GEOLOGY OF THE CENTRAL PORTION OF THE SUNLAND QUADRANGLE, CALIF.

by Bruce Lockwood

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Abstract

The region in which the geology was mapped includes an area in the central portion of the Sunland Quadrangle, just west of the small town of Sunland and about 20 mi. north west of Los Angles. The sedimentary series here consists of interbedded conglomerates, sandstones, and siliceous shales, lower Modelo in age, which rest depositionally on old granites and gneisses. Above the lower Modelo there is a thin section of typical, highly contorted upper Modelo shales, which seem to rest with slight unconformity of the lower Modelo. Above this, and resting depositionally with about a 10^{o} unconformity, there is a section of about 550 feet of Pico (lower Pliocene), which consists of a series of lava conglomerates, white punky shales, and sandstones.

These beds have been faulted in numerous places. The two main faults trend in an approximate N 70^{o} W direction, while the minor faults are oriented in various other directions. There has also been some folding, especially in the area to the west, which seems to be a direct result of the faulting.

Geology of the Central Portion of the
Sunland Quadrangle, Calif.

Introduction

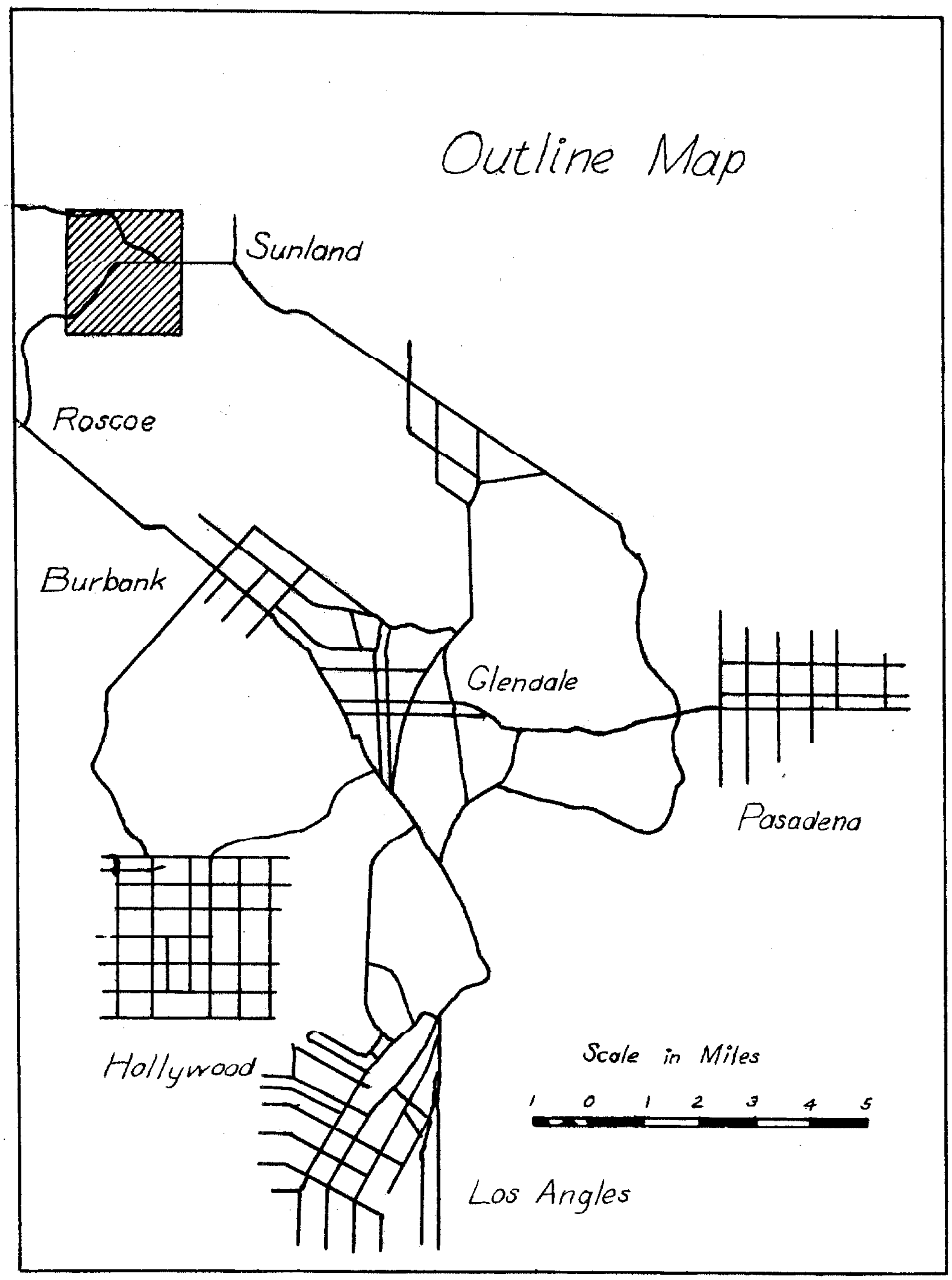
Location:

The region mapped is located in the central portion of the Sunland Quadrangle just west of the small town of Sunland. (See outline map) This area includes approximately seven square miles and is bounded by meridians 118° 19' and 118° 23' and parallels 34° 14' and 34° 16'.

The general region may be reached by two main roads; the first, Foothill Blvd., which runs in an east west direction and passes through Sunland, and the second road is Sunland Blvd., which branches north from San Fernando Rd. at the small town of Roscoe and continues north until it meets Foothill Blvd.

Purpose and Scope of the Report:

This geologic mapping and resulting thesis was undertaken to fulfill part of the requirements for the degree of Bachelor of Science at the California Institute of Technology and was carried on with only a scientific end in view. The original mapping was done with the aid of a Brunton compass on aerial photographs made by Fairchild Aerial Survey in 1928, and was mapped with as much in detail as the scale of the photograph would permit which was 1500' to the inch. It is hoped that the report will give a clearer understanding of the general geology of this region.


Outline Map
Sunland
Roscoe
Burbank
Glendale
Pasadena
Hollywood
Los Angles
Scale in Miles
1 0 1 2 3 4 5

Geography

Relief:

The relief in the area mapped is moderate; and the elevations range from 950' at the west end to 1950' at the east end. The section west of Sunland Blvd. lacks ruggedness of any kind and is formed of maturely eroded and dissected shale hills, which are only lightly covered with brush, while the eastern portion contains many rugged slopes and is on the whole well covered with greasewood, manzanita, poison oak, and numerous other wild bushes.

Drainage:

The Tujunga wash, which forms the north and west boundaries of the area, forms the chief drainage of the area. There are no continuous streams in the area. The stream in Tujunga canyon is continuous while restricted to the mountain areas to the north, but it soon seeps into the wash gravels on reaching the mouth of the canyon.

Exposures:

On the whole the exposures throughout the area are very poor. Many contacts had to be more or less guessed at by float in places where there was a thick covering of soil. This applies especially to the shale areas to the west.

General Geology

The Sunland Quadrangle is a region that includes a large area of igneous rock as well as a thick section of tertiary sediments, of which there are representations from the eocene (?), miocene, and pliocene. There are areas of igneous and metamorphic rock on both the north and the south side of the sediments, and this forms what appears to have been an ancient sedimentation basin.

The igneous and metamorphic rocks, which consist mostly of granodiorites and schists, are cut by numerous pegmatitic, aplitic, and basic dikes. Lying depositionally on these old igneous rocks is the sedimentary series.

To the north in Little Tujunga Canyon are located the patches of the Early Tertiary rocks, which constitute the oldest sedimentary unit in the general region. To the south and bordering the Tujunga wash are located other tertiary sediments and tertiary basalts. They are bounded on the north side by a fault contact with the igneous rocks and on the south side they lie depositionally on the igneous rocks. The oldest of these rocks on the south side are the basalts, of which there is some question as to the origin. Some evidences indicate a flow and others indicate intrusion; in any case they were formed somewhere near the surface, and perhaps they include both modes of occurrence.

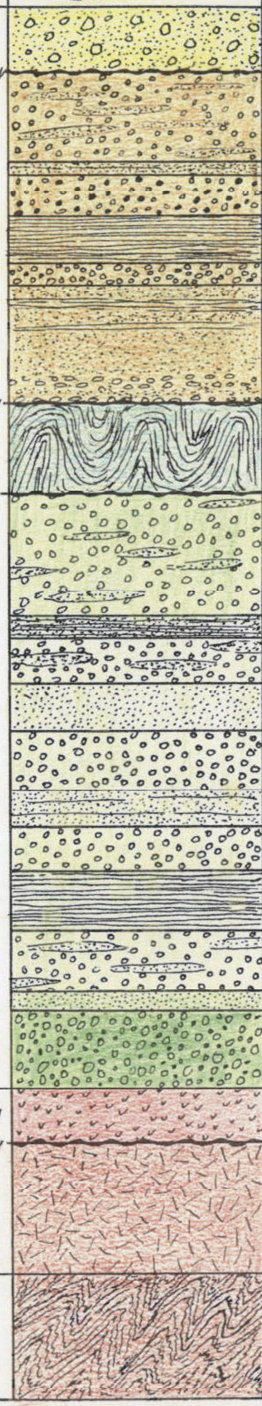
The next youngest group of rocks are Miocene. The lower portions, which are probably Topanga, include interbedded conglomerates, sandstones and cherty shales. On top of this there is a Modelo series. Above these beds stratigraphically are conglomerates, sandstones and shales of Pico and Saugus ages. The degree of consolidation is one of the main factors in determining them. The Pico is the only group represented on the south side of the wash.

Finally, the most recent material in the region is the gravel of the Tujunga wash, which is as yet unconsolidated.

The sediments are traversed by many faults, the average trend being about N 70° W for the major faults. On the south side there are two main faults in the granite, which die out as they extend into the sediments and tend to form anticlinal structures. On the north side of the wash the beds have an average slope of around 35°. The major flexure is the Merrick syncline, which trends parallel to the main fault system. On the north side of this structure the beds are overturned.

Geologically speaking, this general area resembles many other California areas, in that faulting plays an all important role in the structures in the rocks.

Columnar Section



Age	Formation	Section	Thickness	Charater
Recent			100(?)	Poorly sorted stream gravels. Unconsolidated.
	Unconformity			
Pliocene	Pico		200	Large, well rounded acidic boulders. Sandstone lenses.
			20	White, arkosic sandstone. Shale.
			60	Abundant lava. Well rounded.
			75	White punky shale.
			35	
			200	Brown ss. Interbedded shale. Interbedded conglomerate.
	Unconformity			
Miocene	Modelo Shale		150 (?)	Typical Modelo shale. Occasional Interbedded sandstone.
	unconformity (?)			
	Lower Modelo		200	Well rounded, acid igneous boulders. Sandstone lenses.
			35	White arkosic ss. and shale.
			70	
			80	~~White~~ arkosic sandstone. Yellowish
			100	
			60	Brown sandstone and shale.
			70	
			100	White, siliceous shale. Somewhat contorted.
			100	
			30	Well indurated arkosic ss. Fossiliferous.
			130	Basal cg. Fairly well consolidated.
	Topanga		100	Reddish, vesicular, olivene basalt.
	Unconformity			
Jurassic (?)				Well weathered granodiorite (?) Aplitic and basic dikes.
Pre-Jurassic (?)				Micaceous and garnetiferous schists and gneisses. Intruded by granodiorite.

Stratigraphy

General:

The major portion of the area, which includes almost everything south of Foothill Blvd., is composed of interbedded, hard, siliceous sandstones, conglomerates, and shales along with some softer members of arkosic sandstones and muddy shales. These beds were first tentatively assigned to the Topanga on the basis of an astragulus of an Allodesmus Kernensis, which was found in them and which seemed to be the same specie as some material described by Kellog from the Bakersfield region. Later, however, some invertebrate fossils from the same series led to a slightly different conclusion. Some species of "Pecten" cf. P. raymondi Brionianus Trask, which are described by Hoots[1] were found in the same series of beds as the Allodesmus Kernensis, and have caused the beds to be recorrelated as lower Modelo.

Above the lower Modelo there are about a hundred feet of more or less typical Modelo shale with a few thin sandstones and limestones interbedded. The northwest section of the area which protrudes out into the Tujunga wash has been placed in the lower Pliocene (Pico). It consists of a series of alternating sandstones, white shales, and iron stained conglomerates.

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1. Hoots, H. W. - "The Geology of the Eastern Portion of the Santa Monica Mountains, LA. Co., Calif." U.S.G.S. P.P. 165 (c), 1931.

In the eastern section of the area there is a volcanic series that consists of basalt (diabase), flow breccia, and some interbedded sandstone lenses. There is a small outcrop of this same basalt to the southwest.

The mountains to the south and east, which make up the main portion of the Verdugo mountains, are composed entirely of old crystalline igneous rocks probably associated with the Jurassic intrusions and metamorphic schists and gneisses probably of Paleozoic (?) age.

Pre-Tertiary

Locations:

The main portion of the Verdugo Hills, which lie to the southeast of the sedimentary series, consists of the old crystalline rocks. There is also an outcrop of the same complex on the small hill which is situated about four miles west in the Tujunga wash.

Lithology:

The Paleozoic (?) metamorphics consist of coarsely banded biotite gneisses as well as large amounts of biotite schist, which in many exposures appear to be of sedimentary origin. In one place there was found a large boulder of garnetiferous schist in a stream bed. A search was made later for an exposure in place but none was located. The garnets which originally were probably of the variety almondite, range in grain size from about 1 mm. to 10 in diameter and are quite badly decomposed.

The igneous rock is a medium grained rock composed chiefly of quartz, feldspar, biotite, and hornblende and apparently has a granitoid texture. In all cases it seems to be quite highly altered, often times the biotite and hornblende crystals have a small iron stained ring around them. Although no thin sections were made and studied, this rock probably has the composition of a granodiorite or a quartz monzonite.

There are numerous aplitic and pegmatitic dikes cutting the igneous and metamorphic rock as well as gabbroic dikes that are apparently rich in pyroxenes. In several cases the aplitic dikes, which are considerably more resistant to weathering than the granodiorite and metamorphics that they intrude, form small ridges that can be mapped in order to show the structure.

Age:

Since none of the sediments in the area have been intruded, it is quite obvious that the granitic intrusion antidated the Middle Miocene, and since a major portion of the granitic material of the San Gabriel mountains is thought to be connected with the Jurassic, it is probable that this material may also be correlated as such.

The metamorphics for similar reasons have been placed in the Paleozoic era.

Topanga (?) Lava Series

Location:

The major occurrence of the lava is a strip varying in width from about 500' to 1200' and extending from about 1500' east of the N-S portion of Sunland Blvd. 6000' farther east. It covers the north slope of the hill that forms the edge of the Verdugo mountains. The average thickness is estimated to be about a hundred feet, although it probably varies considerably due to irregularities in the erosional surface on which the lavas were extruded and due to the topographic relief which exists today.

There is another minor occurrence of the basalt approximately 400' west of the intersection of Sunland Blvd. and Wheatland Ave. At this location the thickness is only a few feet. It is important here as a means of correlating the sedimentary units.

Flow breccia may be seen at the end of the old road which forms a continuation of Day St. and extends to the ridge; it may also be seen in the small canyon about 200' NW of the corner of Hidden Oak Dr. and Apperson St. A sedimentary lense in the basalt may be seen on the old road mentioned above approximately 700' from the crest of the ridge.

There are also two small islands of lava to the east of the main occurrence, which are apparently erosional remnants of a flow which once extended into Sunland valley.

Lithology:

This lava series may be divided up into three types of material: (1) basaltic lava, (2) flow breccia, and (3) interflow sedimentary lenses.

The basalt itself is megascopically an almost black, fine grained, non-porphyritic, extremely compact rock. Occasionally minute reflections can be seen which apparently indicate the presence of minute plagioclase laths. In many places the basalt is quite vesicular. In general the vesicules have the common spherical or ellipsoidal shape, but in one instance an outcrop was found in which the vesicules were extremely elongated and drawn out to lengths of from one to three inches. In a few cases the vesicules were filled with minerals, which included calcite and probably some of the zeolites.

With a few exceptions this lava weathers to a deep red color that is undoubtedly due to the formation of hematite. In several places, however, the weathered material is a deep buff color. This may be caused by the leaching of the iron. Most of thisweathering is probably of surface origin since fresh lava is generally seen on newly broken surfaces.

A microscopic examination has yielded the following results:[1] Texture - Hyalopilitic to trachytic; composition - Labrodorite (An. 65) and augite in a cryptocrystalline groundmass with feldspar microlites. Euhedral olivine and its alteration product, iddingsite, are also present. The

1. See appendix.

similar lithologic character of this lava to the lava of the north side, thin sections of which were made and studied by C. B. Nolte, gives almost conclusive proof that the two basalts are the same.

The flow breccia is composed of sharp angular fragments of basalt, generally quite highly altered, strongly imbedded in a matrix of similar basalt. This breccia could possibly have originated when the lava was extruded if the cooled surfaces with a crust of hard lava were broken as the lava continued to move forward and the pieces recemented by more lava. On the other hand, perhaps it was caused by the extrusion of another flow of lava over a surface on which there was a large quantity of basalt fragments of a former flow. In this case the loose fragments would be carried along and cemented by the new flow. Perhaps both modes of occurrence are present here.

The sedimentary lenses in the series are quite thin and probably represent pockets in the surface of the lava which filled with material between flows. None of the exposures afford an opportunity to look for baking which might occur along the top of the lense.

On the north side of the wash there was some doubt for a while as to the actual mode of occurrence, whether it was intrusive or extrusive. Evidence such as vesicules and flow breccia pointed to an extrusion, and it wasn't until C. B. Nolte found apophyses of lava in sandstone that it was definitely decided that at least some of the material was intrusive.

Undoubtedly the intrusive is very shallow and could easily have reached the surface before it had traveled as far as the south side of the wash. As yet there have been no apophyses or evidences of baking of sediments discovered on the south side of the wash, and therefore, at least for the present, it is best to assume that the several flows are all extrusive.

Age:

On the south side of the wash there is no absolute means of correlating the basalt, except to say that it is older than any of the sediments. On the north side, however, it intrudes beds of Topanga age, which, provided it is the same series of flows that are being dealt with, places it probably somewhere in the upper Topanga.

Another less substantial criteria leading to assigning of the lava to the Topanga is the fact that in the Santa Monica Mountains, according to Hoots[1] there was considerable volcanic activity during this period.

Lower Modelo Series

Distribution and Thickness:

The beds assigned to the lower Modelo occupy the greatest areal extent of any of the sedimentary series. They form almost a continuous unit from the south, where they are bounded by the basement, to the north where they are bounded by

1. Hoots, H. W. - "The Geology of the Eastern Portion of the Santa Monica Mountains, LA. Co., Calif." U.S.G.S. P.P. 165 (c), 1931.

the Tujunga wash and the Upper Modelo (?) shales. The Tujunga wash also bounds the series on the west end, while the lava and basement form a more irregular eastern boundary. Good exposures are somewhat rare, there being no one stretch where a good view of a large part of the section can be obtained. In the southwest section there are numerous little islands of sediments also of this same age.

The minimum thickness, which occurs in the eastern half of the region, is about a thousand feet. This thickness might increase to as much as two thousand feet in the western half, but due to bad exposures and the irregularity of the folding, no definite estimate could possibly be attempted.

These beds in most places rest with a depositional unconformity on the Basement Complex. In the eastern portion of the area in places they lie depositionally on the lava, showing some overlap. R. D. Reed[1] mentions that after Topanga time, there was considerable diastrophic activity before the enroachment of Modelo seas, and undoubtedly in this area if there were any Topanga beds present, they were uplifted and eroded completely before any of the Modelo was deposited.

The upper contact of these beds, which have been called the lower Modelo, with the upper Modelo is not visible anywhere, and the separation has been made entirely on lithology.

Lithology:

The sequence in the eastern half of the area is as follows:

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1. Reed - "Structural Evolution of Southern California." 1936 & Hollister.

	Feet
Basal conglomerate, small to large boulders	100
Quartzy sandstone, extremely well indurated, fossiliferous	10
Conglomerate, numerous ss. lenses, composed mainly of acidic rocks	100
White shale, contorted	100
Conglomerate, well rounded acidic boulders	70
Interbedded, brown, fairly well consolidated sandstones and shales	60
Conglomerate	100
Yellowish arkosic sandstone	80
Conglomerate and sandstone	70
White, poorly consolidated sandstone and interbedded shales	35
Conglomerate, large well rounded boulders, interbedded sandstone lenses	200

The basal conglomerate of this series is a well consolidated, more or less heterogeneous mixture of various rock types and sizes. The majority of boulders in this unit are acid igneous rocks with numerous aplites. There are also occasional boulders of metamorphic gneisses and schists as well as a few basic rocks. In places there are considerable quantities of lava boulders. This conglomerate is very poorly sorted, the constituents ranging in size from about three feet in diameter down to microscopic dimensions. On the whole the material is subrounded. As this conglomerate is eroded, the larger boulders, which become exposed, are too heavy to be carried away, and, consequently, they remain as residual boulders, which form one of the characteristic features of this formation. Although this formation is fairly widespread, the actual outcrops are quite few, and most of the contact has to be mapped by the residual boulders that have been formed. In places this becomes quite difficult since its weathering is quite similar to that of the basement with which it is in contact a good part of the time.

Above the basal conglomerate there is a ten foot quartzy sandstone member, which is the most important formation in the entire series, since it is in this bed that the only invertebrate fossils were found on which the determination of the age of the series could be based. In the main it is composed of quite angular quartz grains, although there are considerable amounts of extraordinarily fresh plagioclase grains and an occasional flake of biotite too. These constituents have been extremely well indurated by a siliceous cement that contains appreciable quantities of limonite, which gives the rock a yellowish appearance on a freshly broken surface. The color on weathered surfaces is brownish gray. This group of beds is so hard in relation to the formations on either side of it that it characteristically forms a small ridge wherever it occurs.

Above this hard sandstone lies a section of conglomerate, which is at no place actually exposed, and, consequently, was completely mapped on the basis of float. This float consists of well-rounded boulders of acid igneous rocks, which average about $1\frac{1}{2}$" to 3" in diameter. Probably other rock types are represented in this conglomerate but they have become decomposed due to erosion, leaving only the more resistant aplites, etc. to form the float.

The next youngest formation is a section of white siliceous shale that occurs in beds about half an inch thick. Actually on a fresh surface this shale is quite brown instead of white. On exposure there is a red iron stain formed between the layers of this shale. Dips and strikes that are taken on the few actual outcrops that do occur of this shale are quite varied indicating that this section has been crumpled considerably. This shale forms an excellent marker series, since its float is easily recognizable and very abundant.

The next four hundred feet of the section are occupied by a series of interbedded conglomerates and sandstones. The three conglomerate members are quite similar to the conglomerate underlying the white shale. None of them are well exposed anywhere, and are completely traced by means of float, which consists mainly of well rounded 1" to 3" boulders. The lower of the three sandstone members, which is exposed occasionally on spur ridges, is a brownish, fairly well consolidated arkosic sandstone. It contains some biotite flakes and considerable amounts of weathered feldspar material. Interbedded with this sandstone are some thin sandy shale layers, which are of a darker color than the sandstone. The second sandstone is somewhat similar to the first except that it has a distinct yellow color probably caused by limonite staining. The third, likewise, is similar to the other two in most respects. Its chief characteristic is its pure whiteness. It also contains thin beds of sandy shale.

The uppermost member exposed in the eastern half of the area is a coarse conglomerate, which has many features in common with the basal conglomerate. It is composed of all types of boulders ranging in size from 2' down. The boulders average about 5" in diameter and are fairly well rounded. The chief difference between this conglomerate and the basal conglomerate is the lack of any lava boulders in this upper member. This formation likewise weathers in a manner similar to the weathering of the basement, which adds to the difficulty encountered in mapping it.

In the western half of the mapped area the rock types that are met with are quite different than those occurring in the eastern half. On proceeding westward the sandstone and conglomerate members that were prevalent in the eastern half become thinner, while the shale members gradually increase in thickness. There is an interfingering of one type of beds into the other. The exposures are so poor that it is only in a very few cases that this thinning of the sandstone can be actually traced. There are two main types of shale that occur, first, a hard, light colored, thinly laminated siliceous shale, and second, a brown, softer shale, which occurs in beds about a half an inch thick. The siliceous shale is in places cut by many small veinlets of silica (opal). It contains numerous evidences of shallow water life such as remains of reeds and imprints of leaves; several fish skeletons were also found. No remains, except an occasional fish scale were found in the softer shale beds. As one would expect these shales have crumpled somewhat on being folded, and on the whole, dips and strikes taken in this area are not very reliable. Occasionally, however, a sandstone bed is found which aids in determining the structure. In the western half of the area, these shaly beds give rise to a characteristic rounded topography, which does not support greasewood and the other plants common to the granitic and sandy soils, but on the contrary supports a thin stalked plant about three feet in height.

In the western area there is a top member present, consisting of interbedded sandstones and conglomerates, that is not found in the eastern half. The probable reason for this is that this member has been eroded away before the Modelo shales, which are present in the eastern half of the area, were laid down.

<u>Age</u>:

Fossils throughout the area are quite scarce. In only one bed (the quartzy sandstone above the basal conglomerate) were there any identifiable invertebrates discovered. Hoots[1]

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1. Hoots, H. W.,"Geology of the Eastern Portion of the Santa Monica Mountains, Calif." U.S.G.S. P.P. 165 (c), 1931.

has described a similar species of "Pecten" from the Santa Monica Mountains as "Pecten" cf. P. raymondi Brionianus Trask, which places this series on the Lower Modelo. In this same paper Dr. Woodring is thus quoted, "The fossils from the basal part of the Modelo formation are particularly interesting, in as much as "Pecten" cf. raymondi Brionianus Trask is the only species so far recorded from these beds." As this is the only species found in this region, it seems quite probable that these beds are also basal Modelo.

An astragulus of an Allodesmus Kernensis, similar to a species from the Temblor (equivalent of the Topanga in the L.A. basin) of the Bakersfield region and described by Kellog[1] was found by the author and identified by Dr. Kellog. Hoots[2] in the Santa Monica mountains found a first metacarpal of a species also thought to be Allodesmus Kernensis in the lower Modelo, so apparently this fossil cannot be relied on to such as great an extent as the "Pecten", and thus until more evidence has turned up, this series will be placed in the Lower Modelo.

Modelo Shales

Distribution and Thickness:

The Modelo shales are exposed in a narrow band trending about N 65° W a short distance south of Foothill Blvd. near

1. Kellog, R., "Pinnipeds from Miocene and Pliocene Deposits", Univ. of Calif. Pub. 13, No. 4, p. 41

2. Hoots, H. W., "Geology of the Eastern Portion of the Santa Monica Mountains, Calif." U.S.G.S. P.P. 165 (c) 1931

Tujunga wash. They are exposed in an area measuring about 1700' by 400'.

They are so badly crumpled and folded that any exact determination of their thickness is impossible, but a conservative estimate would be about 200'.

Their lower contact is not visible at any point, but they probably rest with slight unconformity on the lower Modelo, since the upper sandstone conglomerate formation is missing in the eastern end of the area and there seems to be no evidence of faulting. They are overlain by sandstones and conglomerates of the Pico formation with an angular unconformity of about 10°. This feature may be seen in the road cut at the point where Foothill Blvd. commences to cross Tujunga wash.

Lithology:

This formation is composed of well-bedded, brown, rather unevenly laminated shales. They are moderately well consolidated, and are characterized by thin sandy layers, often iron stained, between the shaly layers. The iron may be derived from biotite, which is a common constituent in these layers. There are a few this sandstone members in this section, none of which exceed a foot or two in thickness. The whole series has been badly crumpled and in places shattered so that the bedding is scarcely distinguishable.

Age:

No fossils were found in these beds that might give a clue to their proper age, and so merely on the basis of lithology and the slight unconformity that seems to be present both above and below, the author places them in the upper Modelo. Hill[1] on the other hand makes no distinction between these shales and the series existing below them, but includes everything under the term undifferentiated Miocene.

Pico Series

Distribution and Thickness:

Sediments belonging to the Pico are found in the low hills in the north east portion of the section, that is to say, in the hills just west of the town of Sunland. Their boundary lies about 200' south of Foothill Blvd. They include an area of about 2000' square.

Their total thickness amounts to about 550'. They rest on the Modelo shales with an angular unconformity of about 10°. With the exception of the recent gravels in the Tujunga wash, these are the youngest beds in the area.

Lithology:

The sequence of the Pico series is as follows:

Interbedded sandstone, conglomerate, and shale;

ss-arkosic, sh-brown --------------------	200'
Conglomerate, acid igneous rocks ---------	35'
White, finely laminated punky shale ------	75'

1. Hill, Mason, "Structure of the San Gabriel Mts. Univ. Calif. Pub. 19

Conglomerate, 60% lava boulders --------------- 60'

Sandstone and interbedded shale ----------- 5 - 20'

Conglomerate, sub-angular acidic igneous boulders 150'

The lower portion of the basal beds of the Pico consist of beds of sandstone and conglomerate which more or less tend to grade into each other. They are well exposed on the south side road cut on Foothill Blvd. just before coming to Tujunga wash. The conglomerate is composed mostly of well rounded and subrounded acidic igneous boulders averaging about 1" to 4" in size. Occasionally a lava boulder or schistose rock is found. The general color of the conglomerate beds is light brown. The sandstone of the member is on the whole a little lighter in color, and consists of an arkosic sandstone with some muscovite and biotite grains included. The upper section of the series contains similar sandstones but interbedded shales instead of conglomerate. The shale is brown in color and is often iron stained to some degree. It is on the whole of a more sandy nature than the Modelo shale, and occurs in thin layers between the thicker sandstone beds. Occasionally the sandstone beds have large concretions in them measuring up to 3' across.

The conglomerate, which overlies the basal Pico, in many ways resembles the conglomerates that occur below it. A good exposure of it can be seen on Hillrose Drive about 200' north east of Foothill Blvd. Its total thickness is about 35'. Most of its boulders are light colored igneous rocks with an occasional piece of lava or basic rock. It is distinguished from the basal conglomerates by the greater percentage of iron bearing constituents that it possesses as evidenced by the red color that is developed when it weathers.

The next unit in the series is a section of about 75' of white, soft, punky shale. This shale consists of fine laminations of alternating light gray and pure white material. It has a chalky feel and forms a fine powder on rubbing. A good exposure of this shale can be seen on Oswego St. These shales show lateral variation in that the farther west that they are traced, the grayer they tend to become.

The conglomerate overlying this chalky shale is very distinctive. It is made up of subrounded to well-rounded lava and acid igneous rocks, the lava forming about 60% of total. The boulders average around 4" in diameter, but have a range in size from about 2" to 6". On weathering due to the large quantities of iron present, this formation stains a deep red color. Its total thickness amounts to about 60'. The best exposures of this conglomerate are found on Hillrose Drive a few hundred feet north east of Foothill Blvd.

Between this lava conglomerate and the conglomerate overlying, there is an interval of about twenty feet that is taken up by a tan arkosic sandstone, with interbedded brown, more or less sandy shales. The sandstone beds average about two feet in thickness while the shales are typically about a half an inch in thickness.

With the exception of the recent stream gravels in the Tujunga wash, the youngest formation in the region is the conglomerate that lies on top of the sandstones just described. It is composed of sub-angular to sub-rounded granitoid rocks. In contrast to the conglomerate below it that contains such a large quantity of lava, this conglomerate contains almost none. It is moderately well consolidated, but weathers easily so that the good outcrops are quite few in number. Interbedded with this conglomerate are some coarse sandstone lenses which are only a foot or two in thickness and several feet long, which look as though they might represent scour channels that have become filled with finer material. This formation is light in color in contrast to the other conglomerates of the series, and can thus easily be distinguished from them.

<u>Age</u>:

As no determinable fossil material was found in what has been termed the Pico, the age determination had to be made in a somewhat roundabout way. The upper four members of this series, i.e. the chalky shale, lava conglomerate, sandstone, and upper conglomerate, correlate exactly with four formations in the area mapped by L. Schombel[1] on the north

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1. Schombel, L., Senior Thesis, Calif. Inst. Technology, 1937

side of Tujunga wash. These beds on the north side in turn are correlated with known Pico beds in which fossils have been found and determined. Using this correlation in conjunction with the apparent unconformity at the base, it seems logical that these beds should be placed in the Pico.

Structure

Regional:

There is a definite regional structure evidenced in the Sunland Quadrangle. The trend of the regional structures is similar to that in the coast ranges in general, i.e. N 70° W. There also seems to be a more or less uniform regional dip superimposed on all the local structures, which will be described in detail. So little is known about the structure of the San Fernando basin, with its thick layer of alluvium, that it would be almost impossible to postulate the structures that have given rise to this regional dip. They probably arose at the time of the uplift of Verdugo and San Gabriel mountains. About all that can be done is to record the facts as they present themselves in the field.

There are three main faults through the region, namely, the San Rafael fault on the south side of the Verdugo mountains and which undoubtedly has been the fault along which the uplift of the Verdugos has taken place. Proceeding north to the San Gabriel mountains, the next major fault is the Sierra Madre fault, which is more or less a series of faults. One of the more important branches in this region is called the Sunland fault which has a vertical displacement of somewhere in the neighborhood of 5000'. The third fault, which lies farther north in the range is the San Gabriel fault, which is the largest of the three faults. These faults on the whole trend in a NNW direction and are either vertical or steep thrust faults.

Folded Structures

General:

The major folding in the area has been closely associated with the faulting, and probably represents the continuation of fault structures which arise in the basement and gradually die out as they extend into the sediments. There has also been much incompetent folding in some of the weaker shale zones.

Verdugo Anticline:

The Verdugo anticline represents the largest anticline in the area. Its axis trends roughly N 70° W and crosses Sunland Blvd. about 400' south of the intersection of Sunland and La Canada Way. It pitches to the north at an angle of between five and ten degrees and extends for a traceable distance of about 7500'. At the point where it crosses Sunland Blvd., the axis is bent somewhat so that its trend is about N 50° W instead of the normal 70°. This is undoubtedly due to the bending of the two faults that control the structure. At the east end of the fold there are the two faults, just mentioned, which have evidently taken care of most of the stresses which have arisen, and the fold is replaced by them. At the western terminus there is a natural dying out of the fold; as one proceeds westward, the size of the fold diminishes to nothing.

The dips on the north flank of the anticline are on the average of about 10° steeper than those of the south flank, and at first glance it might appear that the original folding might have been such as to cause the axial plane to dip steeply to the south. However, originally the axial plane undoubtedly dipped to the north, because the larger of the two faults, which seems to have caused the anticline, is a reverse fault which dips to the north, and one would expect, therefore, that the dips on the south flank of the anticline caused by it would be steeper than the dips on the north flank, which would cause the axial plane to dip to the north. Probably the southward dip of the axial plane as one sees it today is due to the regional dip which seems to be the most recent major structure that has been superimposed on the pre-existing structures.

Minor Folds:

South of the Verdugo anticline and in the sediments to the west there exist some other folds of a distinctly minor character. They consist of two synclines with an anticline between. They have an average recognizable length of about 5000'. They occur almost entirely in shaly areas where there is a distinct lack of suitable tracer beds, and , consequently, they are located by more or less unreliable and changing dips in the shales. Their trends are parallel to the Verdugo anticline with the most northerly syncline having a similar southward bending of its axis. The southern most syncline is somewhat bulged to the south in the shape of an arc of a circle. All these folds die out at some distance from the basement and apparently are not associated with any visible faulting in the basement as is the Verdugo anticline. Probably these folds arise from the same forces as those that caused the Verdugo anticline, but they have reacted a little differently. On examining the dips on the flanks of the southern anticline, for example, it is found that the dips on the south flank are steeper than those on the north flank, which is opposite of the case in the Verdugo anticline. This indicates that the axial plane is still dipping northward in spite of the regional dip, and that originally the axial plane was considerably flatter than it is now, probably in the neighborhood of 50°, whereas the axial plane of the Verdugo anticline was probably originally somewhere around 80° to the north.

It might also be mentioned that there is considerable folding and wrinkling in the Modelo shale section, which is well exposed in the cliff formed by Tujunga wash at the point where Foothill Blvd. crosses the wash. This folding is probably merely due to the incompetancy of the Modelo shales to withstand the deformation arising since their consolidation. The general attitude of the axial planes of these drag folds in the Modelo is to the north which would conform to the stresses that have been set up in the surrounding beds due to their folding.

Faulted Structures

Faulting in this area has undoubtedly had the dominant role in controlling the structure. The faults include one major fault, one medium fault, and five or six faults of a distinctly minor character. The two larger faults trend in an approximately parallel direction of N 65° W. The minor faults, which have displacements of one hundred feet or less, are divided into two groups. One group trends about N 45° E, while the other group has a direction of N 20° W.

Verdugo Fault:

This fault as stated above trends N 65° W and more or less divides the area mapped longitudinally into two equal parts. It crosses Sunland Blvd. approximately 800' north of the Edison power line; however, at this point the exposure is very poor. The best exposure of this fault is seen in a stream channel about 4500' to the SE from this point where the fault crosses Sunland Blvd. The Verdugo fault is a reverse fault with a dip of about 60° to the NE, which is the dip actually measured on the fault outcrop. This dip is also substantiated by the pattern of the fault across the topography. In the eastern part of the area the stratigraphic displacement is between 1200' and 1500' as determined by the projection of dips on the structure section. However, this displacement gradually decreases to zero to the west within a distance of about 7500', and all the strain is then taken care of by the folding, which has already been described.

In most places this fault has to be mapped as a contact between conglomerate and basement, there being no actual outcrops of the fault. The fault is known to exist, however, because of the attitude of the beds which dip into the granite at all places. At the one good outcrop the contact between the conglomerate and basement can be plainly seen. The brecciated zone occupies a width of a few feet. This fault was not traced beyond the place that the sediments end so its actual length is not known. The portion that was mapped amounts to about 11,000'.

Other faults:

The fault second in size to the Verdugo fault is a fault that approximately parallels the Verdugo fault and is situated from 2500' to 3000' north. This fault does not outcrop at any point so the true attitude of the fault plane cannot be determined. However, it almost certainly exists because in the assumed vicinity, the dips become unusually steep, and there is a portion of the section missing on this side of the hill, which should be present if the Verdugo fault were the only one in the area. From the section that is missing the displacement on the fault is calculated to be somewhere in the neighborhood of 500'. This fault like the Verdugo fault dies out to the west, and in so doing approaches the Verdugo fault.

One of the sets of minor faults lies in the neighborhood of the place where Foothill Blvd. emerges into Tujunga wash (the exact location may be obtained from the map). They trend in an approximate N 45° E direction and are all clearly located by offset beds. From data thus obtained from offset beds, it is easy to calculate their displacement, which in no case is more than about 100'. All three faults may be traced for distances of about 1500'.

The second set, consisting of two parallel faults, is located on a ridge about 1500' NW of the intersection of parallel 34°14' and longitude 118°20' (see map). They trend approximately N 65° W and have displacements of about 75', which can be calculated from the displacements of the beds in the vicinity. The attitude of their fault planes cannot be gotten exactly, since they do not outcrop anywhere, but they are probably approximately vertical.

There may be another fault of relatively minor size at the east end of the lava flow. Here again there is no actual outcrop of the fault, but it seems apparent that there probably is a fault because of the straightness of the contact of the eastern end of the lava, and from the fact that the lava if continued eastward with the same attitude would intersect the hill just across the canyon, which it does not.

Historical Geology

The oldest unit in the area, the metamorphic schists, were probably formed in Paleozoic time as a sedimentary (?) series. Between the time of their formation and late Jurassic they were undoubtedly folded and eroded. The intrusion of the igneous material has probably taken place during late Jurassic time along with the intrusion of many of the other igneous bodies of this region.

From the Jurassic to the Modelo there has probably been considerable orogenic activity with the formation and erosion of numerous land masses. During Topanga (middle Miocene) the land was high in this region and erosion stripped off any older sediments that might have existed. It was at the beginning of Modelo time that the lava was extruded and probably covered quite a large amount of the region. This extrusion consisted of several separate flows with some deposition going on in the interim, which deposited the sandstone lenses that are found in the lava.

After the lava there was a slight subsidence which allowed the Modelo sea to come into the region, and from the nature of the deposits (coarse conglomerates, arkosic sandstones) and fossils (Allodesmus Kernensis, reeds, and leaves), it is evident that the sea was very shallow and the region close to shore.

At the end of lower Modelo there was a slight disturbance accompanied by erosion that removed some of the sediments.

During Pliocene time the conditions of deposition were probably quite similar to those of Modelo time, but the sources of the sediments were eroded to such an extent by this time that the lava was exposed and eroded, which gave rise to the large quantities of lava found in some of the conglomerates.

Pleistocene time found the sea receeding and the gradual rise of the land with the formation of the faults and folds that are found today. Since the rise of the mountains, there has been considerable erosion with the formation of Tujunga wash and its gravels and a considerable denudation of the surrounding hills giving rise to the topographic features as we see them today.

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Appendix

Microscopic Analyses of Thin Sections of the Lava

L 12

Texture
Groundmass hypocrystalline
Porphyritic
Vitrophyric - feldspar phenocrysts have more or less a tendency to be oriented in a parallel direction (very general). In a few cases the essential character of a diabase (penetration of augite by feldspar) is present.

Composition
Phenocrysts
Labrodorite-Andesine, An 51
Augite
Olivene
Serpentine (alteration on augite and olivene)

Groundmass
Feldspar and augite (?) microlites in an almost opaque groundmass. Index of groundmass glass is slightly lower than balsam.

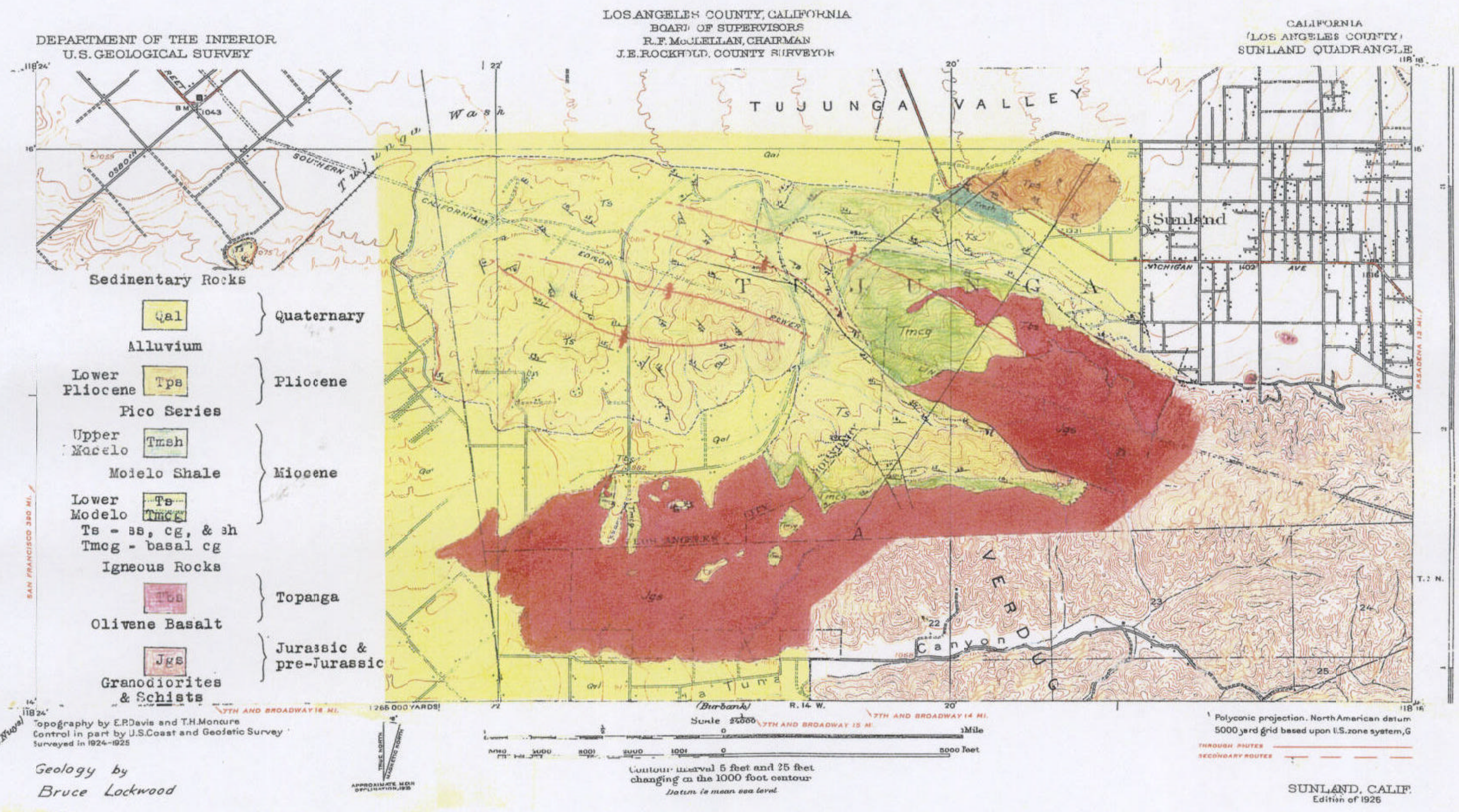
Remarks Name - Olivene basalt.

L 34

Texture
Groundmass hypocrystalling
Porphyritic
Almost trachytic - feldspars fairly well lined up, feldspar phenocrysts are long in relation to their width. Euhedral olivene phenocrysts.

Composition
Phenocrysts
Labrodorite, An 65
Olivene (almost entirely altered to Iddingsite)
Augite
Iddingsite (alteration on olivene)
Serpentine (alteration on augite and olivene)

Remarks Name - Olivene basalt
The presence of at least two flows of lava is evident from the difference in composition of the plagioclase in the two samples, which were taken from localities quite near to each other.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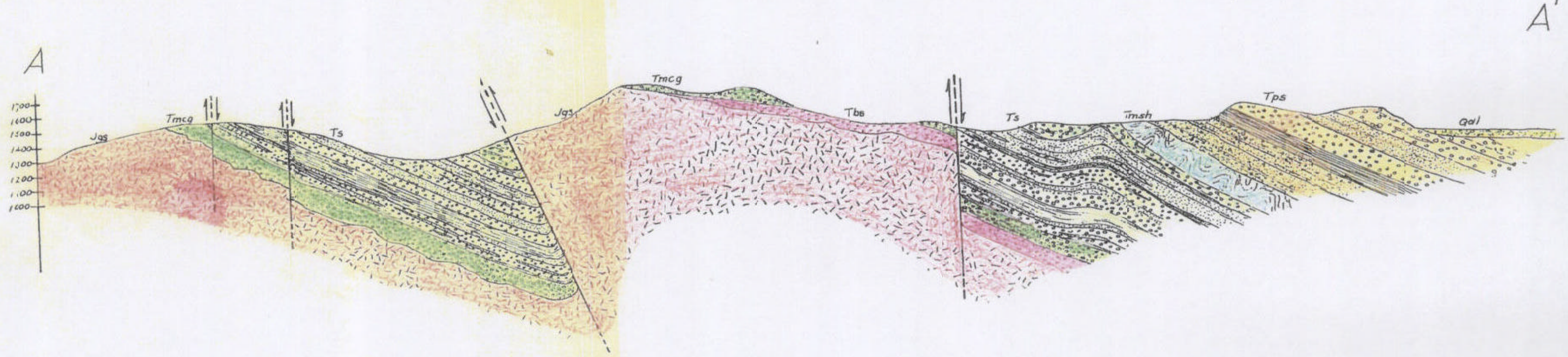
Pliocene
Upper Modelo
Tmsh
Modelo Shale
Miocene
Lower Modelo
Ts
Tmcg
Ts - ss, cg, & sh
Tmcg - basal cg
Igneous Rocks
Tob
Olivene Basalt
Topanga
Jgs
Granodiorites & Schists
Jurassic & pre-Jurassic
Topography by E.P. Davis and T.H. Moncure
Control in part by U.S. Coast and Geodetic Survey
Surveyed in 1924-1925
Geology by
Bruce Lockwood
1937
Scale 1/24000
Contour interval 5 feet and 25 feet changing at the 1000 foot contour
Datum is mean sea level
Polyconic projection. North American datum
5000 yard grid based upon U.S. zone system, G
THROUGH ROUTES
SECONDARY ROUTES
SUNLAND, CALIF.
Edition of 1926



For explanation of symbols and colors see geologic map.

Geologic Section in the Sunland Quadrangle, Calif.

Scale 1" = 666'