G E O L O G Y O F P A R T S O F
The
P A C O I M A A N D S Y L M A R
Q U A D R A N G L E S

Geological Survey and report by

Melvin N. Levet

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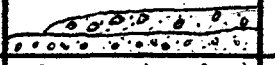
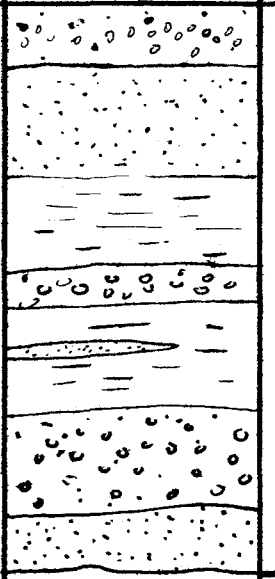
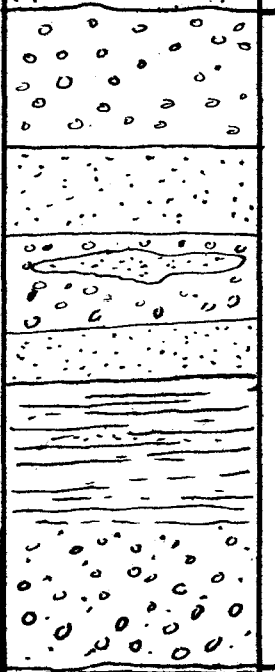
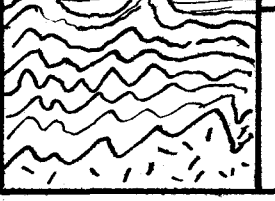
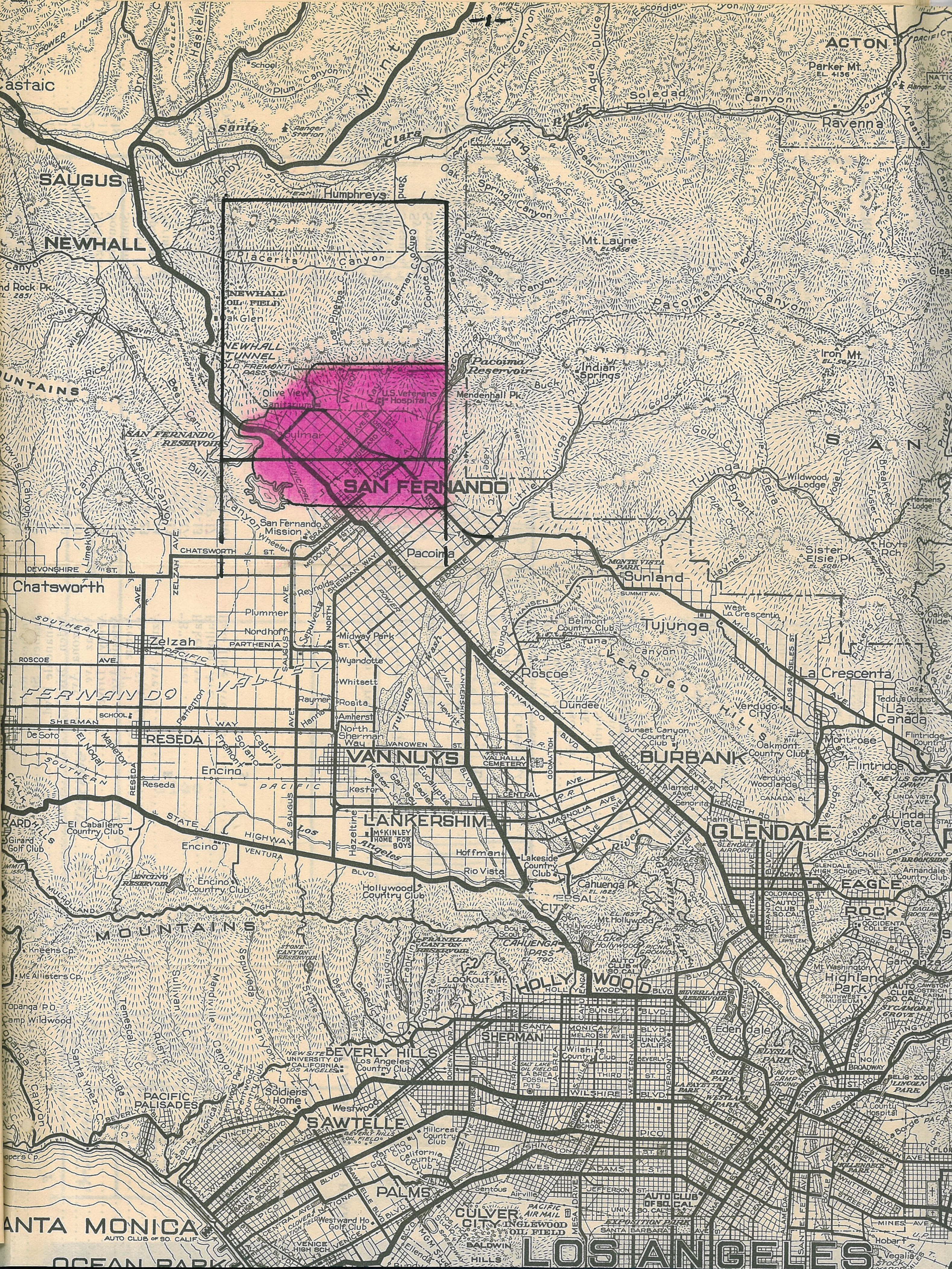
MAP OF LOS ANGELES COUTY SHOWING LOCATION
OF AREA

STRATIGRAPHIC COLUMN

Quaternary	Recent	terrace alluvium	Qt Qal		200 250	angular, unconsol.
S S	Upper Pliocene; Lower Pleistocene	Saugus	Ts		2200	arkosic, conglomerates, sandstones, unlithified, poor bedding
P A I	Lower Pliocene	Pico	Tp		3200	gray, brow, buff sandstones, brown conglomerates, well lithified, well bedded, blue sandstone lenses, fossiliferous
T	Upper Miocene	Modelo	Tm		300	well bedded paper shales.
Mesozoic	Pre Jurassic ?	Basement	bc		?	shists, gneisses limestone, granite


ACTON
Parker Mt.
Ravenna
Castaic
SAUGUS
NEWHALL
Soledad
Canyon
Humphreys
Placerita Canyon
NEWHALL OIL FIELD
Oak Glen
NEWHALL TUNNEL
Mt. Lukens
Pacoima Reservoir
U.S. Veterans Hospital
Mendenhall Pk.
Olive View Sanitarium
SAN FERNANDO RESERVOIR
Sylmar
SAN FERNANDO
San Fernando Mission
Pacoima
Indian Springs
Iron Mt.
Pacoima Canyon
Wildwood Lodge
Sister Elsie Pk.
Sunland
Tujunga
La Crescenta
Chatsworth
CHATSWORTH ST.
DEVONSHIRE ST.
Zelzah
Plummer
Nordhoff
PARTHENIA
ROSCOE
FERNANDO VALLEY
Midway Park
Wyandotte
Whitsett
Raymer
Rosita
Amherst
North Sherman Way
Roscoe
Dundee
VERDUGO HILLS
Verdugo City
De Soto
RESEDA
Encino
VANNUYS
VALHALLA CEMETERY
BURBANK
Montrose
Flintridge
La Canada
LANKERSHIM
GLENDALE
Reseda
El Caballero Country Club
Girard Golf Club
Encino Reservoir
Encino Country Club
VENTURA
BLVD
Hollywood Country Club
Hoffman
Rio Vista
Lakeside Country Club
Cahuenga Pk.
EAGLE ROCK
MOUNTAINS
Mt. Hollywood
Cahuenga Pass
Lookout Mt.
HOLLYWOOD
Highland Park
Topanga P.O.
Camp Wildwood
SHERMAN
Edendale
BEVERLY HILLS
Los Angeles Country Club
PACIFIC PALISADES
Soldiers Home
Westwood
SAWTELLE
Hillcrest Country Club
PALMS
CULVER CITY
SANTA MONICA
AUTO CLUB OF SO. CALIF.
OCEAN PARK
LOS ANGELES

GEOLOGY OF A PORTION OF THE SYLMAR AND PACOIMA QUADRANGLES

INTRODUCTION

Location of Area: The area discussed in this report lies in the southeast portion of the Sylmar quadrangle and the northeast portion of the Pacoima quadrangle, Los Angeles County, California. The area may be reached from Los Angeles by driving northward on U.S. Highway No. 99 as far as San Fernando, then turning north for three miles to foothill Blvd. (consult U.S.G.S. topographic map for roads leading directly into the area. From Pasadena the area may be reached by driving west on Foothill Blvd. through Sunland and Tujunga as far as the Olive View Sanitarium, a distance of about 22 miles from Pasadena.

General view of area looking north from the San Fernando Reservoir. Note erosional scarps of sediments at base of high San Gabriel basement complex in background. Saugus Formation in foreground.

Size of Area: The area is bounded on the north by the face of the San Gabriel Mountains from Rancho Sombrero on the west to the Pacoima wash on the east, a distance of about four miles. The eastern boundary of the area coincides with the eastern boundaries of the Sylmar and Pacoima quadrangles, a distance of about four miles. The southern boundary extends eastward from the lower Los Angeles Resevoir to the quadrangle margin, a distance of about four and a half miles. The western boundary joins the lower Los Angeles Resevoir and the rancho Sombrero. The total area studied for this report includes about 18 square miles.

Purpose of Investigation: The investigation of the area was carried out as partial fulfillment of the curricula for graduation in the course of Geology at the California Institute of Technology, Pasadena, California. The work, carried out and reported as a senior thesis was for the further purpose of acquainting the student with the various problems involved in a detailed Geologic study of an area, including problems in structure, problems, stratigraphy, and problems in palaeontology.

Method of Investigation: The investigation of the area was carried out by field work. Actual mapping was accomplished by walking of contacts--at the same time noting prominent stuctural features such as the attitudes of beds, folding, faulting, and stratigraphic relations. The general petrology of the rocks was also note. The palaeontological record of the Pico Formation was studied in as much detail as possible. Location was made by Brunten compass and U.S.G.S. topographic maps. The topographic maps were to a scale of 1/24000, having

a contour interval of 5 feet inthe San Fernando Valley and of 25 feet in the San Gabriel Mountains. The data mentioned above was assimilated into a detailed report of the area, including a geologic map and suitable profile views.

Culture: The dominant cultural aspects of the area are confined primarily to agricultural products. These products include a large annual production of olives, grapes, citrus fruits, and grain. Climatic conditions in the area render it an excellent spot for sanitarium patients. These institutions include the Olive View Sanitarium and the U.S. Veterans Hospital. Mining intersts in the area have not been developed to any great extent. Two talc mines have been previously operated, though their success is doubtful. Several oil companies hold leases on many acres of the northern portion of the San Fernando Valley. Due to the prime importance of water both for drinking and irrigation in Los Angeles County, cultural aspects include many developments along this line. These include the large San Fernando Reservoir, storage basin of the City of Los Angeles water supply. Minor water developments include small storage dams in Wilson Canyon, and in Pacoima Canyon. The area is readily accessible by state highways and forestry service roads, the latter being confined to the areas of higher relief for the purpose of forest protection.

Acknowledgements: The writer wishes to express his gratitude for the valuable assistance rendered by Mr. James DeLong Jr. in the classification of the fossil record from the Pico Formation; also to Miss Lora David for her classification

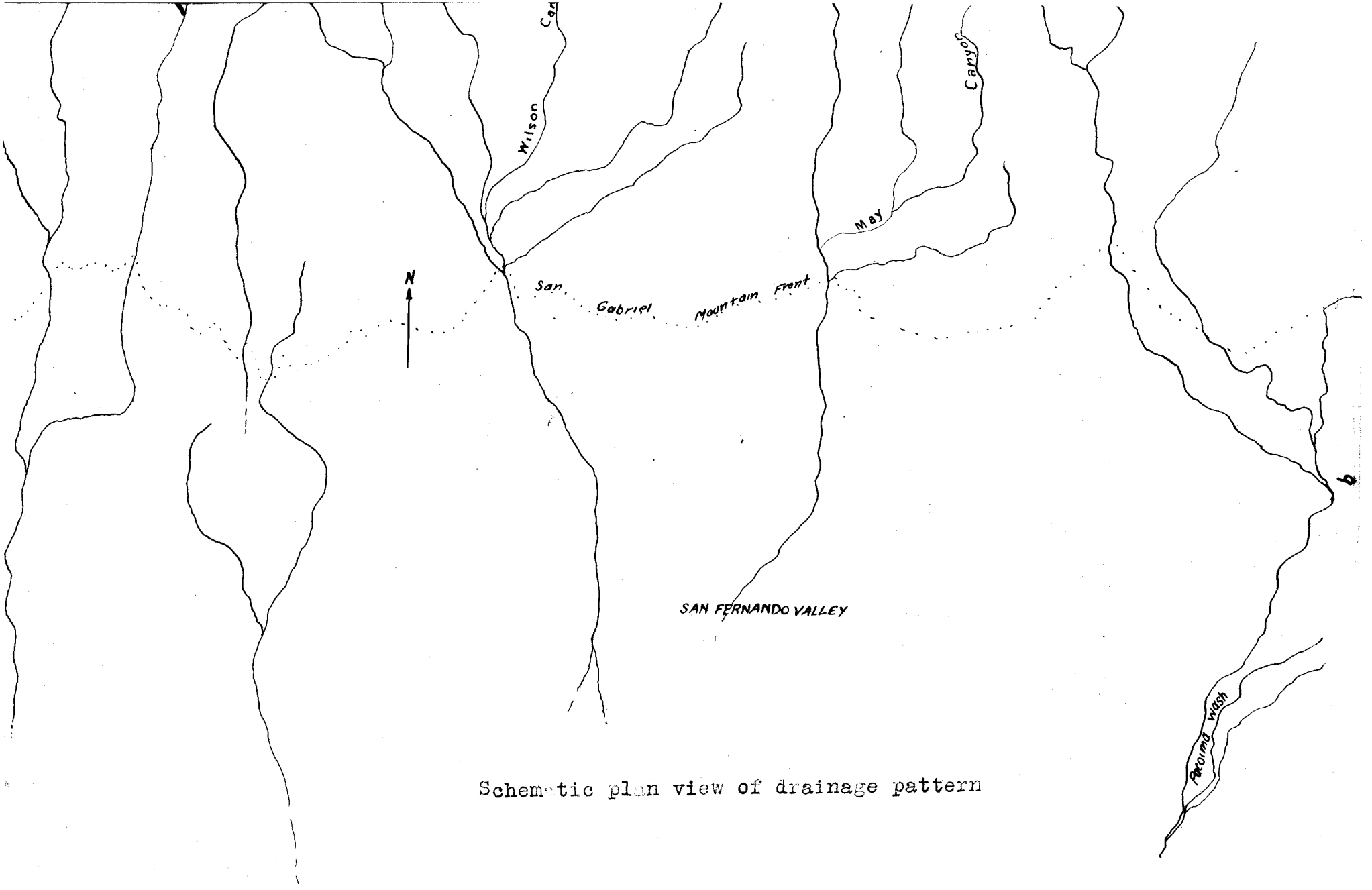
of the fossil fish remains found in the same formation. Further appreciation is extended to the Olive View Sanitarium, Veteren's Hospital, and Rancho Sombrero for their consent to allowing the writer to pass over their land. Mention should also be made of the willingness of the Forestry Service in opening their Los Pinetos Lookout road for the writer's use.

PHYSICAL CONDITIONS

Relief and Elevation: The area discussed in this report may be divided into two parts with reference to its relief and elevation. The southern part includes the north-eastern portion of the San Fernando Valley. This portion is a fairly flat and featureless valley sloping gently upwards toward the San Gabriel Mountains and broken only by rounded hills as for example east of the San Fernando Reservoir. The average elevation of this valley is about 1400 feet. The northern part includes the southern face of the San Gabriel Mountains. The elevations of this range approaches 3000 feet at the crest.

Topography: Except for the flat San Fernando Valley, the area embraces relatively rugged topography, typical of the San Gabriel Mountain Range. The canyons are all steep walled and exhibit streams of a very high gradient. The range extends from west to east attaining its greatest height to the east. A bad land topography has been developed in the eastern section of the area, being a direct result of the weathering inherent in the very loose and unlithified Saugus formation. Several excellent alluvial terraces are present giving rather broad bench-like surfaces that are relatively free from erosion. In general the topography may be said to be in a youthful stage.

Drainage: The area is typical of a semi-arid climate, having an average rainfall of approximately 15 inches. The drainage in the area is entirely toward the south and flows ultimately into the Los Angeles River, the only source of drainage of the entire San Fernando Valley. The drainage



Schematic plan view of drainage pattern

pattern is of the dendritic type, and is characteristic in the fact that it is not controlled by prominent structural features. A parallel arrangement of the larger streams is further evidence of the minor structural control in this area. These larger streams all flow southward. However, one phase of structural control has been noticed as affecting one of the larger streams, this control being due to the Sierra Madre fault, an east -west fault giving rise to a portion of the elevation of the San Gabriel range. This fault has changed the course of one of the streams into a nearly east-west running one with a complementary east-west striking ridge. This is a common feature along faults of this type.

View looking west giving a sky line idea of the topography prevalent in the area. Saugus exposures in rolling hills in the foreground.

Vegetation:: No mention will be made of the vegetation in the valley portion of the area since it is practically all cultural. In the lower reaches of the mountainous area, the vegetation includes a very thick growth of greasewood, buckhorn, sumac, and sage. The higher ridges show a gradual giving way of the scrub growth to larger trees such as oak and fir. The canyons which are moist nearly the year round support a growth of oak trees and sycamore trees. In general the vegetation of the area is typical of all the lower areas of Southern California.

View showing typical types of vegetation in the area--brush predominant on the hill sides, larger trees common in the valleys. Wilson Canyon.

Exposures: Exposures in the area are limited to well weathered ridges and stream cut canyons. Because of the type of climate, advantageous to profuse vegetation and rather rapid erosion, the mountain slopes and steeper slopes tend to be covered with a very thick blanket of mantle. An excellent exposure of the Modelo Formation, Pico Formation, and Suagus Formation is present on a series of north-south trending ridges

along the east boundary of the area. Here the sequence of interformational beds is easily distinguished (to be discussed in more detail under Stratigraphy and Petrography). Several reefs of gray limestone, occuring in the Pico Formation, are well exposed in the area just north of the Rancho Sombrero. Several road cuts within the area have rendered rather good exposures, though in a limited sense. The best exposures in the area occur in the basement complex, in which erosional processes tend to leave clean cut steep walls, especially toward the bottom of the canyons.

Exposure of the Pico Formation on North-south trending ridges in the eastern portion of the area.

View of exposure of Pico Conglomerate. North of Olive View Sanitarium.

Photo illustrating Bad Land Topography occurring in the Pico Formation. Note attitude of beds clearly discernable. View west of Pacoima Wash.

GEOLOGIC CONDITIONS

Regional: The rocks in the area fall into two classes: a metamorphic and granitic complex, and a sedimentary series. The metamorphic series has not been differentiated except for a few prominent limestone lenses. The metamorphic rocks are all of pre-Jurassic age (correlated with equivalents) and have been intruded by granite that is probably the same age as that of the Sierra Nevadas, which is considered to be late Jurassic or early Cretaceous.[1] The sedimentary rocks form the greater percentage of the area and range in age from upper Miocene to recent. They comprise the Modelo Formation (upper Miocene), the Pico Formation (loer Pliocene), the Saugus Formation (upper Pliocene and lower Pleistocene), river terraces (upper Pleistocene and Quaternary), and alluvial deposits (recent). Their lithology shows a great diversity in types of sandstones, shales, conglomerate and limestone horizons. The only fossil record occurred in the Pico formation.

Local Geologic Conditions: Stratigraphy and Petrography:

GRANITIC AND METAMORPHIC ROCKS

The granitic and metamorphic rocks in the area have not been differentiated, except for two small limestone beds which show clearly the attitude of the metamorphic series and subsequent alteration effects of the Jurassic granitic members. The Basement Complex, as this association is termed, is made up of various granitic and metamorphic rock types. The metamorphic rocks consist of interbedded shists, quartzites, slates, and limestones. They make the greater

portion of the San Gabriel range face and show a degree of local folding and faulting. Shistosity planes are prevelent and dip strongly to the south with a north-east--south-west strike. The metamorphic rocks have been intruded generally by granite, probably a granodiorite. Numerous pegmatite and aplite dikes are present. The relations of the metamorphic rocks and granitic intrusives and their probable ages has been worked out by Miller in his Geology of The Western San Gabriel Mountains. He has referred to the series in general as the San Gabriel Formation which includes the Placerita metasediments and various intrusives of different compositions. The ages of the formations have been placed as Paleozoic or older, with the best evidence indicating their pre-Cambrian age. Miller has referred to the shists as belonging to the Pelona shists, described by Hershey (Some Crystalline Rocks of Southern California. Am. Geol., vol29: 273-290). The limestone lenses he believed to be a portion of the Placerita metasediments, almost certainly of pre-Cambrian age.

The writer of this report, however, has found no evidence substantiating the presence of two series of metamorphic rocks (Pelona shists and Placerita formation indicated above). All of the limestone found in the area is without any doubt interbedded with the series of metamorphic rocks, indicating their being of the same age. The writer believes that the limestones and metasediments are all a part of the Pelona shists, probably of pre-cambrian age. As mentioned above, the later igneous intrusions, because of their similarity to the Sietra Nevada granites have been placed as late Jurassic or early Cretaceous.

MODELO FORMATION

The type section of the Modelo formation lies north of Santa Clara valley in the vicinity of Modelo Canyon. Here are found two shale and three sandstone members. Only one very small exposure of the Modelo formation occurs within the area here deiscussed. This occurance is in the south east portion of the region. In general lithology, the Modelo formation is quite characteristic and easily differentiated from the other formations. It is composed chiefly of well bedded shales with sandstone lenses, often course or even conglomeratic. The shales are mostly silicious and argillaceous, and are very finely bedded giving the typical appearance of paper shales. The shale weathers to a gray-buff color, forming a brownish, loose soil. The soil supports a rather dense growth of short grass, quite in contrast to the brushy growths associated with the Pico, Saugus, and alluvial soil. Many zones of light buff to yellow colored layers of chert occur lenticularly. These lenses break down into small rectangular fragments which are controlled by indistinct bedding. A small bed of petroliferous shale of about ten feet in thickness was observed at BM 1152 in the south eastern portion of the area. This rock is a gray-brown color and is finely interbedded with yellow sulfurous laminae. The rock is finely granular and weathers into relatively prominent reefs, as compared with the more easily disintigrated shale members. No fossil record was observed within the area.

The age of the Modelo formation has been placed as upper Miocene. This is based upon the fact that the basal sands of the formation in the Santa Monica Mountains show a

meagre fauna characterized by Pecten raymondi Clark, an upper Miocene species not recognized in strata older than the San Pablo formation (Upper Miocene) of the San Francisco Bay region. Further evidence in the same direction is found in the fact that occurences of the Modelo in the Santa Monica Mountains rest unconformably upon the Topanga formation which is supposed to be of middle Miocene age.

The base of the Modelo formation was not observed within the area, so its relations with older rocks cannot be determined. The general attitude of the formation is of a general east-west strike and of a 25-30° north dip. The maximum thickness of the exposure is about 310 feet.

Conditions of Deposition: From the known extent of the Modelo formation and its uniform character of thinly bedded paper shales, it is probable that the deposits were laid down as off-shore deposits in shallow, quiet, marine waters. Probably the formation occurred independently of any delta environment, since no cross bedding was evidenced and the materials are finer than those usually associated with delta forms.

View showing Modelo-Pico contact; taken perpendicular to strike. Note coarse character of Pico, and and well bedded, fine character of Modelo

PICO FORMATION

The Pico formation, named from its type occurance in Pico cahyon, is the most widely distributed formation within the area. The age of the formation has been placed as lower Pliocene as indicated by its fossil record, which is quite complete. The relation of the Pico with older rocks is diverse within the area. In only one locality does the formation overlie rocks of immediately older age (Modelo, upper Miocene). This locality is in the southeastern portion of the area east of Pacoima Wash. A distinct change in depositional conditions is in evidence at this contact. The lower member of the Pico formation is a course, red-brown conglomerate of continental origin, while the Modelo formation consists of finely bedded shales of marine origin. No definite evidence of an unconformity is present with the exception of the attitudes of the two formations. The Modelo dips northward at about 30°, while the Pico dips northward at about 55°. This locality is interesting since it shows the most complete range of deposition and stratigraphy of the Pico within the area. Attaining a thickness of 3200 feet, the individual members show a high degree of variance in depositional conditions. The horizon was probably a portion of a continually unstable off-shore sea floor as seen from the many changes from shallow to deeper water deposits. A detailed study of the stratigraphy showed the following depositional sequences:

Modelo Formation (Upper Miocene)

Unconformity----------

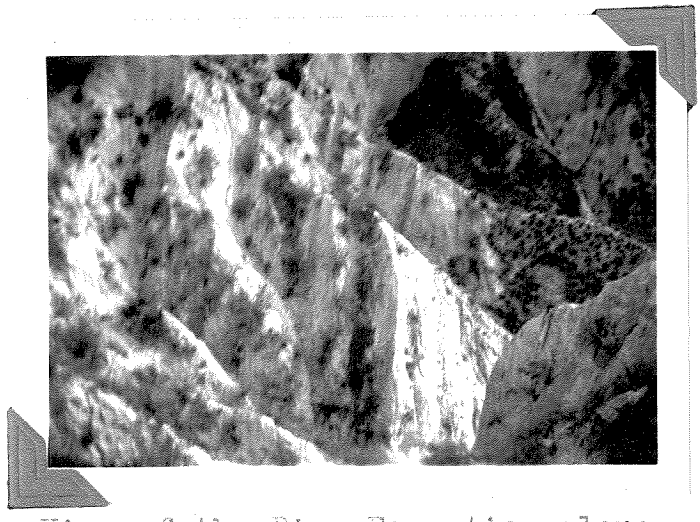
Pico Formation (Lower Pliocene)

560 feet heavy, course brown conglomerate, well consolidated
90 feet finely laminated yellow shale
130 feet heavy brown conglomerate
45 feet finely laminated yellow and brown shales
150 feet massive, heavy conglomerate
360 feet yellow, brown, gray interbedded shales
350 feet interbedded conglomerate, shales, sandstones
75 feet massive white sandstone
500 feet ?
130 feet gray and white loose sandy shales
90 feet massive yellow sandstone
120 feet loose white sandstone and conglomerate
90 feet well-bedded gray shale
150 feet interbedded coarse sandstone, yellow conglomerate, massive sandstones, and Well rounded white arkosic conglomerate.

Unconformity----------

Saugus Formation (Upper Pliocene, Lower Pleistocene)

The stratigraphic members here listed showed a marked continuity from ridge to ridge, where the outcrops were freshest.



View of the Pico Formation along strike showing continuity of beds.

A second large exposure of the Pico occurs as a depositional deposit on the basement complex in the north-west section. The nature of the contact is very irregular, showing the presence of many high points in the old basement complex surface, as well as numerous examples of stream channel filling. The westernmost exposures show a marked tendency toward the capping of what are now ridges in the present system of relief. From a study of the nature of this contact, it is evident that the present San Gabriel range had a certain amount of relief previous to the Pliocene, quite in line with the irregular archipelego conditions then present. The nature of the Pico in this area is not nearly so complete in a stratigraphic sense as in the previously mentioned exposures. The rocks are of a much more massive character, with the consequent obscurance of attitudes. Sandstones of buff to yellow color and weathering to a rust brown are common. These rocks are very poorly lithified and erode very rapidly. There is a considerable amount of a massive, well consolidated conglomerate composed of well rounded pebbles and bowlders. The conglomeratic horizons weather in steep cliffs and are characteristic in their rust brown color. Several light colored sandstone beds showing cross bedding occur near the north contact of the exposures. In the western section particularly, is a prominent bed of gray sandstone that is very well lithified. This bed, in places, tens of feet thick, assumes a reef like like appearance. It is in these beds that the majority of the fossils were found. In addition to the rock types just mentioned, is the occurance of several large

lenses of blue sandstone very well lithified, massive, of uniform testure, and prolific in its fossil record. The conditions of deposition of a good part of this section was non-marine, material aggregating as channel fillings, alluvial fans, and outwash plains. The few marine horizons are mainly shallow water types, including delta formations and materials collected in small bays.

A characteristic feature of the Pico formation, and also of the Cenezoic deposits, is the occurance of many limonite concretions. These concretions range in size from a few millimeters in diameter to some having a diameter of a foot or more. The nodules are usually much harder than than the host material, and hence stand out prominently on erosion surfaces. The limonite stains derived from the concretions is often sufficient to discolor the bulk of the host or matrix material.

A third occurance of the Pico formation is in the south western portion of the area, just east of the San Fernando Reservoir. The Pico here is composed mainly of thin, well bedded shales of rather silicious and sandy character. The shales are light gray to white in color and weather to a tan or buff color. Interbedded with the shales are several beds and lenses of a very hard, yellow-white chert that stand out as narrow reefs. These beds are so much more competent and resistant to erosion than the associated shale members, that they offer an excellent means of tracing the exposures. The thickness of the chert beds amount to about 15 inches. In addition to the chert, there is a general interbedding of diatomaceous earth that weathers to a chalky white. The only fossil record found in this

locality were the remains of a sea-bass belonging to the family Serranidae.

Conditions of deposition of this section of the Pico were relatively stable, occuring in moderately shallow water along the continental bench.

General conditions of deposition: During the Early Pliocene, an archepelego condition was in evidence along the California coast. The channel Islands are today a remnent of this feature. Deposits were laid down heterogeneously and with minor extent. Many high points and low areas were present, exposing a surface of moderate relief. These conditions, with the addition of an unstable marine condition, resulted in a series of discontinuous or isolated marine and non-marine beds. Extensive transportation of material took place, resulting in the presence of an abundance of well rounded pebbles and, strangely enough, an abundance of residual limonite. Subsequent dynamic conditions created a well lithified group of sediments.

General Fossil Record of The Pico:

Marine fossils were found in several localities, most of them being restricted to a gray to blue group of well lithified sandstone beds and lenses. A few remains (casts) were found in the less well consolidated light colored silts. The localities referred to in the Occurance Chart are as follows:

Locality P1: South side of NW-SE trending ridge 1100 feet due north of turn in Edison Co. Transmission line, which is N5°W of Olive View Sanitarium. Elev. 1800 ft.

Locality P2: Crest of ridge 0.9 miles N5°W of

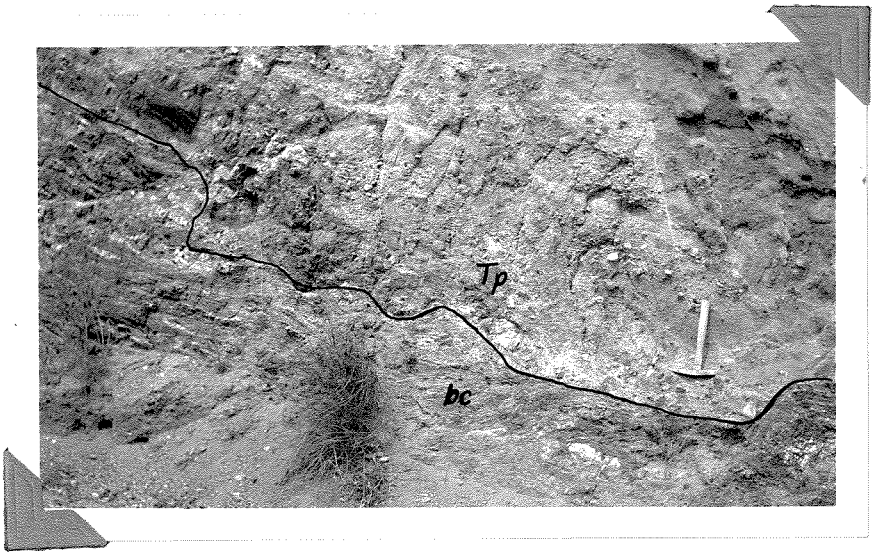


Photo showing unconformable depositional contact between the basement complex and the Pico formation. Note irregularity of contact,

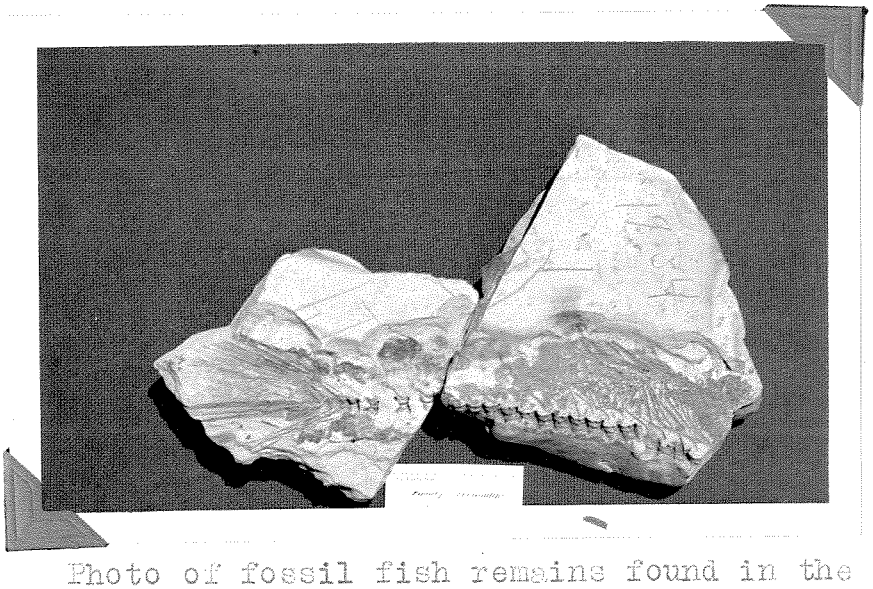


Photo of fossil fish remains found in the Pico shale member. Family Serranidae.

View of Pico Shale member, east of San Fernando Resevoir. Taken at axis of anticline; note slight plunge of fold toward observer.

Exposure of Pico east of Pacoima Wash. Note local unconformity in central portion of view. Saugus exposure in right center

Locality P2 (cont.): Olive View Sanitarium; 500 feet north of x2536.

Locality P3: Sandstone beds 100 feet east of 2536 (see locality P2).

Locality P4: Blue -gray sandstones 750 feet north of 2536.

Locality P5: 2500 foot contour, on west slope of small knob of ridge north of 2536 (same ridge).

Locality P6: 1000 feet north of north tip of basement exposure, which is just east of fault b. N/ corner of area.

Locality P7: Directly under turn in Edison Co. Transmission line, north of Olive View Sanitarium.

Locality P8: East end of Lower San Fernando Resevoir Dam.

The fossil localities showing the most varied types of fauna were P1 and P4. The fauna of the Pico formation includes the Lower Fernando fauna and Middle Fernando fauna as listed by Eldridge and Arnold in 1907[1]. The fauna listed below is a compilation of the species collected by the writer. The number of species listed is not, in most cases, the total number found. The more common varieties may be seen from the numbers of species.

1 U.S. Geol. Survey Bull. 309, pp. 24-25

FOSSILS FROM THE PICO FORMATION

	P1	P2	P3	P4	P5	P6	P7	P8
Pelecypoda:								
Arca trilineata Conrad ...	1	1		8				
Corbula sp	2							
Clementia sp		1						
Dosina cf poderosa Gray, var. Jacalitosana Arnold....					1			
Laevicardium sp...				2				
Lucina acutilineata Conrad....	11	7		2		11		
Lucina excavata Carpenter...				1				
Mactra cf hemphilli Dall.....	2							
Macoma cf secta Conrad..				1				
Mytilus sp				2				
Neventa reclusia Deshayes...	1	2	1	5		2		
Pectin sp							1	
Pectin cf purpuratus Lamarck...		1		5	1			
Salen sicarius Gould.....						1		
Veneridi sp	2							
Venus sequris Shumard, var. Fernandoensis English....			1	1	1	1		
Gastropoda:								
Astraea cf grodata Grant, Gale..				2				
Calliostoma canaliculatum Mottyn...						1		
Crepidula princeps Conrad.....		1						
Neptunea so.....					1			
Neverita seclusiana Deshayes....				11		1		
Turritella cooperi Carpenter...	1			11				
Vertebrate Fauna:								
Serranidae..... (family)								1

SAUGUS FORMATION

As described by Hershey (Am. Geol. vol. 29 1902), the Saugus fomation consists of a great series of unlithified sand, gravel, and clay. Physical characteristics are unmistakeably those of alluvial deposits and river deltas progressively sinking. The type locality is Soledad canyon near Saugus.

Three exposures of the Saugus formation are present within the area. These exposures occur in the same general localities as the Pico formation, though onlt one of the exposures shows depositional continuity. This locality is in the southeast portion of the area, east of the Pacoima Wash. Here the beds of the Saugus are apparently conformable with the underlying Pico members. The formation is of upper Pliocene and lower Pleistocene age and shows a much more stable type od deposit than the Pico. A marked change in the rock type is inherent at the contact; changing from a well bedded, well lithified non-marine formation (Pico), to a very loose, massive arkosic sandstone and conglomerate. This occurance of the Saugus formation shows a series of poorly bedded course sandstones, and well rounded medium conglomerates. All of the members are distinctly arkosic and hence yield very light colored exposures that often show a light pink shade. The type of erosion is quite in contrast with the underlying Pico, usually resulting in a "bad land" topography. Vegetation is rather sparse while on the Pico a thick growth of brush is supported. The maximum thickness of the Saugus is here about 2500 feet, as estimated from the surface not obscured by mantle.

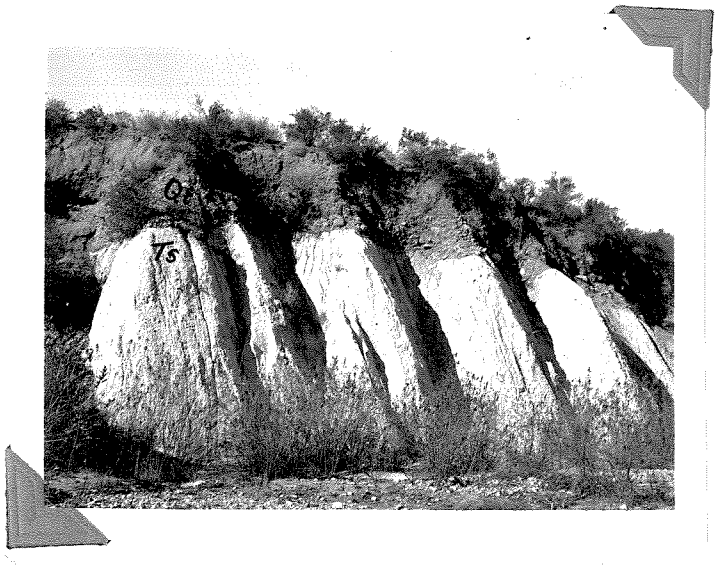
The second exposure of the Saugus is just north of the Olive View Sanitarium and occurs as a down dropped normal fault block against the Pico. The character of the formation here is quite in contrast with the previous locality. The material is of a later age, probably lower Pleistocene. The material strongly resembles the more recent pleistocene terrace deposits, having a very course and unlithified assemblage of angular fragments of granite, pegmatite, aplite and various metamorphic types. The basis of distinction from the terrace deposits is made upon the attitude of the beds. In general, the terrace deposits are nearly flat, having suffered little or no tilting or folding, except in the vicinity of the Sierra Madre fault, where a little drag folding is in evidence. The Saugus member is tilted quite steeply to the South, indicating an age somewhat older than the terraces.

The third locality where the Saugus exposures are present is in the vicinity east of the San Fernando Reservoir. Here again, the contact is a fault contact by which the Saugus has been normally faulted down in contact with the Pico. The thickness here has a maximum of about 2700 feet. The relief of the section is small, giving rise to a gentle rolling topography. Hence it is that exposures are nearly alw ays obscured except in places where road cuts are present. The nature of the material in this area is highly variable. The lowest portion of the section shows a course brown, well rounded and lithified conglomerate slowly giving way to a series of light colored loose sandstones and medium arcosic conglomerates. Several dark beds of petroliferous sandstone are present that stand out in moderate relief. Toward the upper

portion of the section, the semi-sorted material gives way to an angular conglomerate of unlithified character, quite similar to the material found north of the Olive View Sanitarium.

The general conditions of deposition of the Saugus members was continental. A few marine members have been found, but they are restricted to the west end of the San Fernando Valley. Material was deposited relatively near its source, as seen from the great amount of arkosic material and unsorted conglomerates that are present. During the deposition of the formation, conditions probably changed topographically giving rise to a series of less well sorted material of courser and more angular charecter. This topographic change in all events must have been such to have brought the source of material much nearer the region of aggregation. Deposition of the older portion (upper Pliocene) section occurred on broad outwashplanes, while the younger material (Lower Pleistocene) aggregated as alluvial fan or fanglomerate deposits.

Photo showing Saugus-terrace contact. Note steep attitude of beds.



Saugus-terrace contact. Note design of weathering of the Saugus.

TERRACE FORMATIONS

The presence of terrace deposits throughout Southern California is a general and common feature. Due to successive uplifts and tilting of the Southern California block, these deposits have been exposed and show an aggregation of material quite different than the recent alluviums. A considerable portion of the area discussed here is covered by such deposits. Two ages of the terraces are apparently present, though their differentiation has not been accomplished in detail. The older terraces are upper Pleistocene in age and are present in the higher reaches of the foothills bordering the San Gabriels. They have been reduced considerably to a well eroded surface, and show moderate relief. The occurrences to the west still show an excellent beach like topography and the only effects of erosion have been to produce shallow, box-shaped canyons of a very straight nature. The maximum thickness of this member is about 200-250 feet. The younger member of the terraces is probably recent in age and is much more youthful in its stage of developement than the previous deposits. The material is relatively featureless and occurs as a broad fanglomerate on the upper portion of the valley floor. A primary dip is present that is approximately equal to the slope of the broad fan. The maximum thickness of these terraces is not more than 75-100 feet.

The material present in both members of the terraces is very similar, being composed mainly of unsorted, unlithified, angular fragments from the San Gabriel Mountains. Several sandstone lenses are present, typical of sand-bar formations on a fluvial surface. Conditions of deposition of the terraces

were relatively simple, being chiefly as a result of fanglomerates, coelescing alluvial fans, and stream channel fillings. The source of the material was very near, probably never exceeding a few miles in distance. In general, the Pleistocene terraces show a deeper dip than the nearly horizontal recent terraces, evidences of an unconformity between the two has been difficult to find, except on this basis.

View showing general character of the terrace deposits. Note heterogeneous character and angularity

View showing bench like topography of terraces toward the western exposures Alluvium in foreground

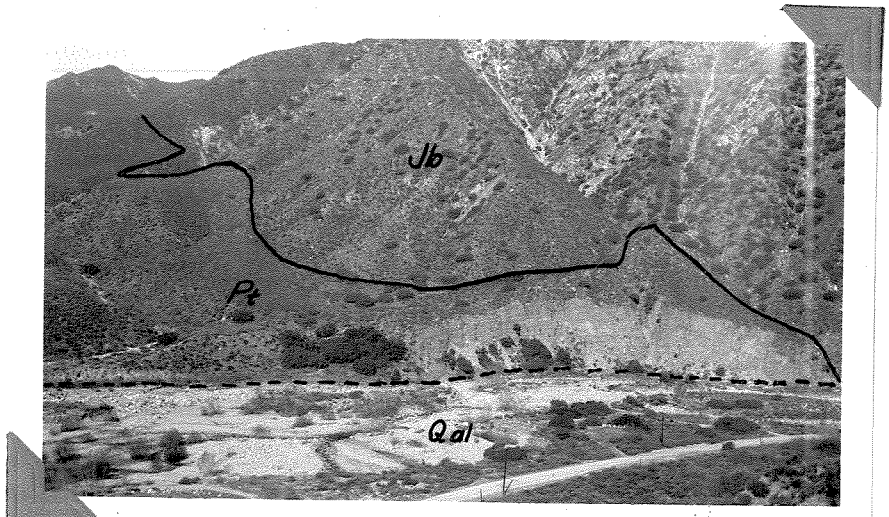


Photo showing relations between basement, terraces, and alluvi l deposits. From Pacoima Canyon

Photo showing level bench like terrace East of Olive Sanitarium

ALLUVIUM

The recent alluvium of the area is considerable in extent, arising mainly from the San Gabriel range, with minor quantities finding a source in the hills of the Pacoima Wash. The material is extremely varied in its range of size and degree af decomposition. Occurances are restricted in the north section of the area to stream and river washes, while to the south, these fluvial sources coelesce giving rise to general and wide spread deposition of material. The maximum thickness of the alluvial material probably does not exceed 200-300 feet. The more uniform aggregations of the recent alluviums have been profitably worked by sand and rock companies in their search for suitable building materials.

GEOLOGIC STRUCTURE

Regional: The structure is typical of the California Coast ranges, comprised of a series of more or less parallel folds. Ths structural axis of the region is nearly east and west, being reflected in the topography. Deformation occurred in late geologic time. Tertiary and pleistocene beds have been folded almost as much as older beds. A deformation period took place after the Modelo , and during the Pleistocene. Folding and faulting was not simultaneous. Earthquakes indicate that the deformation is still in progress. General tilting of the Southern California block prevents drainage directly to the ocean, with consequent drainage to the south east.

Local: The Geologic structure of the area included in this report can be divided under three main headings: attitudes of formations, faulting, and folding. The metamorphic series of the basement complex shows a general tendency toward a north west strike and moderate south dip. Local conditions of folding have resulted in general obscurance of this attitude in many places, but in the canyon just east of Rancho Sombrero excellent exposures of the metasediments are available. Intrusion of the later granitic rocks have contorted the old series to a great extent, and have introduced secondary metamorphic effects upon the metasediments. These effects are chiefly in the vicinity of the limestone members and include such contact metamorphic minerals as garnets, and diopside. The presence of a rather large serpentine dike was of importance primarily because of its discontinuity pointing out one of the faults of a series of step faults, to be discussed later. The dike, striking east-west, dips slightly to the north and has a thick-

ness of about thirty to forty feet. Incipient with the serpentine are several stringers of talc which has been previously exploited for economic interest. A second occurance of talc was found associated with Pacoima Fault in the northest corner of the area. Considerable asbestos was also found here. The origin of these materials was in all events probably in connection with hydrothermal alteration of these metasediments. The source of the solutions is assumed to be fromthe fault passing through this locality.

The attitudes of the sedimentary beds can be summed up rather briefly. Only one formation is relatively horizontal and free of folding and tilting. This is the recent terraces. The other formations have either been tilted or folded, or both, to a great degree. The effects of folding will be discussed later.

Faulting inthe area has not been of a pronounced nature and shows strong tendencies toward a structural grain. Two groups of faults will be discussed. The first group, the east-west trending group, and the second group, the north-south trending group. The first group of faulting can be associated with the general trend of the San Gabriel Mountains into an east-west range. The prominent fault of this group is the Sierra Madre fault, a normal fault that has contributed considerably toward the elevation of the range. The age of the fault is probably late Pleistocene since the Pleistocene terraces have been faulted agaist the basement in the central portion of the area. An approximation of the displacement along this fault can be made from the fact that terrace deposits of Pleistocene age occur one mile north of the Olive View

Sanitarium. Assuming these terraces to be of synonamous age with those occurring on the south side of the fault in the vicinity of the Sanitarium, gives a vertical displacement of about 1000-1200 feet. The trace of the Sierra Madre fault in the eastern central portion of the area was made by association of narrow gouge zones up to one inch across with kerncols and kernbuts, all of which were present on most of the ridges. A fault controlled ridge and valley were also noticed at the mouth of May Canyon. This feature of parallelism with the range is a common one inthe San Gabriels where considerable faulting has taken place. A second large fault of the east-west group is th Pacoima fault occurring entirely in the basement complex. This fault is probably a complementry fault of the San Gabriel fault which passes through Placerita Canyon several miles to the north. The north side of this fault has been dropped down, while the north side of the San Gabriel fault has been elevated. It is conceivable that a graben structure has been developed here which has somewhat reserved the elevation of the core of the San Gabriel Mountains in this region. Evidences for the occurance of the Pacoima fault were first noticed from a Fairchild Aereal Survay photograph of the area. The photo showed a decided tendency toward reverse on all ridges in the southern drained portion of the range. The slopes showed a definite tendency toward lineation in an east-west direction. Investigation was carried out in Pacoima Canyon, at the intersection of the supposed fault. Here an anmomolous feature was observed. Coincident with the fault line was a rather deep valley trending definitly in an east-and west, direction, parallel

to the range. Many ridges were inspected and kerncols and kernbuts were found. In the north west corner of the area, a large zone of brecciation within which stringers of gouge were found, further substantiating the presence of the fault. The course of the Pacoima river to the North-east also points toward the same conclusion. It flows for some distance due west, coincident with the San Gabriel fault, then flows south until it intersects the Pacoima fault. Here again it flows due west for some distance before breaking to the south. The age of the Pacoima fault is evidently pre-Pliocene since it does not affect the Pico deposits due north of the Sanitarium.

There are two other faults belonging to the first group, which may be linked with the formation of the San Gabriel range. These faults are normal faults of moderate displacement, east of the San Fernando Reservoir. The southern one is the only one meriting mention. Here the Saugus formation has been faulted down to the Pico . A narrow gouge zone is present with little or no brecciation.

The second group of faults is the north-south trending group which occurs to the notth and west of the Olive View Sanitarium. The faults occur as normal step faults with the east side being dropped down.

The basis the presence of these faults has been made in general upon the abrupt discontinuity of the Pico beds and its suddenly giving away to the basement complex. Fault "a" was first observed from the displacement of the serpentine dike mentioned previously. This displacement amounts to about three hundred feet. The Los Pinetos fire road cuts this fault in several places. Excellent views of the fault zone are available. A zone of brecciation some thiry inches wide is present with

slight drag folding of the metasediments. Considerable loose gouge and clay is also present. Fault "b" , the western most of the series shows a highly brecciated zone just north of the Rancho Sombrero. Here the Pico-basement contact is considerably obscured, and stringers of Pico are found to be incorporated in the brecciated basement. The age of the series is late Pleistocene, which may hint to its being linked with the Sierra Madre fault, and give some idea to the sources of stresses inherent in the cause of faulting.

View of fault "a" showing large breccia zone.

View of fault "a" showing relation of down dropped Pico block. Note zone of brecciation

Clos up view of fault "a" showing nature of fault zone

View of east-west canyon controlled by the Pacoima fault. View looking upstream in the Pacoima Canyon. Note straight character of Canyon.

Folding: The folding pattern in the area corresponds with the general pattern of Southern California, showing an east-west parallelism. Two folds are present within the area, both very open. A broad anticline occurs east of the San Fernando resevoir in the Pico shales. On the south flank a slight monocline has developed which immediately overturns to the south with consequent local folding in the shales. This fold plunges to the west at about 15 ^{o}. To the north, the fold gradually flattens out into a very shallow and open syncline, which is now filled with recent alluvium in the vicinity of the city of San Fernando. The north flank of this fold attains a much greater elevation than the south flank, as well as a steeper dip. This is evidenced in the northern most exposures of the Pico formation. The reason for the greater elevation is due to the movement along the Sierra Madra fault. The only other folding in the area is in the immediate neighborhood of the faults, where slight drag folds are often developed.

HISTORICAL GEOLOGY

1. deposition of old pre cambrian sediments.
2. metamorphism of sediments in post cambrian.
3. upper Cretaceous or Jurassic intrusion of granites.
4. period of faulting and tilting, and erosion.
5. deposition of Modelo shales in stable sea; upper Miocene
6. slight period of tilting and folding.
7. erosion.
8. deposition of Pico during lower Pliocene, archepelego conditions.
9. period of erosion
10. deposition of Saugus during upper Pliocene and lower Pleistocene, continental deposits on dropping river delta.
11. period of erosion, folding, faulting.
12. deposition of terraces during upper Pleistocene.
13. uplift and erosion.
14. recent terraces and recent alluvium .
15. recent faulting and erosion.

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ROCK CLASSIFICATION

P1 Gray-blue sandstone-fossiliferous, massive, weal lithified. north of Olive View

P2 Gouge material from Sierra Madre fault. note angular fragments

P3 Diatomeaceous earth. Note very light weight of material

P4 shale from the Pico in vicinity of San FernandoReservoir. well bedded, well lithified.

P5 Iron stained conglomerate from Pico just north of Olive View.

P6 Medium conglomerate from Pico; note well rounded, well lithified character.

P7 Chert from bed in Pico, East of Resevoir

M1 well bedded hard silicious shale from Modelo, east of Pacoima wash.

M2 petroliferous shale from Modelo, note brown color and sulfurous laminae.

bc 1 Aplite dike material from basement complex.

bc2 shist typical of basement complex.

bc 3 limestone from the Basement complex, showing contact metamorphic garnets and diopside.

bc 4Massive white limestone (marble) from the basement complex.

bc 5 gouge from the Pacoim fault zone; north-west corner of area.

bc 6 serpentine dike material, north of Olive view

bc7 granular serpentine dike material " " "

bc 8 asbestos stringer from mine in north-west corner of area.


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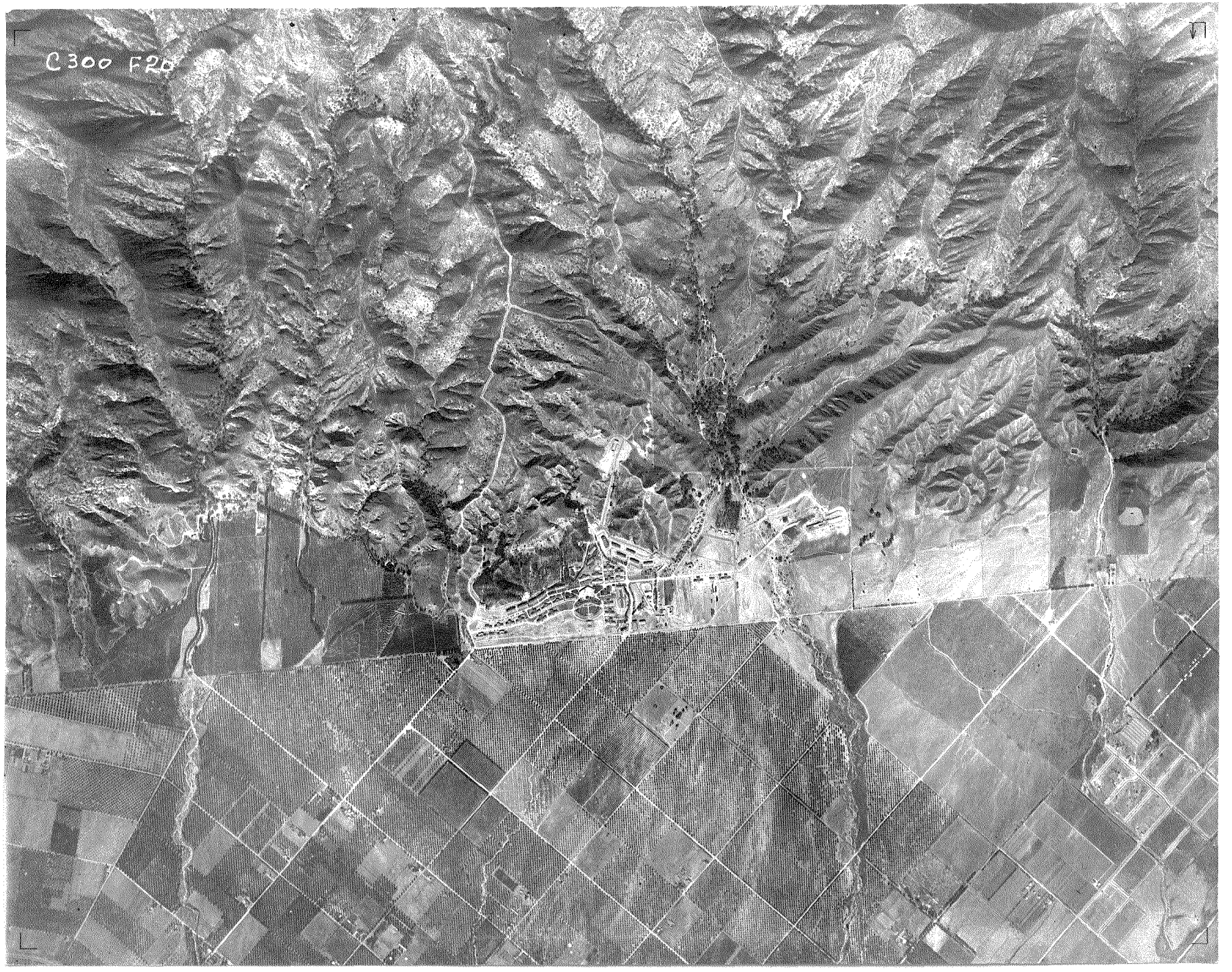
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