GEOLOGY OF THE PACOIMA HILLS

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ABSTRACT

The Pacoima Hills lie between Foothill Boulevard and the San Fernando Road, three miles southeast of San Fernando, California. In this area are exposed Jurassic(?) granodiorite intruded in older gneiss, and a mid Miocene Topango(?) sedimentary section lying in both fault and sedimentary contact with the intrusive complex. Two distinct lava flows and a small laccolith of andesite occur within the Topango(?) formation. The principal structural feature is an anticline plunging steeply northward. An upward acting force is postulated to have produced this anticline; upon cessation of the force, normal faulting occurred with consequent down-dropping of north-south blocks.

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INTRODUCTION

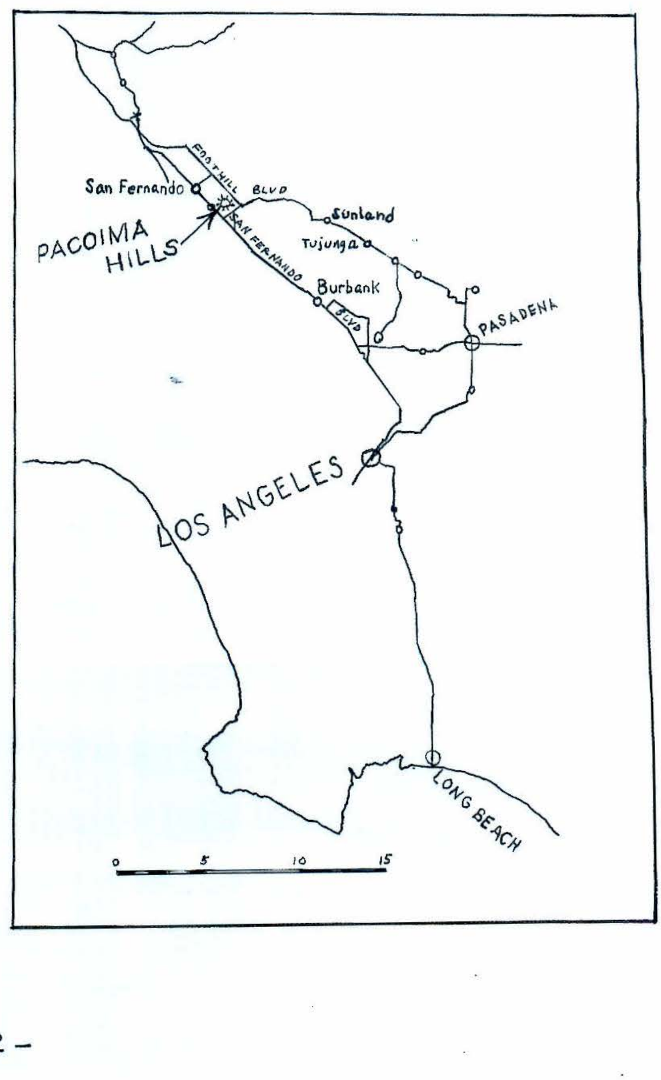
Field work in the Pacoima Hills is the second mapping project assigned in Field Geology, Ge21abc, courses given to juniors at the California Institute of Technology.

Approximately fourteen days were spent in the field. The mapping was done one day each week from April 2 through May 28, 1948. The base map was a portion of a quadrangle map enlarged to the scale 1" = 500'. Location was made by estimation, triangulation with the Brunton, and by an aerial photograph covering the southern portion of the area. The Pacoima Hills lie three miles southeast of San Fernando, California; they are one mile northeast of San Fernando Boulevard at the town of Pacoima.

The author is grateful to Mr. M. E. Denson, field instructor, for his suggestions, aid in the field, and use of the fossils he collected. Credit is due to J. G. Barr for most of the photographs. Great thanks are given to Jeanne, the author's wife, for coloring the maps and typing the manuscript.

INDEX MAP


CALIFORNIA
San Francisco
Los Angeles
San Diego


FOOTHILL BLVD
San Fernando
Sunland
PACOIMA HILLS
SAN FERNANDO
Tujunga
Burbank
BLVD
PASADENA
LOS ANGELES
LONG BEACH
0
5
10
15

GENERAL DESCRIPTION

Typical Southern California brush flourishes in the Pacoima Hill s; it rarely impedes traverse, however. The Climate is semi-arid with about fifteen inches of rainfall per year. Although winter and spring are the rainy seasons, only two field days were lost for this reason. Pacoima Hills lie between San Fernando Road and Foothill Boulevard one mile northeast of Pacoima, California. The index map shows Pacoima is 18 miles northwest of downtown Los Angeles. The area mapped was about one mile long and one-half mile wide. The average elevation is about 1150 feet; maximum relief is 380 feet. Drainage takes place radially through subdued canyons from the high central area. The Tujunga River lies three-fourths mile to the west.

Residences are established about the margin of the hills. The northern half of the area is used for pasturage.

The good exposures are chiefly quarries. Natural out-crops of the basalt occur; occasional ridges of sandstone and limestone are seen across the central portion of the area. Often, however, lack of exposure makes interpretation difficult.

STRATIGRAPHY

The Pacoima Hills are completely surrounded by alluvium and are thus isolated from direct correlation with other areas.

Igneous and Metamorphic Rocks

A. Basement Rocks

The Basement is well exposed in quarries at the south end of the area. The Basement rocks weather to a depth of about 20 feet, shown by a red color. They are extensively fractured.

1. Gneiss

Mineral description:

a. Biotite 40%

b. Feldspar (Plagioclase) 30%

c. Pyroxene (?) 30%

Granular gneissic structure with fine grains of biotite; very coarse crystals of pyroxene; unequal rounded crystals of finely twinned plagioclase. This black rock was probably intruded by the granodiorite; this relation is observed in the quarries southeast of Rabbit Ridge. An apparently isolated block of gneiss is surrounded by granodiorite in a quarry south of Dual Peaks. Its basic nature may indicate that it was not of sedimentary origin.

Figure 2. Abundant calcite amygdales in the Lower Basalt. Hammer is for scale.

2. Granodiorite

Mineral description:

a. Feldspar 69%

b. Quartz 30%

c. Biotite 1%

Massive, light grey, coarse grained granodiorite. Some of plagioclase identified by twinning. This rock is interpreted as representing batholithic intrusion into gneiss. Intrusion in the Santa Monica Mountains has been dated as Triassic; this rock may be part of the same batholith.

B. Extrusive Rocks

1. Lower Basalt Thickness, 20 to 100 feet

The Lower Basalt extends across the southern portion of Pacoima Hills. It is dark brown; the abundant spherical calcite amygdales are shown in the photograph, figure 2. Occasionally vesicles are filled with powdery iron oxide. A weathered zone occurs near the top, observable entirely across the area. As well as can be determined, the basalt is not separatedfrom the lower sediments by an angular unconformity. The contact changes in accordance with variation in attitude of the beds. The top of the upper bed of the Lower Sediments is grey and hard. This fact is interpreted as representing baking of the sediments by solution from the hot lava flow.

2. Upper Basalt   Thickness 200 to 300 feet

The Upper Basalt extends across the central portion of the area. This rock caps Hi Hill and is very resistant. It is dark brown, and very massive and hard. On weathered surfaces, contorted flow lines are brought out. The flow is thickest near Hi Hill. The basal bed is composed of rounded to angular massive basalt fragments granule to bowlder in size, well cemented with glassy clay. This material is interpreted as a "mudflow". It apparently overlies the Middle Arkose without an angular unconformity. The Upper Basalt is extensively brecciated and fractured, especially noticeable in the quarry north of Hermes Hill. The upper contact, Upper Basalt-Upper Sediments, does not show evidence of baking. The foregoing facts about the Lower and Upper Basalt suggests the following interpretation: The Lower Sediments became emergent; the Lower Basalt was extruded and covered them with accompanying baking of the Lower Sediments. The lava flow ceased; a period of weathering occurred; streams deposited the Middle Arkose. The "mudflow" of basalt fragments was possibly caused by welling up of volcanic mud with incorporated basalt fragments and deposition of them on the Middle Arkose. The volcano had been inactive, allowing the arkose to accumulate. Probably solutions colored and helped cement the Arkose. The Upper Basalt then flowed over the land surface and, finally, volcanic activity ceased. Another interpretation of the mudflow is that it represented the washing of detritus into place. However, if this were so, the fragments probably would have been derived from the Lower Basalt, and they would contain amygdales. However, the fragments are massive, and it is thought the first interpretation is the better of the two. The idea that the basalt was extruded on land rather than underwater is supported by lack of pillow structure.

No direct evidence for dating the above sequence was obtained. However, Hoots[1.] described a very similar sequence in the Santa Monica Mountains, which possibly dates the Pacoima extrusions as mid-Miocene Topango.

1./ Hoots, H. W., Geology of the eastern part of the Santa Monica Mountains, Los Angeles County, California: U.S. Geol. Survey Prof. Paper 165, pp. 83-134, 1930

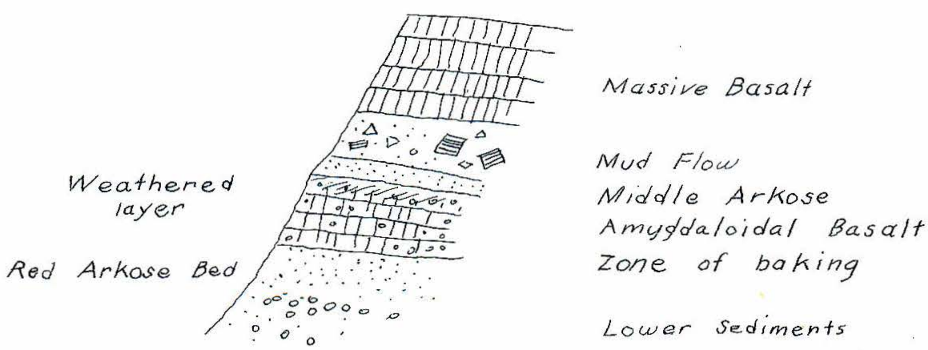


Figure 3. Diagrammatic section illustrating lava sequence.

C. Intrusive Rocks

1. Granodiorite

Discussed under Basement

2. Andesite

The Andesite outcrops on the south side of Sin Hill in subdued patches. The Andesite is dark pinkish grey with small oriented acicular crystals of plagioclase. The field relations suggest the body is a small laccolith--its isolated character, its shape, and the variation in attitude about the upper contact. It is evidently intrusive, for a contact zone of altered limestone is thought to be recognized. A breccia of basalt fragments occurs at some points. This breccia may represent fragments broken from the sides of a conduit tube by the molten material in passing through the Lower and Upper Basalt.

The age of the intrusion is post-deposition of the Upper Sediments. It probably is mid-Miocene, as are andesites in other Southern California areas. Intrusion may have occurred while the Upper Sediments were still submerged. Thus the andesite is post-basalt; the reverse is ordinarily true[2].

2/Driver, Herschel L.; Genesis and evolution of Los Angeles basin, California; Bull. Amer. Assoc. Pet. Geol., Vol. 32, No. I, (Jan., 1948), pp. 109-125

Sedimentary Rocks

A. Lower Sediments

The Lower Sediments extend east-west across the southern portion of Pacoima Hills.

Approximately the lower twenty feet is unlithified sandy conglomerate of subangular to subrounded pebbles to boulders, 24 % granodiorite, 19% gneiss, 14% salicious extrusives, 14% basic extrusives, and 29% quartzite.

The middle portion of the member is similar to the lower, except no quartzite is present; 2 feet thick beds of coarse sandstone are also observed.

The upper bed is very coarse, unsorted, conglomeritic arkosic sandstone. It is well stratified; facies change but not abruptly. It is reddish buff in color. The subrounded pebble to cobble conglomerate portion is 15% basalt, 50% granodiorite, and 35% gneiss. The bed is at least 28 feet thick. The uppermost portion is grey and hardened near the contact with the Lower Basalt. On the east side of Rabbit Ridge, a white, light, noncalcareous substance occurs near the contact with the Lower Basalt. Whether it represented a local rhyolite flow, welded ash, or something else was undetermined. The total thickness is estimated as approximately 140 feet.

B. Middle Arkose

The Middle Arkose may be traced east-west entirely across the south central part of the area. It is an excellent marker bed.

Figure 4. Roadcut east of Sin Hill, showing alternating laminated shale and massive limestone beds. The contorted beds are due to drag on a fault at a slight angle to the road; the right side moved down. The reader is looking northwest.

It is unsorted very coarse sandstone, well cemented with noncalcareous cement; it is usually grey but sometimes reddish. Solutions from overlying mudflow may have helped color and cement the rock. Thickness is 10 to 15 feet.

C. Upper Sediments

The basal portion, extending to the Andesite laccolith, is sorted medium sandstone, partly cemented by calcium carbonate. It is light grey, massive to bedded, and contains many poorly preserved fossils.

The overlying bed is limestone or marl. It is oolitic, massive and in beds about five inches thick, very hard, and a yellow brown color. This bed grades into thin laminated sandy shales with occasional beds of limestone; the latter beds are shown in figure 4. No good exposures are obtained between Sin Hill and Top Peak. Refer to figure 6 for a detailed description of beds observed in the roadcut at that point.

Fossils were collected in the basal sandstone portion of the Upper Sediments on the south flank of Sin Hill. However, tentative identification revealed none were sufficiently limited in time range to be useful. The following forms were tentatively identified:

(1) *Panope generosa* Cal., Miocene to Recent

(2) *Macoma nasuta* Cal., Miocene to Pleistocene

(3) *Metis alta*

The *Turritella ocoyana* fauna is the index of the Topango Formation; unfortunately, none of these were found.

D. Interpretation of the Sediments

The Lower Sediments probably represent enroachment of the sea on a denuded Basement area. The numerous quartzite fragments in the base of the member probably resulted from prolonged erosion of the Basement, exposing portions of meta-sedimentary rocks.

The Middle Sediments were probably stream laid.

The massive sandstone beds of the basal Upper Sediments was probably a littoral or neretic deposit along a subdued coastline, since no basal conglomerate of basalt is observed. The abundant fossils in a poor preserving medium, coarse sand, probably represent rapid burial.

The oolitic limestone may derive its structure by depositing around a silt particle. If this were so,it would indicate deposition because of super-saturation and thus perhaps an isolated embayment or sea.

The beds exposed in the roadcut at Top Hill reveal a change from a previous calcareous environment to a salicious environment. Possibly shore conditions were altered such that precipitation of silica was caused by mingling of fresh and salt waters.

The section designated Topango is strikingly similar to the sequence mapped by Hoots in the Eastern Santa Monica

Mountains; however, the Santa Monica section is much thicker. The basal quartzite conglomerate is 1000 feet thick; the Pacoima Hills quartzite conglomerate is only a few tens of feet. Also the basalt section here is much thinner. Perhaps this locality lay just at the edge of the basin of deposition. Hoots lists volcanic ash beds as characteristic of the Modelo formation. Therefore, it may be barely possible that the Topango-Modelo contact lies within the Upper Sediments section. However, for convenience, the entire sedimentary and extrusive section is designated Topango in this report.

Figure 5. Roadcut at Top Hill.

Formation	Member	Columnar Section	Thickness	Character
Topango	14		13	Alt. 2' th. sh. & ss.
	13		2	Volc. ash.
	12		14	Cherty sh. & ss.
	11		12	Well sorted vy. coarse ss.; carbon at top.
	10		14	Lam. chert & ss.
	9		13	Coarse ss.; bed of fine ash.
	8		4	Gr. fine ash, fract. conch. Soapy.
	7		4.5	Chert; or. ye. ss.
	6		7.5	Alt. sh. & ss.
	5		1	Gr. salicious ss.
	4		15	Gr. lensing hard sh. 1st chert.
	3		6	Well sorted ang. med. ss.
	2		9	Lam. sh.
	1		10	Lt. gr. sorted ss.

Figure 6. Columnar Section for the Roadcut at Top Hill.

GEOLOGIC STRUCTURE

A. Major Anticline

The attitude of strata southwest of Hermes Hill is north-south, dipping west; in the region of Hermes Hill, it is east-west, dipping north; on Sin Hill it is north 20 west, dipping north. This variation is interpreted as representing an anticline or anticlinal dome plunging steeply north. This interpretation is substantiated by the shape of the Upper Basalt-Upper Sediments contact at Pony Hill.

B. Faults

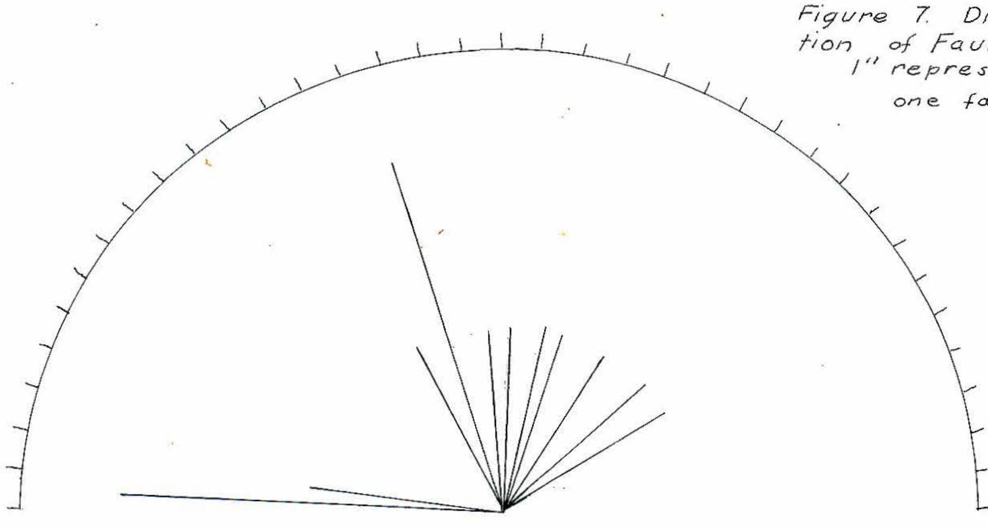


Figure 7. Distribution of Faults. 1" represents one fault.

The majority of faults trend northward, as seen from the distribution diagram, figure 7. Figure 8, the structure section, illustrated the possible tendency to form north-south blocks. The block between Hermes Hill and Hi Hill has apparently been dropped about seventy-five feet. The relations at this point are a result of interpretation in the field rather than concrete evidence. The block is bounded by normal faults, the easternmost dipping 64 west.

Mex Fault is apparently also a reverse fault. It dips approximately 55 north. Its displacement is approximately 200 feet if considered a dip slip fault. The apparent offset is approximately 650 feet.

The Upper Basalt-Upper Sediments contact is offset south of Sin Hill. If the following interpretation is correct, a method of determining relative ages of the north-trending faults and the east-west trending faults is available:

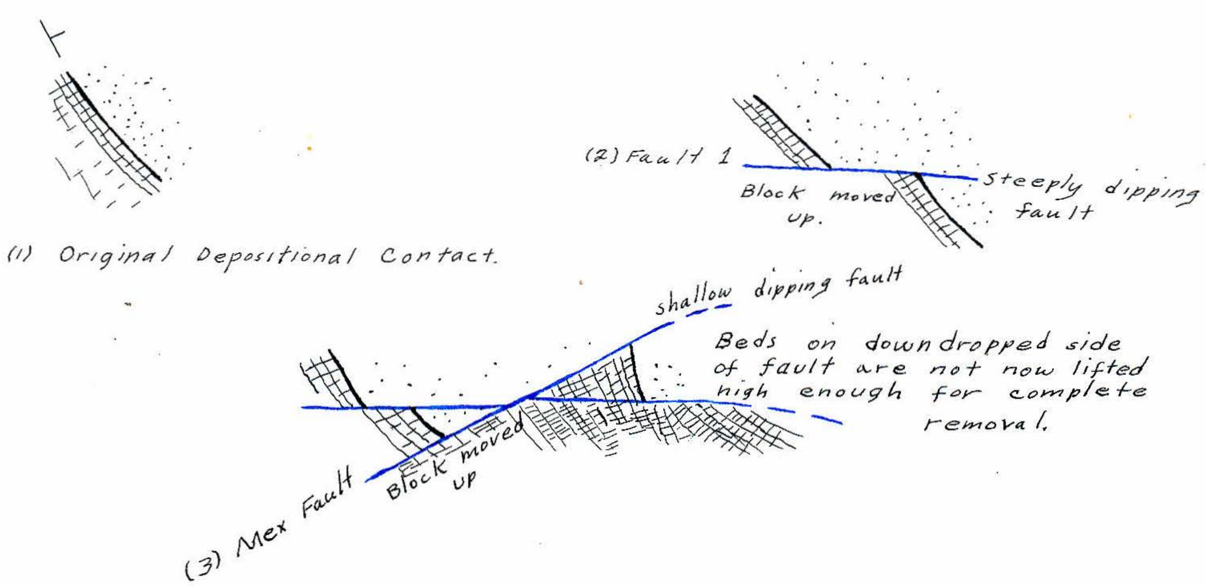


Figure 10. Intersecting Faults south of Sin Hill.

Thus it is possible the east-west faults are older than the north-south system.

STRUCTURE SECTIONS

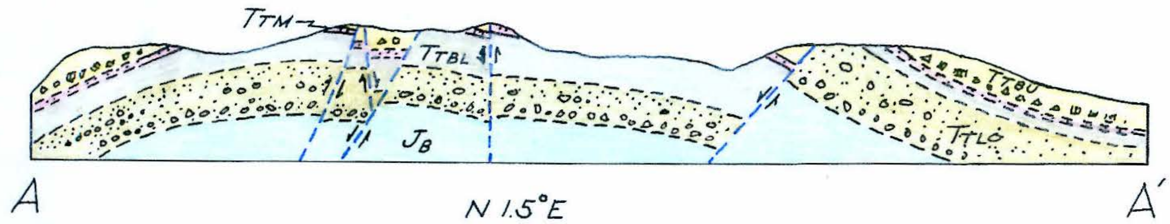


Figure 7

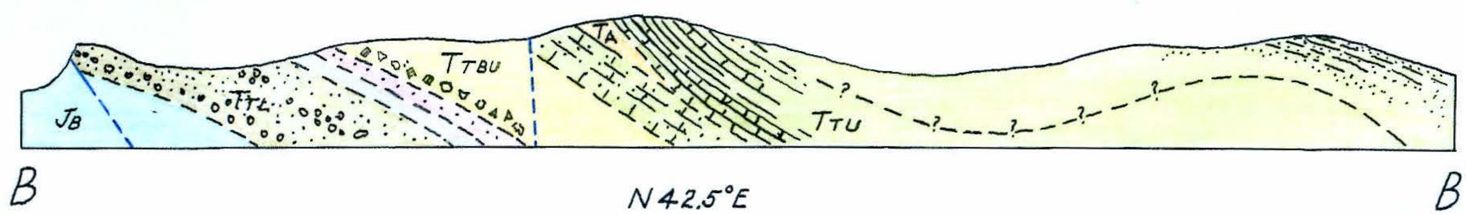


Figure 8

C. Other Folds

If the few isolated attitudes are sufficient evidence, the varying attitude near Lone Hill represents a syncline lying parallel to the Major Anticline axis. Also, the varying attitudes on the ridge east of Sin Hill may represent a syncline with the axis trending north. Finally, the attitudes on Top Ridge may possible be due to an anticline. The latter two possible structures are idealized in the second structure section, Figure 9. It is emphasized these other folds are purely conjectural. It might be more realistic to assume the block structure continues into the sedimentary section.

D. Structural Development

The foregoing observed structures may be tied into a coherent picture as follows: The east-west faults may have been produced at the same time a doming force was operating upward. The south sides of the east-west faults are observed to be up with respect to the north. The auxiliary folding, if such exists, may have occured as the result of outward horizontal pressure resulting from the doming. After cessation of the upward force, collapse may have taken place, with blocks dropping downward along the former line of upward force.

No evidence for dating the above events was obtained. However, the deformation was probably not connected with the mid-Pliocene orogeny, because the latter was the result of north-south forces acting southward.

GEOLOGIC HISTORY

1. Intrusion of granodiorite into gneissic country rock in Jurassic or possibly Triassic time.

2. History unknown until denudation of intrusive complex in mid-Miocene time.

3. Deposition of Lower Sediments by a transgressive sea.

4. Withdrawal of the sea; flow of basalt.

5. Period of weathering followed by stream deposition of Middle Arkose.

6. Welling up of hot mud from a volcanic vent and deposition of mudflow containing basalt fragments; immediately following is flow of Upper Basalt.

7. Submergence and deposition of Upper Sediments with the environment gradually shifting from calcareous and clastic to salicious and clastic deposition.

8. Intrusion of Andesite, forming small laccolith and disturbing beds.

9. Possibly doming resulting from upward forces made the area emergent and may have separated the mid Miocene Topango and upper Miocene Modello formations. Upon cessation of

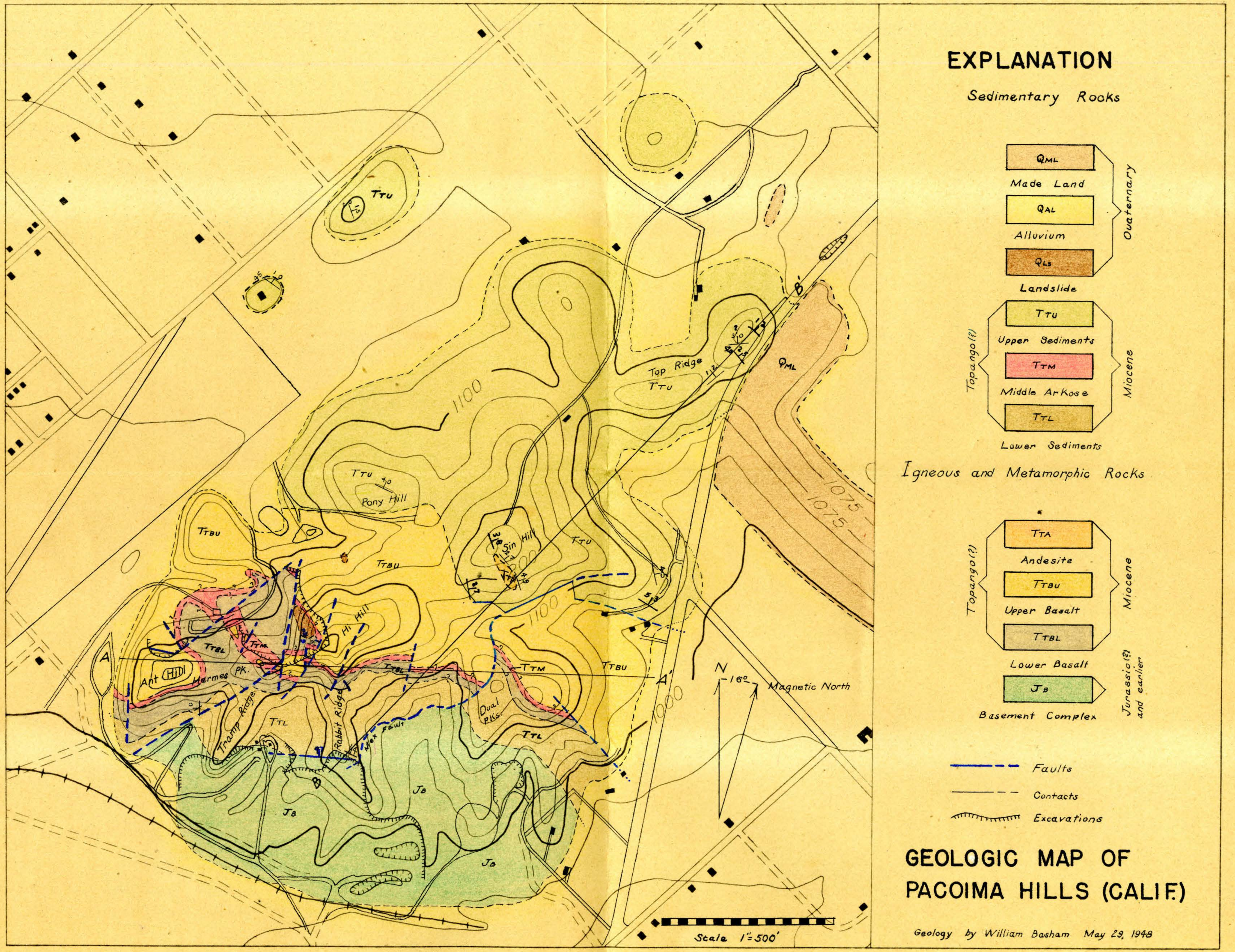
Figure 11. Small landslide on the north slope of Hi Hill. The slide occurs in the Upper Basalt.

upward force, the down-dropped blocks may have occurred.

10. Possible Pleistocene uplift and then erosion to approx-present height.

11. Possible formation of pediment (thought to exist in western portion of area) followed by more recent uplift with consequent tilting of pediment surface.

12. Continued erosion; small scale landsliding.


EXPLANATION
Sedimentary Rocks
QML
Made Land
QAL
Alluvium
QLS
Landslide
Quaternary
TTU
Upper Sediments
TTM
Middle Arkose
TTL
Lower Sediments
Topanga(?)
Miocene
Igneous and Metamorphic Rocks
TTA
Andesite
TTBU
Upper Basalt
TTBL
Lower Basalt
Topanga(?)
Miocene
JB
Basement Complex
Jurassic(?) and earlier
Faults
Contacts
Excavations
N
16°
Magnetic North
Scale 1" = 500'
Top Ridge
Pony Hill
Sin Hill
Hi Hill
Ant Hill
Hermes Pk.
Tramp Ridge
Rabbit Ridge
Dual Pks.
Mex Fault
1100
1075
1000
A
A'
B
GEOLOGIC MAP OF
PACOIMA HILLS (CALIF.)
Geology by William Basham May 29, 1948

5 846 m. ss.
6 833 L Sed
868 Base
889z Basalt.
4 848 U Sed
U Basalt 873
2 887
3 Qsl 817
1 Q fill
898 And
Lone Hill
Airport
1100
1000
BM
Monite
Granod.
Gn
Mex Fault