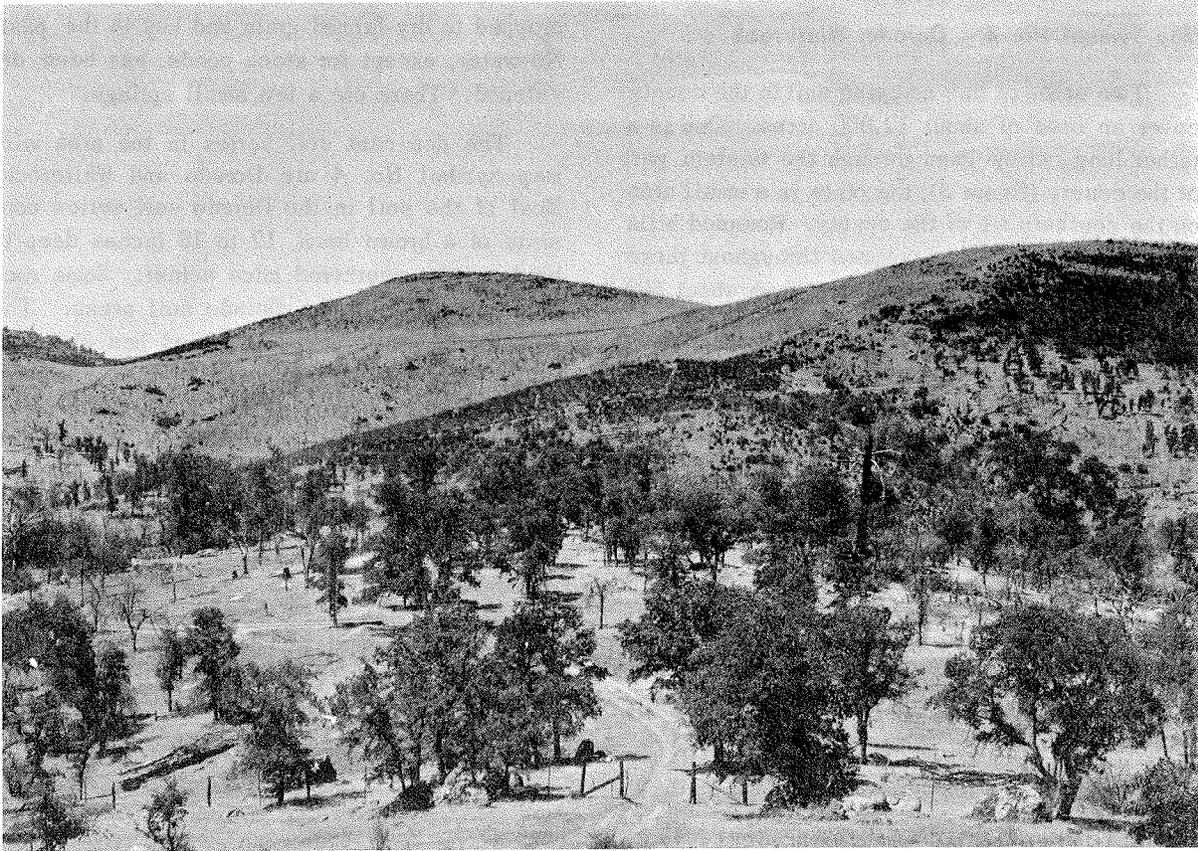


FIGURE 2. Grass and blue-oak-covered Auburn and Argonaut soil association (map symbol No. 2) occurs in the foreground, and the shrub and grass-covered Goulding soils (map symbol No. 13) are on the tops of the hills. The Goulding soils usually have a very dense cover of chamise and associated shrubs. The shrubs have been removed by fire and grasses planted in the area.

### **Map Symbol No. 3 – Dorado**

Five rather small areas with map symbol No. 3 occur in the north central part of the county. They have a total of about 25,000 acres.

The Dorado soils occur on low hills with smooth rounded slopes, most of which are less than 30 per cent. Elevations range from about 500 to 1,500 feet.

Native vegetation is annual grasses and forbs, with a few blue oaks. Most areas are used for cattle range. A small acreage is dry farmed to barley, and a few acres around Jamestown and Campo Seco have been developed to irrigated pasture.

The Dorado soil series usually has 12 to 24 inches of brown loam over weathered but hard mica schist. The schist rock is very platy and turned, so that the plates are almost vertical. Roots and water enter the rock to varying depths.

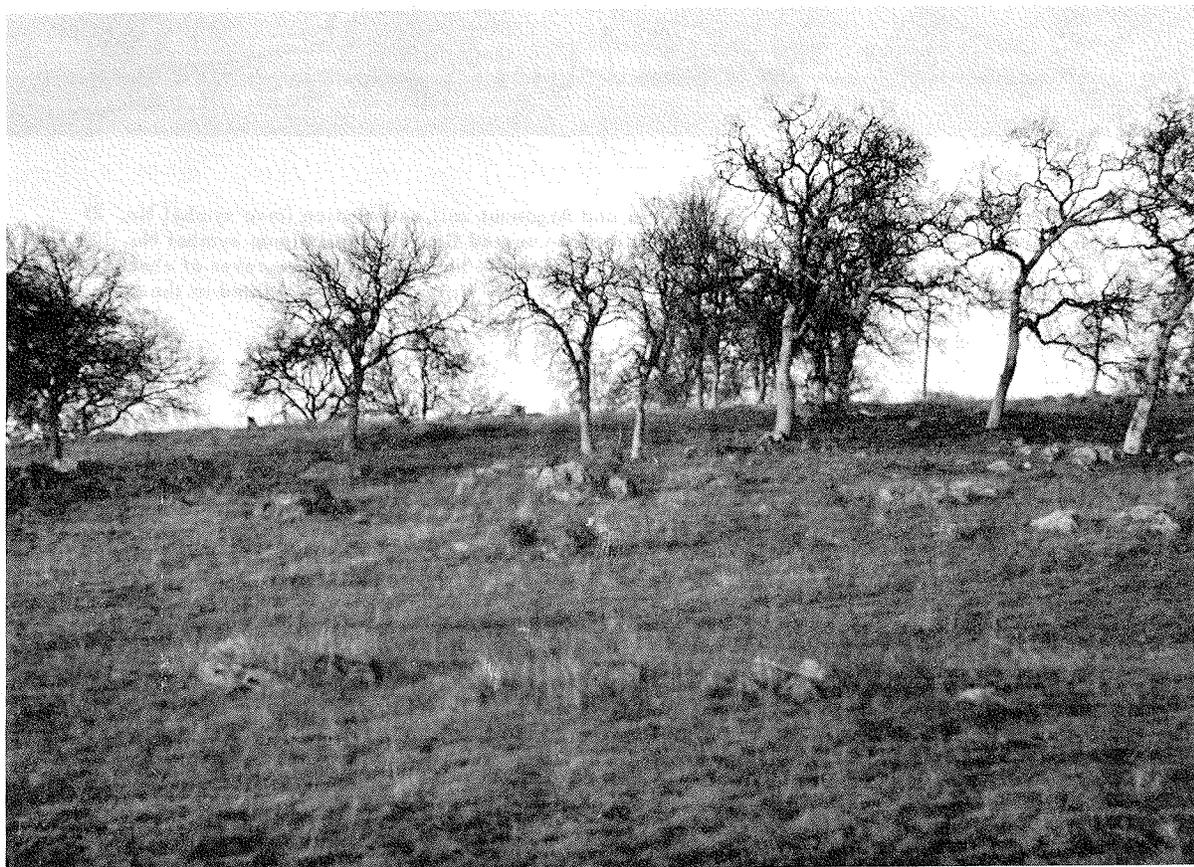
**Map Symbol No. 4 – Dorado, Whiterock**

Two areas of this mapping unit in the county cover an area of about 12,000 acres. One is a rather long, narrow band through the western part of the county (figure 3); the other is a small area on the southern tip of the county. Rounded hills with gentle slopes are common throughout these mapping units. Elevations range from about 500 to 1,500 feet.

Natural vegetation is annual grasses and forbs, with a few blue oaks. The entire area with map symbol No. 4 is used for cattle range. A relatively small acreage of these soils has been

cropped to dry-farmed grain and hay in the past. No water, except for stock ponds, has been developed. There are a few small springs.

The dominant soil series in the area with map symbol No. 4 are Dorado and Whiterock. Most of the soil in the Dorado soil series consists of a brown loam, 12 to 18 inches deep to hard, partly weathered mica schist. Some rock outcrops occur in the Dorado soil areas. The soil in the Whiterock soil series has about 12 inches of gray-brown gravelly loam over a hard, partly weathered platy slate. These platy rocks are nearly vertical, and outcrops in places give the appearance of tombstones.



**FIGURE 3.** View of Dorado-Whiterock soil association (map symbol No. 4) about  $\frac{1}{2}$  mile west of Keystone. This is a cattle range. Note tombstonelike rocks and blue oaks.

### *Map Symbol No. 5 – Fallbrook*

Two rather small areas with map symbol No. 5 occur in the western part of the county, with a total of about 2,500 acres. The low hills in these areas have gently rounded slopes. Most slopes are less than 30 per cent, with the exception of some steeper slopes around Don Pedro Reservoir. Elevation ranges from about 1,000 to 1,500 feet.

Natural vegetation is annual grasses and forbs, with a few blue oaks. All the area is used for cattle range. The abandoned homesteads in the general area indicate that the smoother and more gentle slopes were once cultivated.

The Fallbrook is the dominant soil series in the areas with map symbol No. 5. The surface soil to a depth of about 15 inches is a brown to reddish brown sandy loam. The subsoil is a reddish brown loam. Partly weathered granitic rock (grano-diorite) occurs at a depth ranging from 24 to 48 inches.

### *Map Symbol No. 6 – Pence, Hideway, Rockland*

The table mountains and the adjacent slopes along the northwestern edge of the county are in this mapping unit. The several areas in this unit have a total of about 5,000 acres.

The topographic features of these table mountains are very striking. They have flat tops which stand up abruptly 100 feet or more above the surrounding hills. In general, the mountain tops are long and narrow. The longest ridge is nearly 10 miles, but at no place is it more than ½ mile wide. The side slopes are nearly vertical along the edge of the ridge top, but fan out to gentle slopes around the lower edges. Elevation ranges from 300 to 2,000 feet.

Natural vegetation is annual grasses and forbs, with some blue oaks and interior live oaks. Most areas with map symbol No. 6 are used for cattle range, although some areas are too rocky to be much value for range.

The lands with map symbol No. 6 have either Rockland or the Pence and Hideway soil series. The Pence soil series consists of gray brown sandy loam over hard volcanic tuff; soil depth varies from less than 12 to nearly 24 inches. All of this soil occurs on the more gentle slopes around the lower edges of the table mountains. Most slopes are less than 30 per cent. The Hideway soil series occurs on the tops of the table mountains. This soil is a brown stony loam, often less than 12 inches to a very hard massive basalt. The amount of stone on the surface varies considerably. Rockland areas are covered with 50 per cent or more rock. A large percentage of this mapping unit is Rockland.

### *Map Symbol No. 7 – Trabuco, Sierra*

This group of soils, near the center of the surveyed area, covers approximately 12,000 acres. These soils are on smooth rounded hills, with most slopes less than 30 per cent. Elevations range from 1,000 to 3,000 feet.

Natural vegetation is annual grasses and forbs, with some blue oaks and interior live oaks. The dominant land use is cattle range. A small acreage near the town of Standard has water available for irrigation where a small acreage of irrigated pasture has been developed.

Trabuco and Sierra soil series are the dominant soils in the area with map symbol No. 7. The surface soil of the Trabuco soil series is brown sandy loam to a depth of about 15 inches. The subsoil is red clay. Soil depth to the partly weathered grano-diorite will range from 2 to 3 feet. Roots and water generally are able to penetrate the weathered rock several feet. The surface soil of the Sierra soil series is reddish brown sandy loam to a depth of about 15 inches. The subsoil is reddish brown sandy clay loam. Soil depth to the weathered grano-diorite rock will range from 2 to 4 feet.

### **Map Symbol No. 8 – Mined Land**

Areas on the map with symbol No. 8 have been hydraulically mined for gold. Originally they were old gravel deposits; however, most of the gravel material has been washed away. Some of the areas have been leveled and planted to irrigated pasture. However, some very rough hydraulically mined land still remains near the town of Columbia. The irregular surface of the gray and white hard limestone which underlies the gravel here is partly exposed. The mined land around China Camp is fairly gravelly; a few spots remain of the old gravel material which have not been hydraulically mined. There are about 3,000 acres of the mined land in the county.

### **Map Symbol No. 9 – Permanente**

A relatively small acreage of the Permanente soil series, near the center of the mapped area, covers an area of less than 1,000 acres in the county. The hills on which this soil occurs are rounded and rather rough. Most of the slopes are less than 30 per cent. Elevation ranges from about 1,000 to 2,000 feet.

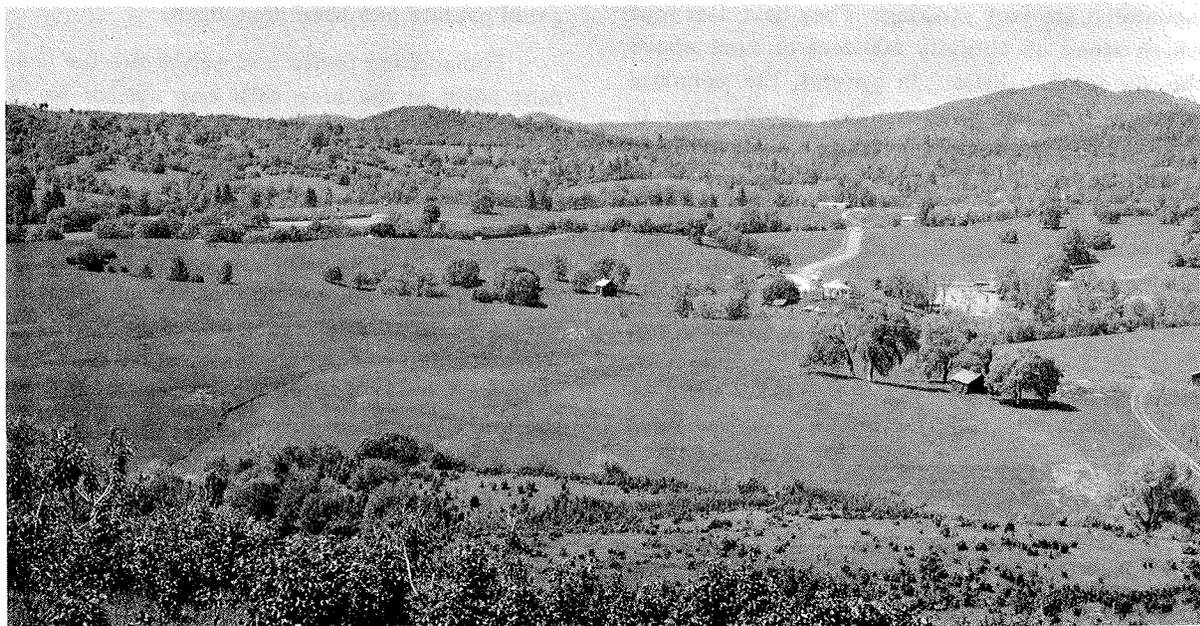
Natural vegetation is annual grasses and forbs, with blue oaks and interior live oaks. All the soil is used for cattle range. No water has been developed for use on this soil.

The surface soil of the Permanente series is reddish brown loam to a depth of about 12 inches. The subsoil is reddish brown to red clay loam. The soil rests very abruptly upon irregular weathered hard limestone. Soil depth varies from 2 to 3 feet. Not all of the Permanente soil areas in the mapped area are shown. There are a number of very narrow bands of limestone outcropping through the Jamestown, Sonora, and Columbia area. These areas of Permanente soil are too narrow or too small to be shown on this scale of map.

### **Map Symbol No. 10 – Auburn**

This soil occurs west of Sonora to Jamestown and extends in a narrow band down to Jacksonville (figure 4). It covers approximately 12,000 acres. The topography is quite varied. Some rather steep slopes occur on ridges and on the canyon walls in the Jacksonville area. There is a sizable acreage in the Jamestown and Sonora area, however, with slopes of less than 30 per cent. Elevations range from 1,000 to nearly 3,000 feet.

Natural vegetation is annual grasses and forbs, with blue oaks, interior live oaks, and shrubs. Many of the steeper slopes and ridges are shrub covered. The shrubs are mostly manzanita and ceanothus, with some toyon and poison



**FIGURE 4.** A view of an Auburn area (map symbol No. 10). The grass-covered rounded hills with the scattered blue oaks are typical of this soil area.

oak. Nearly all the area outside the residential developments around Sonora, Shaws Flat, and Jamestown is used for cattle range. Very few acres are cultivated at present.

The Auburn soil series in this area ranges from 2 to 3 feet deep to relatively hard but weathered greenstone. The soil is reddish brown loam to gravelly loam throughout. A few of the areas may show a slight increase in clay in the lower depths. The area under the very dense brush may have a thin layer of dark soil on the surface with a weak granular structure, whereas in the grass-oak areas the surface structure is nearly massive.

#### **Map Symbol No. 11 – Dorado, Maymen, Los Gatos**

The area with map symbol No. 11 occurs in a band through the center of the surveyed area in the county (figure 5). This group of soils covers an area of about 25,000 acres, and nearly all is on steep slopes of very deep canyons.

The natural vegetation is mostly shrubs, with some blue oaks, interior live oaks, and annual grasses and forbs. Although part of the area is used for cattle range, a large part of it is either too steep or too brushy to be of much value for cattle range. The brushy areas, however, afford some browse and cover for wildlife.

Dorado, Maymen, and Los Gatos are the dominant soil series in areas with map symbol No. 11. The Dorado soils are 1 to 2 feet deep to a rather hard mica schist. The soil is brown loam with a massive but porous structure. A grass and blue oak vegetation is most common on this soil. Most of the chamise and manzanita grow on the Maymen soil series, which is less than 12 inches deep to the hard mica schist and is brown gravelly loam with a granular structure. Generally, a wide variety of shrubs naturally grow on the Los Gatos soil. The surface soil is brown granular loam to a depth of about 12 inches. The subsoil is reddish brown clay loam. Soil depth to the hard mica schist ranges from 18 to 30 inches.



**FIGURE 5.** A view of the shrub-covered slopes of the Dorado-Maymen-Los Gatos soil association (map symbol No. 11). These relatively steep slopes can be seen from California Highway 49, about 7 miles southeast of Jacksonville.

### **Map Symbol No. 12 – Henneke**

Most of this soil occurs in the western part of the surveyed area and covers an area of about 14,000 acres. The topography is very uneven and rough, with many steep slopes. Elevations range from about 1,000 to 2,000 feet.

A sparse cover of shrubs, forbs, and grass naturally grow on the Henneke soils (figure 6). The high amount of magnesium in relation to other plant nutrients, mainly calcium, is not favorable for good plant growth. Plants growing on this soil have a low grazing value for cattle or sheep.

The surface soil of the Henneke soil series is reddish brown gravelly loam to a depth of about 6 inches. The subsoil is gravelly clay loam to nearly clay. Soil depth to hard, partly weathered serpentine rock varies from 1 to 2 feet. Most areas have from 10 to 50 per cent of the surface covered with rocks from 6 inches to 2 feet in diameter.

### **Map Symbol No. 13 – Goulding**

One area of this soil in the southern end of the county covers about 5,000 acres. All of the area has relatively steep slopes, although most of the slopes are relatively smooth. Elevations range from about 500 to 1,500 feet.

Nearly all of the soil is shrub covered, mostly with chamise and manzanita. There are some interior live oaks and a few digger pines. At present, little use is made of the area. A small acreage, cleared of brush and planted to grass

with some success, is used for cattle range. The remainder of the brush area provides some browse and cover for wildlife.

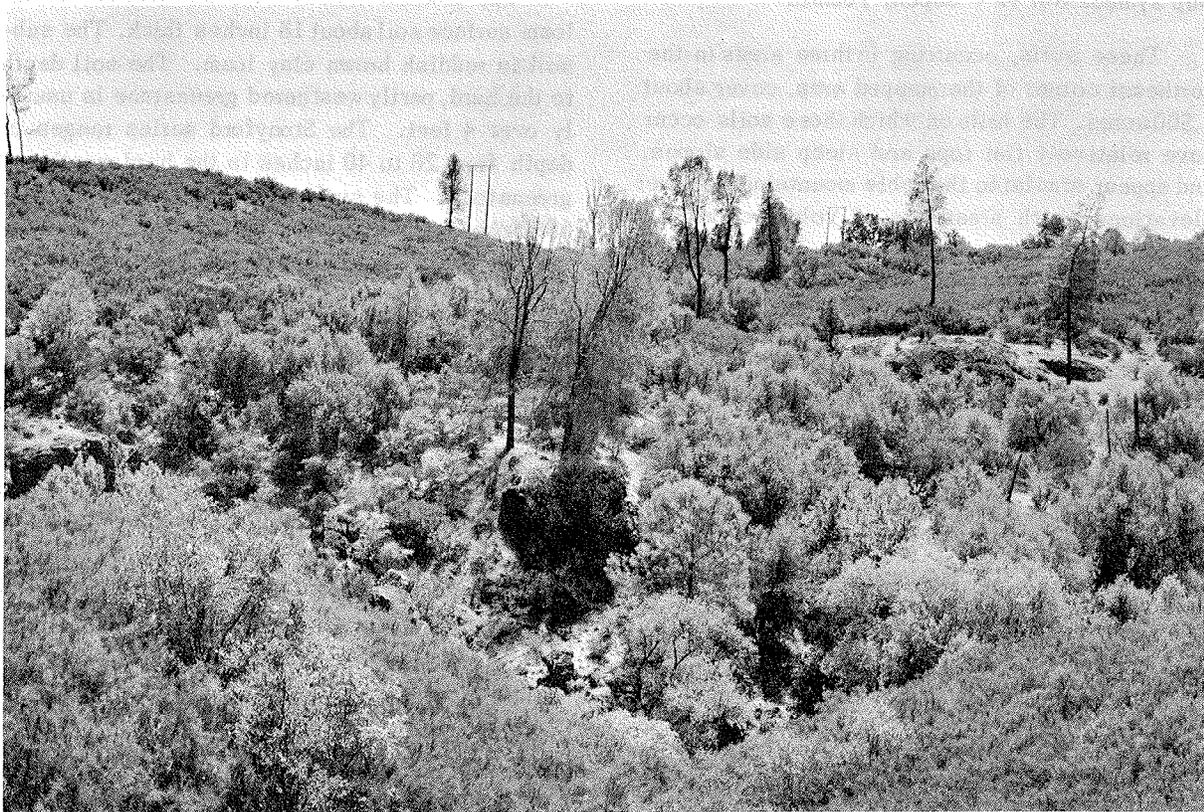
The Goulding soil series to a depth of 18 to 30 inches is brown gravelly loam. The soil material rests rather abruptly upon hard but weathered gabbro rock. This rock appears to be similar in composition to some of the serpentine which adjoins it to the north.

### **Map Symbol No. 14 – Henneke, Delpiedra**

The areas with map symbol No. 14 occur west of Sonora and cover about 9,000 acres. The topography is rather uneven, but many of the slopes are less than 30 per cent. Elevations range from about 1,000 to 1,500 feet.

The natural vegetation is annual grasses and forbs, blue oaks, and shrubs. All of the area is used for cattle range.

Henneke and Delpiedra are the dominant soil series in areas with map symbol No. 14. Most of the Henneke soils are less than 2 feet deep to hard, partly weathered serpentine rock. The surface soil is brown loam to a depth of about 6 inches. The subsoil is reddish brown clay loam. Serpentine rock may cover 10 to 50 per cent of the surface. The vegetation growing on the Henneke soils is generally chamise, leather oak, common manzanita, and digger pine. Seldom is there more than a sparse growth of grass and forbs. The Delpiedra soil also is less than 2 feet to hard serpentine rock. The soil consists of brown to reddish brown gravelly loam. The natural vegetation on this soil is grass and blue oak.



**FIGURE 6.** A typical landscape of the Henneke soils in the Henneke-Delpiedra soil association (map symbol No. 14). The mixed shrub cover with digger pine is very common. Grass and forbs are sparse in these open areas. This area is located about 2 miles south of Jamestown.

**Map Symbol No. 15 – Sacata, Dorado, Maymen**

These soils occur in a band running north and south of Sonora, and cover approximately 11,000 acres. The topography is quite varied. Many of the slopes are very steep. Elevations range from about 1,000 to 3,000 feet.

The natural vegetation is annual grasses and forbs, shrubs, blue oaks, interior live oaks, and digger pines. Some of the area is used for cattle range. Some of the very dense, brush-covered areas have little use other than to provide cover and browse for wildlife.

The Sacata, Dorado, and Maymen soils are dominant in areas with map symbol No. 15. The Sacata soils have brown loam surface soils extending to a depth of about 12 inches. The subsoil is reddish brown clay. Hard, weathered mica schist occurs at a depth of 30 to 48 inches. The Dorado soil series is gravelly loam to a depth of 18 to 24 inches. The soil rests rather abruptly upon hard mica schist. The Maymen soil series

generally is less than 12 inches to hard mica schist. The soil material is brown loam with a granular structure.

**Map Symbol No. 16 – Stonyford**

One area of this soil, along the southern edge of the county, is about 2,500 acres. All of the soil is on very steep slopes. Elevations range from about 1,000 to 2,000 feet.

The natural vegetation is shrubs—the most common are chamise, wedgeleaf, ceanothus, and common manzanita. Little use is made of the area; the shrub cover provides cover and browse for wildlife, and some protection to the watershed.

The Stonyford soil series ranges in depth from 20 to 40 inches to hard but partly weathered greenstone. The surface soil, from 6 to 10 inches, is reddish brown loam with a granular structure. The subsoil is reddish brown, heavy loam or clay loam. Five to 20 per cent of the surface soil may be covered with angular rocks.

**Map Symbol No. 17 – Supan, Toomes**

These soils, occurring in three areas in the northeast corner of the mapped area, cover about 1,500 acres. The hills on which these soils occur have relatively flat tops and steep side slopes, and appear similar to the table mountains at lower elevations (both areas are of volcanic origin). Elevations in the area range from 1,500 to 2,000 feet.

Natural vegetation is most commonly annual grasses and forbs on the Toomes soil; interior live oak, common manzanita, and blue oak, with annual grasses and forbs on the Supan soils. Cattle range is the dominant use. The densely wooded areas provide cover and browse for wildlife.

The Supan and Toomes soil series are the dominant soils in areas with map symbol No. 17. The Toomes soils often are less than 12 inches deep to hard volcanic rock. The soil is brown loam throughout. Often 10 to 50 per cent of the surface is covered with rock 6 to 18 inches in diameter. The Supan soils often are about 3 feet deep to hard volcanic rock. The surface soil is brown loam, and the subsoil is brown clay loam. Large rocks may cover 5 to 20 per cent of the surface.

**Map Symbol No. 18 – Boomer, Stonyford**

These soils occur in a relatively small area north and west of Columbia and cover about 1,300 acres. The topography is quite uneven. Nearly half of the area is along a ridge top with slopes of less than 30 per cent; in the part along the Stanislaus River canyon, most slopes are over 30 per cent. Elevations range from about 1,000 to 3,000 feet.

Natural vegetation growing in these soils may be shrubs, oaks, or conifers, with some annual grasses and forbs. Grass has been planted in a few areas where the woody vegetation has been removed. These cleared areas are used for cattle range. Ponderosa pine has been harvested for timber from some of the Boomer soils. The very brushy areas have no use other than to provide cover and browse for wildlife.

The Boomer soil series has reddish brown loam surface soil about 18 inches thick. The subsoil is reddish brown clay loam. The soil depth to the hard, partly weathered greenstone is usually over 4 feet. The Stonyford series ranges in depth from 20 to 40 inches to the hard, weathered greenstone. The surface soil often is less than 10 inches and is reddish brown loam. The subsoil is reddish brown heavy loam or clay loam.

**Map Symbol No. 19 – Ahwahnee, Trabuco, Musick**

These soils occur in the northeast part of the surveyed area, and cover approximately 13,000 acres. The topography is quite uneven, although most of the small hills have rounded slopes of less than 30 per cent. The steepest slopes occur in the Bald Mountain and Telegraph Hill areas. Elevations range from about 2,000 to 4,000 feet.

The natural vegetation consists primarily of annual grasses, shrubs, oaks, and a few conifers. Cattle are grazed on a large part of these soils during the winter and spring. A small acreage of apples is planted on the deeper Musick soils. Ponderosa pine has been harvested for timber from some of the Musick soils. The brush-covered areas have little use other than to provide cover and browse for wildlife.

The dominant soil series in areas with map symbol No. 19 are Ahwahnee, Trabuco, and Musick. The Ahwahnee soil series ranges in depth from 18 to 30 inches to hard but partly weathered granodiorite. The surface soils are brown sandy loams with a thickness of about 15 inches. The subsoils are brown heavy loams to clay loams. The Trabuco soil series has brown loam surface soils with a depth of about 15 to 18 inches. The subsoils are reddish brown clays. The depth of the soil to hard but partly weathered grano-diorite ranges from 20 to 40 inches deep. The Musick soil series has reddish brown loam surface soils with a thickness of about 18 to 20 inches. The subsoils are often red clays. The depth to the hard grano-diorite is more than 5 feet. The lower part of the subsoil may be yellowish red sandy clay loam.

**Map Symbol No. 20 – Musick, Holland**

These soils, in the northeast corner of the surveyed area, cover about 5,000 acres. They occur on broad ridge tops with rounded slopes, many of which are less than 30 per cent. Elevations range from about 3,500 to 4,500 feet.

The natural vegetation is dominantly conifers, with some oaks and shrubs (figure 7). A relatively small acreage, which has been cleared of trees and now is grass, is used for cattle range. Ponderosa pine, sugar pine, Douglas fir, and white fir are harvested throughout the area. A

small acreage of apples has been planted in some of the cleared areas. Considerable residential development is taking place on these soils around Twain Harte and Sugarpine.

The dominant soil series in areas with map symbol No. 20 are Musick and Holland. The surface soil of the Musick soil series is reddish brown loam with a thickness of about 18 inches. The subsoil is red clay. Soil depth to the partly weathered grano-diorite often is more than 5 feet. The subsoil is yellowish brown sandy clay loam. Soil depth is generally more than 5 feet to the weathered grano-diorite.



**FIGURE 7.** Conifers and black oak growing on Musick and Holland soils (map symbol No. 20), in an area about  $\frac{3}{4}$  mile northeast of Twain Harte. Note the rounded boulders of granitic rock.

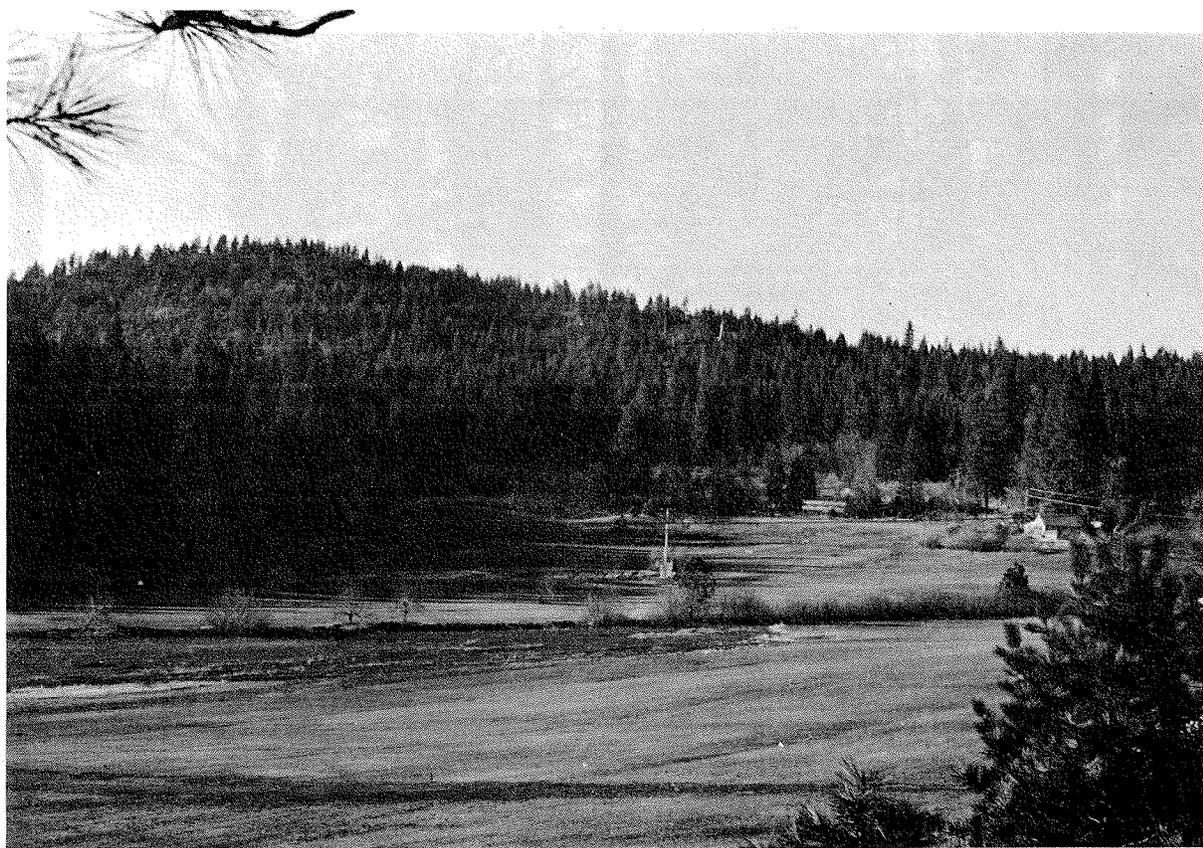
**Map Symbol No. 21 – Josephine, Mariposa**

These soils occur along the north and east edges of the surveyed area. They cover approximately 15,000 acres and occur on ridge tops and associated side slopes of the higher mountains. The Josephine soils generally have slopes less than 30 per cent; Mariposa soils often occur on slopes over 30 per cent. Elevations through the area range from about 2,000 to 4,000 feet.

Conifers, such as ponderosa pine, sugar pine, Douglas fir, white fir, and incense cedar, are the dominant natural plants growing in the area. Included, however, are black oak, canyon live oak, and a number of shrubs (figure 8). Some areas have been cleared and planted to apples;

other cleared areas are in annual grasses and forbs. Part of the area is used for cattle range. Timber has been harvested throughout the area. Considerable residential development is taking place on these soils around Groveland.

The surface soil of the Josephine soil series is a reddish brown loam about 20 inches deep. The subsoils are reddish brown clay loams. Soil depth to the hard but partly weathered mica schist often is more than 5 feet. The Mariposa soil series has brown or reddish brown gravelly loam surface soils, often to a depth of less than 12 inches. The subsoils are reddish brown gravelly loam near clay loam. Soil depth to the hard but partly weathered mica schist often is less than 40 inches.



**FIGURE 8.** A view of the Mariposa-Josephine area (map symbol No. 21) about 1 mile northeast of Twain Harte. A rather dense stand of mixed conifers is typical of this area. In the foreground the land has been cleared and planted to pasture. Some of these cleared areas have been planted to apple trees.

**Map Symbol No. 22 – Sacata, Josephine, Mariposa**

These soils occur along the north and east edges of the surveyed area and cover about 15,000 acres. They occur on the lower ridges and slopes of the mountainous areas. The ridge tops have slopes which range from less than 30 per cent on much of the Josephine and Sacata soil, to more than 30 per cent on the side slopes in most of the Mariposa soil areas. Elevations range from about 2,000 to 4,000 feet.

Natural vegetation is dominantly conifers with shrubs and oaks, and annual grasses and forbs in the open or cleared areas (figure 9). Many of the cleared areas are used for cattle range, although a small acreage of apples has been planted. Timber has been harvested throughout most of the area. Very little use is made of the very dense, shrub-covered areas, except to provide cover and browse for wildlife and protection to the watershed. The conifers are ponderosa

pine, sugar pine, Douglas fir, white fir, and incense cedar; the oaks are mostly black oak and canyon live oak. There are many kinds of shrubs through the area, but manzanita, ceanothus, and mountain misery are dominant.

Soils of the Sacata, Josephine, and Mariposa series are dominant in areas with map symbol No. 22. The Sacata soil series has brown loam surface soils about 15 inches thick. The subsoils are reddish brown clay. Soil depth to the hard, weathered mica schist ranges from 30 to 40 inches. The Josephine soil series has reddish brown loam surface soils, generally about 18 inches thick, with reddish brown clay loam subsoils. Soil depth to the weathered mica schist is often more than 5 feet. The Mariposa soil series has brown or reddish brown loam surface soils with a thickness of about 15 inches. The subsoils generally are reddish brown loams to clay loams. Soil depth is often less than 40 inches to the hard but partly weathered mica schist.



**FIGURE 9.** A view across the Sacata-Josephine-Mariposa soils (map symbol No. 22). The area has been partially cleared of trees and shrubs and planted to grass. This area is about 3 miles northeast of Groveland.

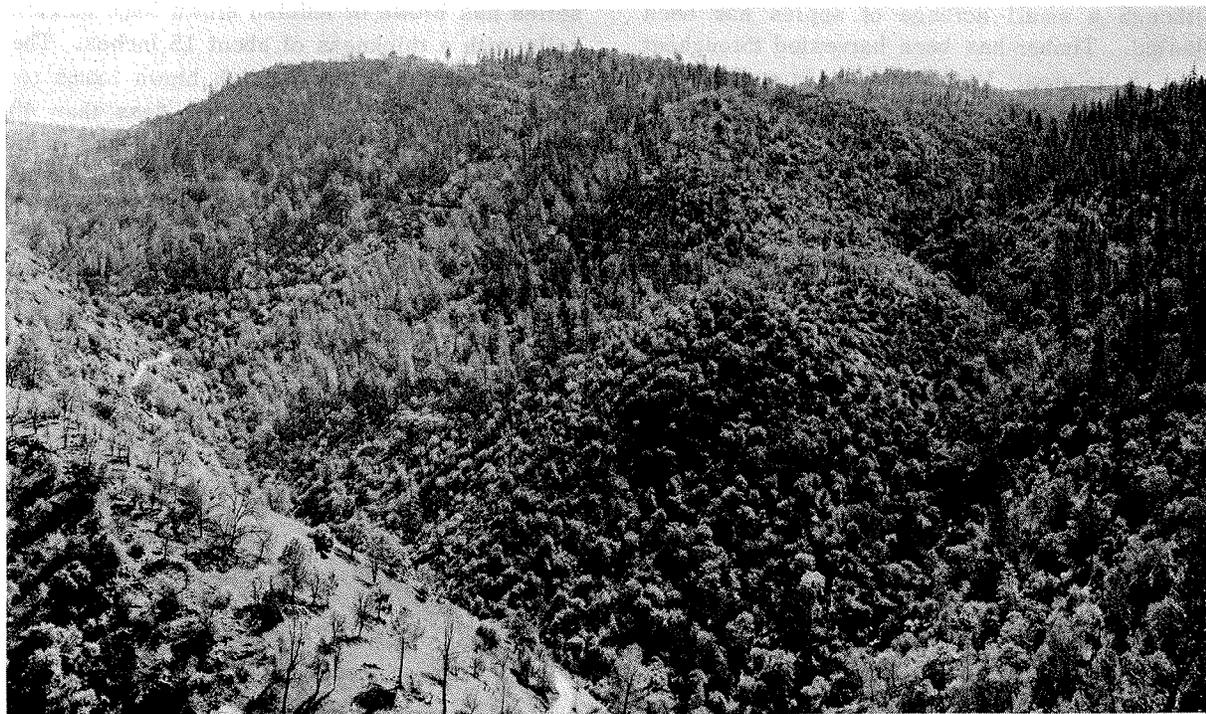
**Map Symbol No. 23 – Dorado, Rockland,  
Josephine**

These soils occur in the north and east parts of the county. They cover about 13,000 acres along the steep canyon walls of the Tuolumne and Stanislaus Rivers. Elevations range from about 1,000 to 4,000 feet.

The natural vegetation is quite varied on these soils. There are rather dense patches of shrubs, open areas with annual grasses and oaks, and small pockets of conifers with shrubs and oaks (figure 10). The dominant shrubs are manzanita, chamise, and ceanothus. The oaks are

blue oak, canyon live oak, and black oak; the conifers generally are ponderosa pine and Douglas fir. Some areas are used for cattle range, but for the most part very little use is made of these areas. They do, however, provide cover and browse for wildlife.

The Dorado soil series is brown gravelly loam throughout. Soil depth to the hard mica schist often is less than 18 inches. In the Rockland areas, rock outcrops occur over 50 per cent of the surface. The Josephine soil series has reddish brown loam surface soils about 18 inches deep. The subsoils are reddish brown clay loams. Soil depth to the partly weathered mica schist often is more than 5 feet.



**FIGURE 10.** A view into the Tuolumne River Canyon about 6 miles south of Tuolumne. The Dorado-Rockland-Josephine soil association (map symbol No. 23) is dominant in this area. The Dorado soils are in the lower left-hand corner of the photo with the grass cover and the scattering of digger pine and blue oak. The Rockland is in the hardwood areas in the center of the photo; the Josephine soils, for the most part, are in the area where the ponderosa pines are growing.

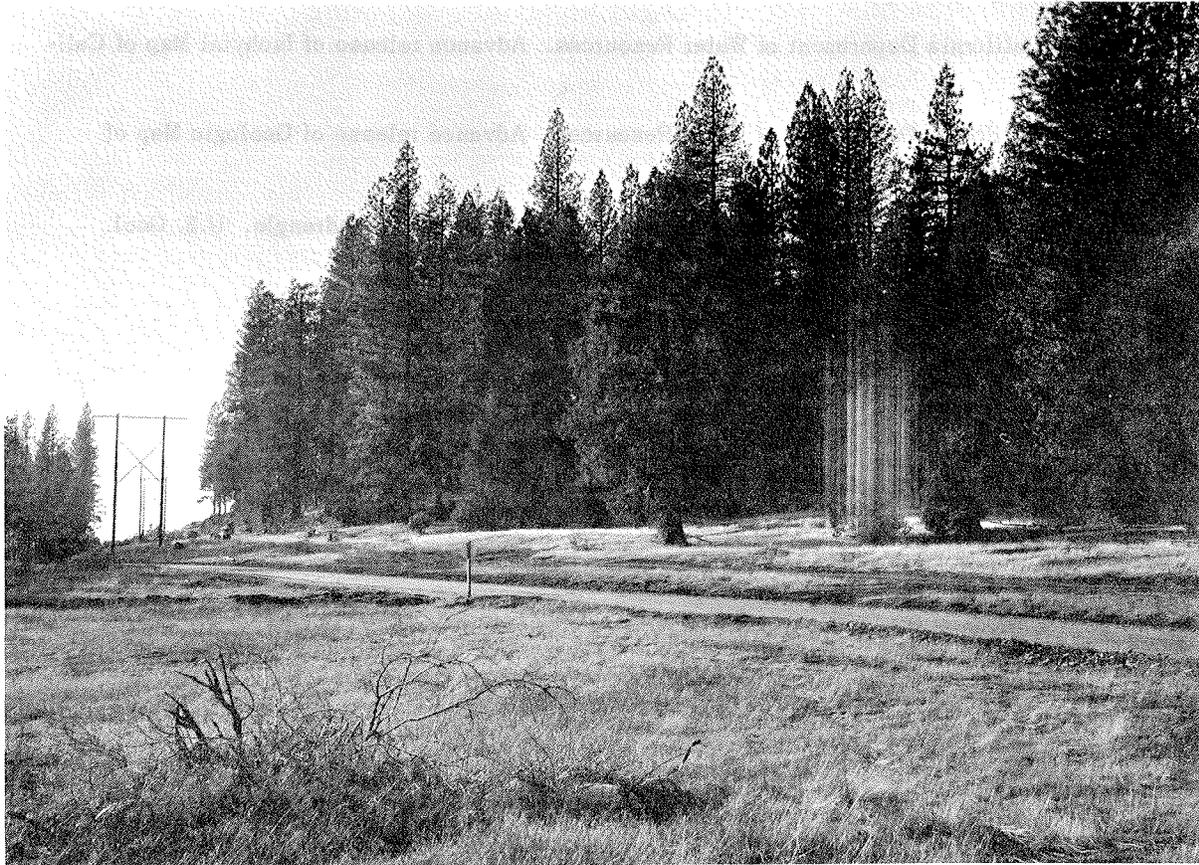
**Map Symbol No. 24 – Cohasset**

This soil occurs in the northeast corner of the surveyed area and covers about 4,000 acres. The soil occurs on the ridge tops of mountains, with most slopes less than 30 per cent. Elevations range from about 3,000 to 4,000 feet.

The dominant natural vegetation is ponderosa pine, sugar pine, Douglas fir, and white fir, with some incense cedar, black oak, and man-

zanita (figure 11). A few areas have been cleared and planted to apples. Timber has been harvested from most areas. At present, there is some residential development on the soil around Twain Harte and Sugarpine.

The Cohasset soil series has reddish brown loam surface soil with a thickness of about 18 inches. The subsoil is reddish brown clay loam. Soil depth to the partly weathered andesitic breccia or volcanic rock often is more than 5 feet.



**FIGURE 11.** A dense stand of ponderosa pine growing on Cohasset soils (map symbol No. 24). This area is about 2 miles northeast of Twain Harte.

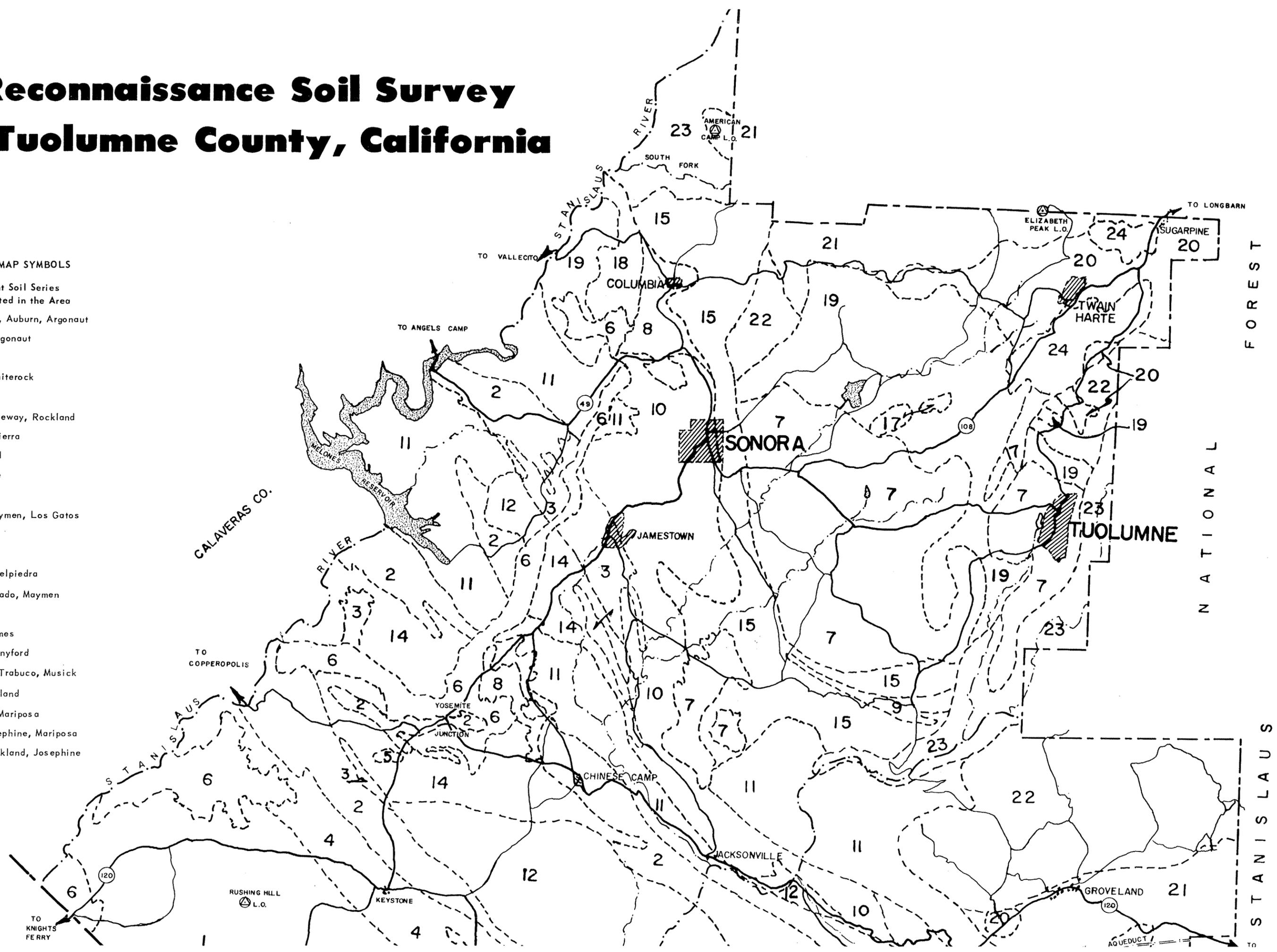
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# Reconnaissance Soil Survey of Tuolumne County, California

## LEGEND FOR MAP SYMBOLS

Map Symbol	Dominant Soil Series Associated in the Area
1	Exchequer, Auburn, Argonaut
2	Auburn, Argonaut
3	Dorado
4	Dorado, Whiterock
5	Fallbrook
6	Pence, Hideway, Rockland
7	Trabuco, Sierra
8	Mined Land
9	Permanente
10	Auburn
11	Dorado, Maymen, Los Gatos
12	Henneke
13	Goulding
14	Henneke, Delpiedra
15	Secata, Dorado, Maymen
16	Stonyford
17	Supan, Toomes
18	Boomer, Stonyford
19	Ahwahnee, Trabuco, Musick
20	Musick, Holland
21	Josephine, Mariposa
22	Secata, Josephine, Mariposa
23	Dorado, Rockland, Josephine
24	Cohasset



TO KNIGHTS FERRY

TO YOSEMITE NATIONAL PARK

BRIEF DESCRIPTION OF SOIL SERIES

Soil Series	Dominant Depth of Soil to Rock (Feet)	Most Common Slopes	Parent Rock	Soil Texture	
				Surface	Subsoil
Argonaut	2 to 4	Less than 30%	Greenstone	Loam	Clay
Ahwahnee	1 to 3	Slopes up to 70%	Grano-diorite	Sandy loam	Sandy loam
Auburn	1 to 3	Less than 30%	Greenstone	Loam	Loam
Boomer	4 to 5	Less than 30%	Greenstone	Loam	Clay loam
Cohasset	4 to 5	Less than 30%	Andesitic Breccia	Loam	Clay loam
Delpiedra	1 to 2	Less than 30%	Serpentine	Stony loam	
Dorado	1 to 2	Slopes up to 70%	Mica Schist	Gravelly loam	
Exchequer	1	Less than 30%	Greenstone	Loam	
Fallbrook	2 to 4	Less than 30%	Grano-diorite	Sandy loam	Sandy clay loam
Goulding	2 to 3	Slopes up to 70%	Gabbro	Stony loam	
Henneke	2 to 3	Slopes up to 70%	Serpentine	Stony loam	Stony clay loam
Hideway	1	Less than 30%	Basalt	Stony loam	
Holland	Over 5	Less than 30%	Grano-diorite	Sandy loam	Sandy loam
Josephine	Over 5	Less than 30%	Mica Schist	Loam	Clay loam
Los Gatos	2 to 3	Slopes up to 70%	Mica Schist	Loam	Clay loam
Mariposa	2 to 3	Slopes up to 70%	Mica Schist	Loam	Clay loam
Maymen	1 to 2	Slopes up to 70%	Mica Schist	Stony loam	
Mined Land	Hydraulically mined land; quite variable				
Musick	Over 5	Less than 30%	Grano-diorite	Sandy loam	Sandy clay
Pence	1	Less than 30%	Volcanic Tuff	Sandy loam	
Permanente	2 to 3	Less than 30%	Hard Limestone	Loam	Clay loam
Rockland	Outcrops of rock covering over 50 per cent of the area				
Secata	3 to 4	Less than 30%	Mica Schist	Loam	Clay
Sierra	2 to 4	Less than 30%	Grano-diorite	Loam	Clay loam
Stonyford	2 to 3	Over 30%	Greenstone	Loam	Clay loam
Supan	2 to 3	Less than 30%	Andesitic Breccia	Loam	Clay loam
Toomes	1	Less than 30%	Andesitic Breccia	Stony loam	
Trabuco	2 to 3	Less than 30%	Grano-diorite	Loam	Clay
Whiterock	1	Less than 30%	Slate	Gravelly loam	

STANISLAUS CO.

MARIPOSA CO.

TO L.A. GRANGE

TO L.A. GRANGE

PENON BLANCO L.O.

Surveyed By  
K.D. Gowans  
H.S. Hinkley  
University of California  
Agricultural Extension Service  
1964

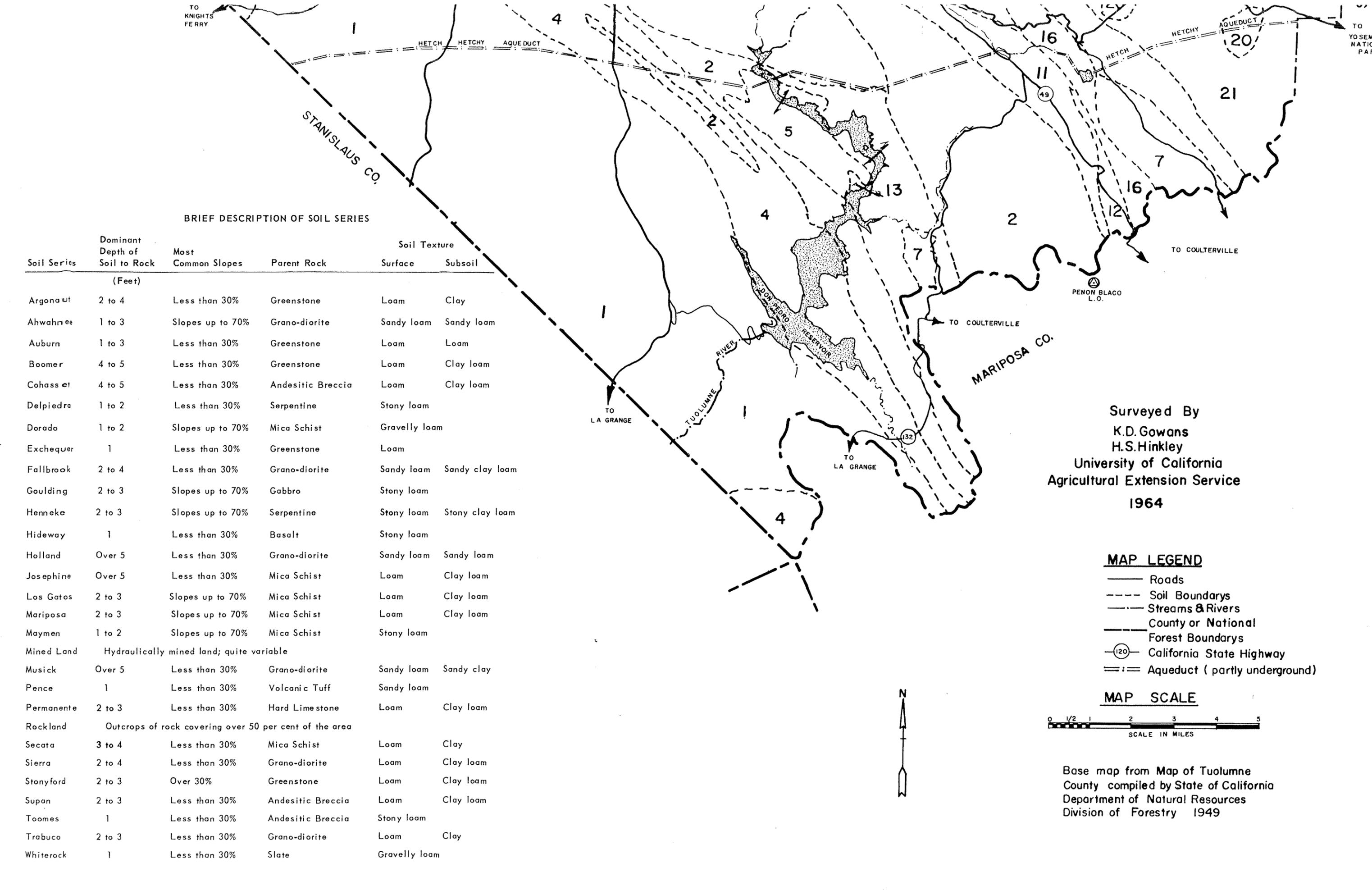
MAP LEGEND

- Roads
- - - Soil Boundaries
- · - · - Streams & Rivers
- County or National Forest Boundaries
- ⊙(120) California State Highway
- ≡ ≡ ≡ Aqueduct (partly underground)

MAP SCALE



Base map from Map of Tuolumne County compiled by State of California Department of Natural Resources Division of Forestry 1949



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- (3) email: [program.intake@usda.gov](mailto:program.intake@usda.gov).

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