GEOLOGIC REPORT ON A PORTION OF THE LITTLE TUJUNGA QUADRANGLE AND A PORTION OF THE SUNLAND QUADRANGLE

Report on an Area in the Fulfillment of
the Requirement of a Senior Thesis in
Geology

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INTRODUCTION

The area under investigation is in the north-west portion of Sunland Quadrangle and the south-west portion of the Little Tujunga Quadrangle, Los Angeles County, California. The maps used were the advance sheets of these two quadrangles surveyed in 1933 by the United States Geological Survey with a scale of 1:24,000 and a contour interval of twenty-five feet.

The area is reached by traveling westward along Foothill Boulevard from Pasadena through the town of Sunland and continuing along the boulevard approximately six miles past Sunland and then turning right on the road pointing to Kagel Canyon.

Specifically, the area is bounded on the south by the alluvium of Tujunga Valley, on the west by Lopez Canyon, on the East by Herrick Canyon, and on the north by the so called Sierra Madre Fault which give the fault contact between the Saugus sediments and the basement complex. The area is about three miles long (North-South) and two and one-half miles wide (East-West) giving a total area of approximately seven and one-half square miles.

The field work was done on occassional Saturdays and Sundays during the school year of 1936-1937. The purpose of the work is to gain a more thorough knowledge of geological field mapping and of the structural interpretation of field work results.

The work was done largely under the supervision of Dr. Francis Bode. His suggestions were very helpful. Mr. Richard Hopper's help was very valuable. Mr. Walter White, who covered the same area as partial fulfillment of his thesis for a Master's degree in geology offered many suggestions.

For reference, the paper, "Structure of the San Gabriel Mountains North of Los Angeles, California", by Mason L. Hill found in the University of California Publications in Geological Sciences, Volume 19, 1929-1931 was used as well as U.S.G.S. Bulletin 753 by William S.W. Kew.

PHYSICAL CONDITIONS

The greatest relief in the region is found north of the area investigated in the San Gabriel Mountains. In the area proper, the southern portion is the one of highest relief. To the north in the area the relief is only moderate.

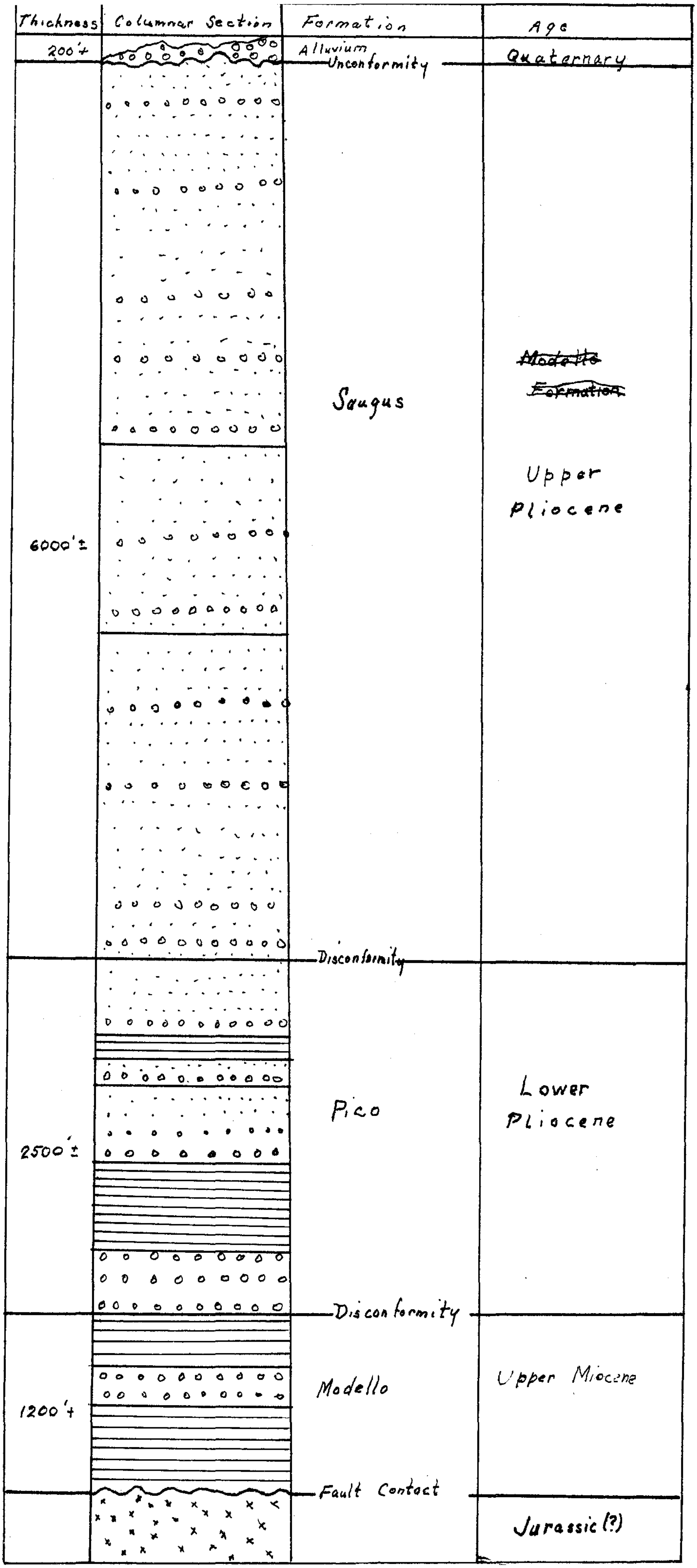
The principal drainage is through valleys running from north to south, with the drainage to the south. The principal drainage channels are Herrick Canyon on the east, Kagel Canyon in the middle, and Indian Canyon and Lopez Canyon in the west.

The outcrops are fairly abundant due to the semi-arid climate and to the fact that the formations are chiefly sandstones ad conglomerates which are not easily convertible into soil. The outcrops are particularily well developed in those portions of the area where the relief is the greatest

GEOLOGICAL CONDITIONS

Basement Complex

The igneous intrusive making up the large part of the San Gabriel Mountains, is regarded as Jurassic in age and as a part of the tremendous intrusives of that period found in the West Coast Region. Little work was done in the igneous rock. According to Kew (U.S.G.S. Bulletin 753), it is either agranodiorite or a diorite. Noticeable just north of the Sierra Madre Fault are several pockets of hornblendite cut by aplite dikes.



Thicknesses measured along ridge just E. of Lopez Canyon, except alluvium.

Age relations from Kew.

The hornblendite probably represents local accumulations of the once molten magma caused either by segregation or iron-rich wallrock material accumulated in the magma and recrystallized under high temperature conditions. The aplite dikes formed during the last stages of crystallization of the magma .

Modelo Formation

The Modelo Formation is Upper Miocene in age. In this area it ranges in thickness up to 1200 feet. On the south, it forms an unconformable contact with the alluvium of the San Fernando Valley and on the west and east, a disconformable contact with the Pico Formation. In the center of the area, the Modelo forms a fault contact with the Pico along the Kagel Canyon Fault.

The Modelo series is made up of two shale members with a conglomerate bed in between. The shale members are quite similar. They are white in color due, no doubt, to their diatomaceous character. They are thinly banded, and along the laminae planes some limonite staining is found. The shales are very fine grained and quite uniform in character throughout.

The intermediate conglomerate bed is separated by a disconformity above and below the two shale members. The conglomerate bed and the upper shale of the so called Modelo may really represent a portion of the Pico Formation. No fossils were found in either bed to settle the matter one way or the other. The reason for their being indluded in the Modelo is for convenience and because the two shale members are very similar in character, differing markedly from the shales in the true Pico.

It is likely that there are really two conglomerate beds in the Modelo which do not overlap, and whose relative position in the stratigraphic column cannot be accurately determined. West of Kagel Canyon Fault, one

PICO FORMATION

Formation	Columnar Section	Description
Saugus		
Pico		Sandstone and a few conglomerates. Massive. Light cream color
		Shaley sandstone. Gray and yellow, some shale lenses.
		Coarse grained sandstone Conglomerate at base.
		Conglomerate at the base. Gradational upwards into a medium-grained sandstone
		Arenaceous and limy shales. with some shaley sandstone. Gray-green to red-yellow.
		Coarse conglomerate, well cemented, igneous boulders, reddish color
Modello		

conglomerate bed is found. Tracing it eastward toward the fault, it becomes thinner and passes into a coarse sandstone. East of Kagel Canyon Fault, another conglomerate bed is found which has been folded. This conglomerate is similar in lithology to the one west of the fault, but it becomes thinner to the west. It is conceivable that the two conglomerate beds were laid down at approximately the same time; one with source material in the west and one with source material in the east, with the are under discussion a graben. It is not possible that the source material should be from anticlines with a syncline as a depositional area, since there is no noticeable angular unconformity between the conglomerate and shale members.

The conglomerates are rather coarse, sub-angular to rounded, and consist almost entirely of igneous boulders. They are well cemented and resistant to the forces of weathering. The igneous boulders are probably granodiorites judging by the dark mineral content and by the character of the feldspars.

Judging by their character and the fact that fossils have been found in them, the shale members of the Modelo are definitely marine. Because of its coarseness, grading character, lack of fossils, and color, the Modelo conglomerate is quite certainly a land-laid deposit.

The Modelo-Pico contact is a disconformity with no noticeable angular difference in attitude.

Pico Formation

The Pico Formation of Pliocene age is the most interesting one found in the area due to its varied character. The accompanying columnar section of the Pico gives an idea of this. Generally speaking, the Pico is well cemented and becomes coarser grained to the east. Shale members grade into arenaceous shales and then to fine grained sandstones, fine sandstones grade into coarse sandstones, coarse sandstones grade into conglomerates and conglomerates grade into coarse conglomerates. The maximum thickness is about 2500 feet, but in places it is cut down to less that half of that thickness due to the activities of the Nagel Canyon fault which will be explained under Geologic Structure.

A word should be said about the Pico shale with reference to its differentiation from the Modelo shale. The Pico shale is gray-green to yellow-red in color. Characteristically, the Pico shale is arenaceous in character, and is always coarser grained than the Modelo.. Platy laminae are not well developed in the Pico.

The lowest member of the Pico formation, the conglomerate bed, is difficult to distinguish from the so called Modelo conglomerates, litholgically. Color, boulder size, degree of cementation, and petrology of the boulders are very similar. One can differentiate by their position in the geologic column; the Modelo conglomerate is between two diatomaceous shale beds, and the Pico has a diatomaceous shale bed below it, stratigraphically, and an arenaceous, gray-green and yellow-red, shale bed above. Also, the Pico conglomerate is at least twice as thick as the Modelo. Finally, the Pico conglomerate is rather uniform in thickness, while the Modelo varies.

Except for the lowermost reddish conglomerate bed, the Pico is probably miarine judging by its well bedded and well cemented character, and its cream color. According to Kew, fossils have been found in the Pico. The coarseness and red color of the lower conglomerate indicate that its origin was probably non-marine.

Saugus Formation

The Saugus Formation of Upper Pliocene and Lower Pleistocene age is the thickest formation in the area, reaching 6000 feet. It too, forms a disconformable contact with the Pico Formation. The Saugus consists of poorly bedded, poorly cemented conglomerates and sandstones. Judging by its character, this portion of the Saugus is an alluvial deposit. No fossils are found in it. According to Kew, a portion of he Saugus is marine in origin. "The marine deposits are fairly well bedded and contain fossils at several horizons". In the central part of the Saugus in the area under investigation, bedding is fairly well marked and the beds are cemented to a fair degree. These beds are set off both in the map and structure sections. It is possible that they represent a marine phase in the Saugus. However, no fossils were found in them, ad their lithologic character is similar to the remainder of the formation. More probably, these cemented beds were laid down as alluvial deposits with a greater amount of lime (acting as a cement) than the rest of the formation.

The entire formation had a common source judging by the similar lithologic character of the beds. The sands and gravels are light, white to a light cream in color. Few dark minerals are represented. The source rock was a leucocratic granite or grancdiorite. Sub-angularity characterizes the condition of the sands and gravels. There is no definite arrangement of gravels and sands; tht is, gravels may grade into sands rather slowly or there may be a sharp break between the two. Also, the thickness of the different gravel and sand members varies rather widely.

Quaternary

Finally, there are the Quaternary gravels which ae divided into those gravels found in the bottom of the principal canyons draining the area, and those that are found on many of the ridges in the area. The latter are older, probably Pleistocene in age, ad were laid down when the present area was without its present dránage, but after the folding and patial uplift of the San gabriel Mountains had taken place. They form a sharp unconformity with the underlying formations and evidentally had their source from the igneous material making up a large part of the San Gabriel Mountains. The size of the boulders varies widely, from an inch to several feet. They are angular. The boulders are made up of material found in the igneous basement complex, coarse grained and melanocratic. Weathering has played its part, for there is considerable alteration particularily of the dark constituents to limonite ad hematite.

The alluvium found in the canyons is Recent in age. It is accumulating today, and started after the development of the present drainage system (Post early alluvium). Its lithologic character is very similar to that of the early alluvium, except that weathering has not been so active and its color is more nearly agray rather than the yellow-red of the early alluvium. The alluvium dips about nine degrees to the south. It ranges in thickness up to about two hundred feet.

GEOLOGIC STRUCTURE

REGIONAL

Regionally, the area is a block of sediments cut-off by a reverse fault on the north and a reverse fault on the south. These sediments are dipping about sixty degrees to the north and striking about N 75 W and are cut off in the north by a reverse fault dipping roughly sixty degrees to to the north and striking about N 70 W giving a fault contact with the basement complex. On the south, these sediments are again cut off by a reverse falt whose dip is unknown but whose strike is roughly N 80 W. This lower fault causes an unconformable contact between the sediments and the alluvium of San Fernando Valley. That is, an unconformable contact is visible on the surface for the fault itself is buried in the alluvium.

The northern reverse fault is known as the Sierra Madre Fault. The southern reverse fault is called the Foothill Fault.

The Kagel Canyon Fault traverses a portion of the lower part of the area. It also is a reverse falt, but its dip is roughly sixty degrees to the south. Along this fault there is strike-slip movement as well as reverse fault movement as will be explained under "Kagel Canyon Faulting".

The Merrick Syncline is the most prominent fold in the area. It is found just south of the Sierra Madre Fault and is largely a drag phenomenon. Well marked folding occurs in the Modelo formation giving rise to the Kagel Canyon Anticline and Syncline.

FAULTING

Sierra Madre Fault

Faulting can be said to be the dominant structural feature of the area. The outstanding fault is the Sierra Madre Fault which is a reverse fault causing the rise of the basement complex. The evidences of faulting along the Sierra Madre Fault are here given:

(1). Lithologic change - the Saugus sands and gravels are distinctly younger than the complex igneous rock against which they abut.

(2). Topographic evidence - the basement complex is definitely higher topographically.

(3). Drag phenomena - this is seen in the Merrick Syncline.

(4). Some gouge and slickensides is visible along the fault.

(5). Fault scarp relief due to movement.

Evidences of the reverse character of the faulting:

(1). Buckling of the sediments (Merrick Syncline).

(2). Absence of step topography sometimes found in normal faulting.

(3). Very prominent relief of the fault scarp.

(4). Overturning of sediments (seen just north of the Merrick Syncline).

Judging by the dipping of the sediments, the nature of the Kagel Canyon Fault, and the sharp overturn of the Merrick Syncline, the Sierra Madre Fault has a considerable horizontal component acting compressionally against it. The source of the compressional force is probably from the north-east as will be shown under "Kagel Canyon Fault".

The Sierra Madre Fault has definitely had recent movement along it. That is, a good deal of movement since Pliocene times. The evidences for this are given:

(1). According to Kew, the Saugus Formation is Upper Pliocene and Lower Pleistocene in age. Most of the uplift must have occurred since that time.

(2). Presence of a bold, steep fault scarp.

(3). Tilting of the Quaternary sediments as seen in Kagel Canyon.

Movement along this fault is probably in the nature of thousands of feet judging by the present height of the range.

Foothill Fault

The Foothill Fault along the south front of the foothill portion of the San Gabriel Mountains, is not visible, but its presence is based on the following observations:

(1). Remarkable straightness of the front of the foothill range.

(2). Relief of the relatively soft and easily eroded Modelo shales which make up the fore part of the foothills; that is, a fault scarp.

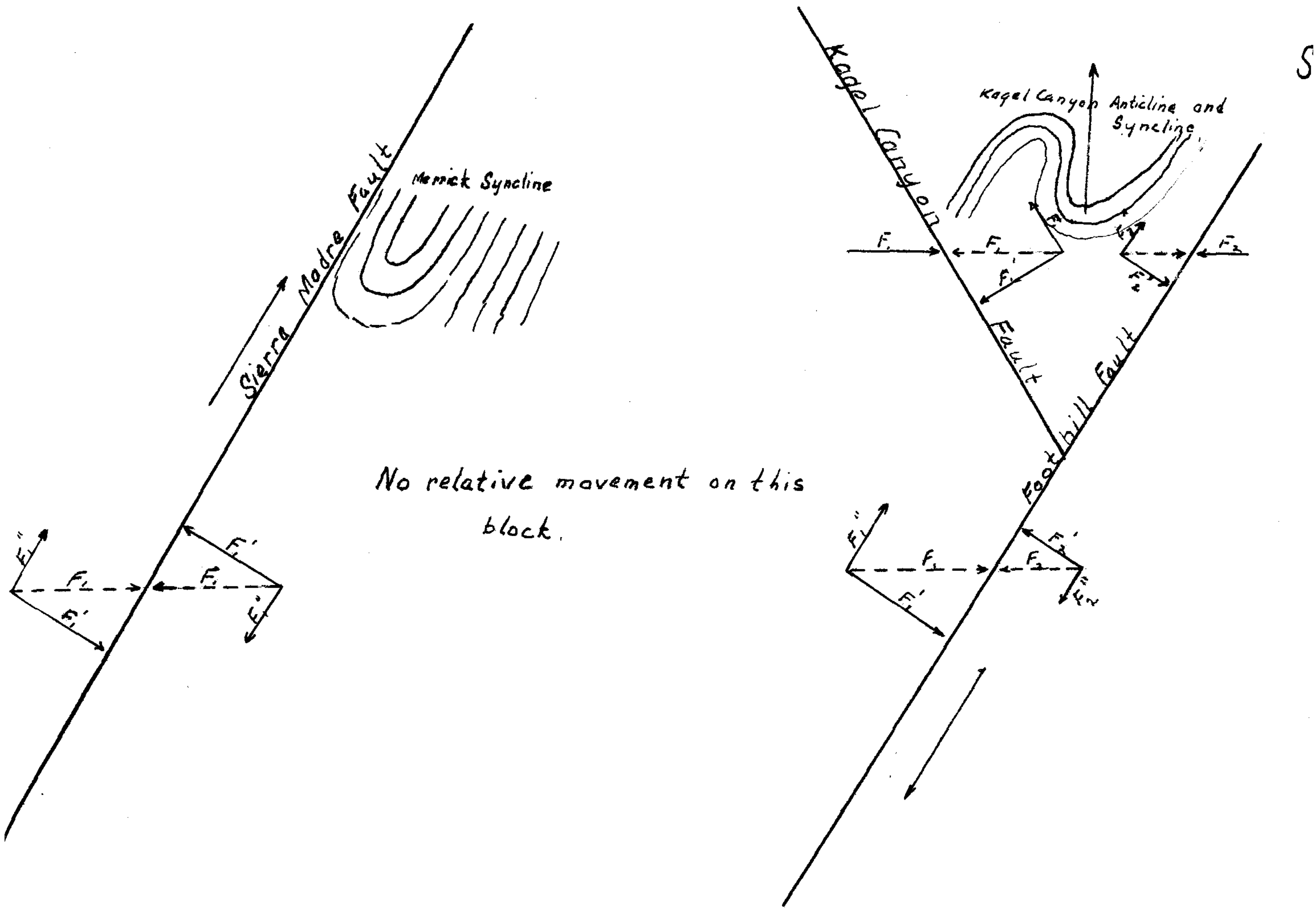
This Foothill Fault is possibly a reverse fault, but there is no real evidence proving this. The only reason for believing it to be a reverse fault is the fact that the Sierra Madre Fault, which is the dominating structural feature in the region is a reverse fault, and it seems likely that the great forces causing it would possibly give rise to ather reverse faults in the region.

The exact location of the fault is problematical. Mason Hill has it running several hundred feet south of the front of the foothills. The fact that there has been recent movement along the fault judging by the presence of the fault scarp in the soft Modelo shales, and the fact that there has been no uplift of any alluvium along the front of the foothills, leads to the belief that the fault is located very near the front of the foothills.

It is likely that there has not been a great deal of movement along Foothill Fault, because small hills of Modelo shales are found within a few thousand feet south of the fault. If there had been any great movement along this fault, the Modelo shales would have been deeply buried by alluvium.

Analysis of Forces Causing Faulting and Folding

Sectional Drawing



Red arrows represent resultant forces

Kagel Canyon Fault

The Kagel Canyon Fault is perhaps the most interesting feature in the area under investigation. It has an attitude of approximately N 70 E 60 S. The accompanying diagram is an attempt at a explanation of the forces involved. The Kagel Canyon Fault is a reverse fault with a likely strike-slip fault component. The vertical displacement is at least 600 feet; and, if there is no strike-slip component, at least 2000 feet.

Little need be said bout the reverse fault movement. The explanation of it is is shown in the diagram, page . The possibility of a strike-slip component is interesting and also likely. No close examination of the fault trace itself was made so slickensides evidence is not possible. However, displacement of the beds has taken place with accompanying drag effects as shown on the geologic map. This displacement and drag could have occurred with reverse faulting, but it is a point to consider. The chief evidence for believing that strike-slip faulting has occurred is the strike of the fault itself. Both the Foothill and the Sierra Madre Faults have a strike of about N 80 W, while the Kagel Cayon Fault has a strike of about N 60 E. If the strike of all three faults was the same, there would be little question as to whether or not any strike-slip faulting had taken place, for simple compression would then explain the Kagel Canyon Fault. Because the Kagel Canyon Fault is probably the sme age as the other two, since there is fair evidence that it cuts the Saugus Formation, its origin must be explained with reference to the major fault of the region, the Sierra Madre, and the Foothill Fault. By use of the strain ellipsoid and assuming a component of force from the north-east it is possible to account for a strike of N 60 E along the Kagel Canyon Falt. The horizontal displacement of the beds and the drag phenomena are added evidence in fsor of a strike-slip component.

Added evidence for the possibility of a strike-slip fault component along the Kagel Canyon Fault, is the Kagel Canyon Syncline and Anticline. With the relative movement south-westward of the south-eastern block, compression would result to cause folding in the relatively plastic Modelo shales. This evidence is enhanced by the trend of the folds. Near the fault, their strike is nearly northwest, and away from the fault, where less force was exerted, the strike swings around to north-west, and the intensity or tightness of the folding decreases away from the fault.

However, it is definite that a reverse fault component is present. That is necessary in view of the shortening of the Pico Formation as seen in the western portion of the area. Shortening of the formation was caused by the uplift of the block to the south of the fault with resulting rapid erosion. With the beds dipping to the north, this erosion meant the removal of some of the Pico Formation entirely. It also meant the thickening of the Modelo Formation as seen in the western portion of the area. The increase in thickness of the Modelo is not as great as at first seems by looking at the map, for an anticline and syncline found in this portion of the Modelo decrease the apparent thickness.

FOLDING

Merrick Syncline

The Merrick Syncline is found just south of the Sierra Madre Fault. In the area worked, it is rather difficult to see, because a good portion of it is covered over with alluvium. It is most clearly shown between Kagel and Lopez Canyons. Above the axis of the fold; that is, north of the fold, the Saugus beds are overturned. Evidence for this is found in the turned over old stream channels found in the Saugus just south of the Sierra Madre Fault. The dip of and plane of the fold is roughly north sixty degrees. The strike is as shown on the map.

The Merrick Syncline is an expression of drag phenomena found in sediments near faults, but drag alone could not account for a fold of this size in gravels and sands. The compression caused by the reverse fault plays an important part in the formation of the syncline.

Kagel Canyon Folds

The origin of this anticline and syncline was mentioned under the discussion of the Kagel Canyon Fault. It should be added tha the dip of the axial planes of the folds is about sixty degrees to the north. Near the Kagel Canyon Fault, the folds are tight, but they broaden out across Kagel Canyon, and disappear toward Little Tujunga Cnayon

Slumping in the Modelo Shales

Some slumping is seen in the Modelo Shales at various places in the area. This slumping is shown by a decrease in the northern sips of the beds from sixty degrees to forty nd thirty degrees.

HISTORICAL GEOLOGY

In Jurassic times, there was an intrusion of igneous material into old sediments that are no longer found in the area investigated. Possibly there was uplift along the Sierra Madre Faults, but this is pure speculation. However, there was uplift of some kind causing erosion of the old sediments which had probably been converted into schists and gneisses by the action of the intrusive magma.

Following uplift there was a long period of erosion and denudation and sinking of the area. In Upper Miocene times, the area was under the sea, and the Modelo diatomaceous shales were laid down. The intermediate conglomerate bed is probably land lad and represents a period of uplift in a nearby region.

After the deposition of the Modelo Formation, there was a period of slight uplift with some erosion, followed by subsidence and the marine deposition of the Pico Formation with no angular unconformity with the Modelo. The source material for the Pico was probably under frequent oscillation judging by the varied character of the sediments.

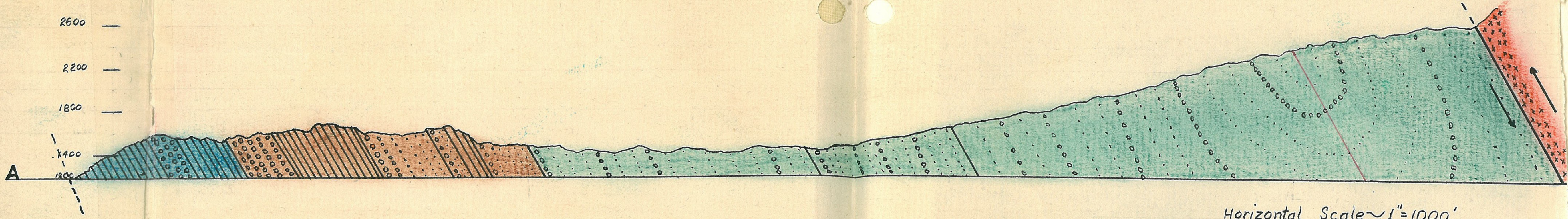
The non-marine deposition of the Saugus Formation followed, again with no angular undonformity with the Pico. The source rock was probably from the north, the old San Gabriel Mountains. They did not extend so far south as they now do, judging by the sub-angularity of the fragments and the presence of many relatively fine grained sandstones. It has been found that there is considerable thinning of the Saugus toward the San Gabriel Mountains as additional evidence for their source.

The sediments are probably from a leucocratic phase of the basement complex, for they have a very small percentage of dark minerals. The difficulty is the fact that the Saugus is a very thick formation and it is difficult to conceive of such a tremendous source of leucocratic material from the basement complex. Another difficulty is the fact that the basement had been subject to considerable erosion before the deposition of the Saugus with the removal ofthe top of the batholith where the leucocratic phase of an igneous mass is found.

Following the deposition of the Saugus, the entire region was tilted. The forces causing the tilting were regional in character since the tilting is a regional feature. Its exact nature is not known, but it is probably associated withtthe faulting in the region.

After the tilting, aperiod of erosion followed reducing the area to a penaplane. Old Quaternary gravels were then deposited on the area with the renewed activity on the faults. With uplift of the entire region, present stream channels were developed.

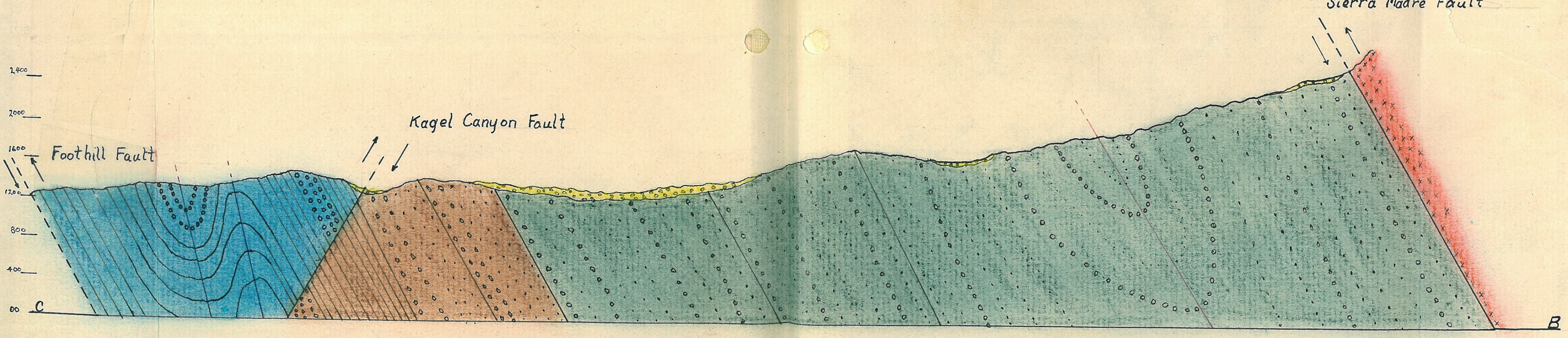
Deposition of the young Quaternary gravels probably did not begin before early Recent times. These gravels were deposited and are still being deposited in the principal canyons in the area.



Horizontal Scale ~ 1" = 1000'
Vertical Scale ~ 1" = 1000'

STRUCTURE SECTIONS

- Quaternary
- Saugus
- Pico
- Modelo
- Granite


Sierra Madre Fault
Kagel Canyon Fault
Foothill Fault
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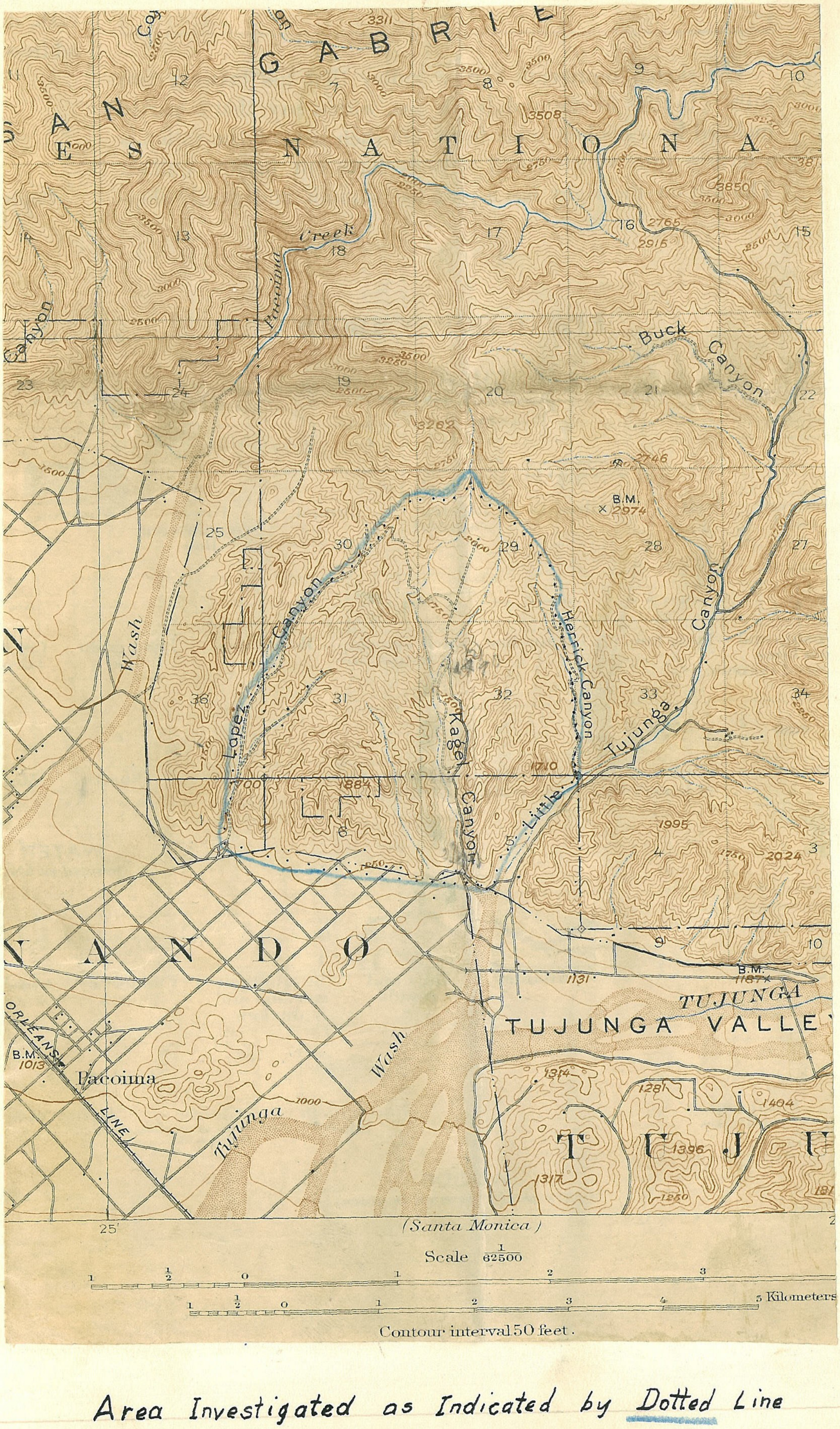
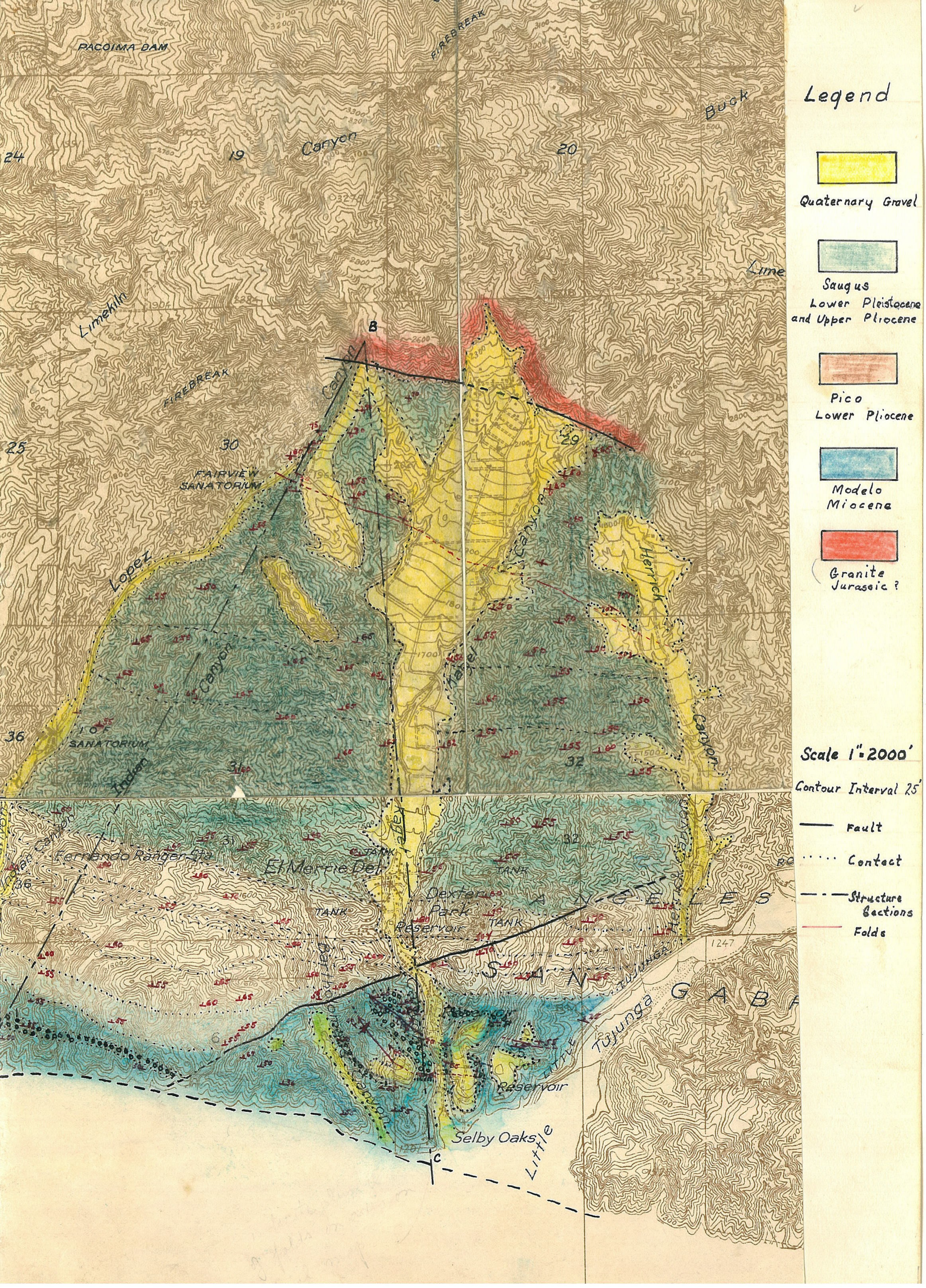


Area Investigated as Indicated by Dotted Line



Legend
Quaternary Gravel
Saugus
Lower Pleistocene
and Upper Pliocene
Pico
Lower Pliocene
Modelo
Miocene
Granite
Jurassic ?
Scale 1"=2000'
Contour Interval 25'
Fault
Contact
Structure
Sections
Folds
PACOIMA DAM
FIREBREAK
Canyon
Buck
Lime
Limekiln
FAIRVIEW
SANATORIUM
Lopez
Canyon
Indian
Kagel
Canyon
Herrick
Canyon
SANATORIUM
Fernando Ranger Sta
El Merrie Del
Dexter
Park
Reservoir
TANK
Reservoir
Selby Oaks
Little
Tujunga
B
C