GEOLOGY OF THE HUMPHREYS STATION AREA
LOS ANGELES COUNTY
CALIFORNIA

A Thesis

by

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Submitted in partial fulfilment of the requirements for the degree of Master of Science in Geology, to the California Institute of Technology, Pasadena, California, 1947.

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AUTHOR'S NOTE

In the Eastern part of the Ventura Basin are several areas in which the details of structure and stratigraphy are little known. The Humphreys Station Area is one of these.

Although detailed studies of some of the formations here exposed have been made in other places, the only areal geologic mapping in the immediate vicinity was of a reconnaissance nature.* That work, although somewhat generalized, was sufficiently accurate that the understanding of the geology of the Ventura Basin as a whole was advanced by it. More intensive study naturally brings to light new evidences; and it is the writer's hope that the interpretations put forth in the present paper may be of value in the clarification of some of the current problems in the easternmost Ventura Basin.

* A semi-detailed report by C.D. Cooksey (1934) may be found in the divisional files of California Institute of Technology. This was presented as a Master of Science Thesis in 1934.

ABSTRACT

Six formations of Tertiary and Quaternary Age are present south of the Santa Clara River in the Easternmost Ventura Basin.

The upper Miocene non-marine Mint Canyon formation is successively overlain by the uppermost Miocene marine "Modelo" formation, the lower Pliocene marine Pico formation, the Pliocene-Pleistocene non-marine Saugus formation, and by Pleistocene terrace deposits and Recent alluvium. Angular unconformities characterize most of the boundaries between these formations, but disconformable relationships appear to exist locally.

As a result of two or more major periods of deformation, the rocks are highly folded, with broken anticlines and dips that vary from horizontal to vertical. Overturning occurs at least at one place. Compressive stresses from the north appear to have been the most active agents of deformation; but the block-type San Gabriel fault, which runs through the Southern part of the Humphreys Station area, may have had some tilting effect upon the beds throughout this whole region.

In general, the structural trend is northwest-southeast. Broad folds in the Mint Canyon formation plunge northwestward at low to moderate angles. Post-Modelo thrusting from the north has developed minor folds on the limbs of the major folds. Superimposed on the highly folded formations are the later formations, themselves slightly folded.

As a result of Quaternary erosion, the topography is

one of late youth to early maturity; with maximum relief in the mapped area of about 1000 feet.

INTRODUCTION

Previous Work

The first description of the oldest formation exposed in the Humphreys Station area was published in 1902. In that year O.H. Hershey (1) gave the name "Mellenia Series" to beds which were later called by Kew (see below), the "Mint Canyon" Series.

In 1901-2 G.H. El ridge (2) of the United States Geological Survey, made a survey of the Santa Clara River Valley in Los Angeles and Ventura Counties, and later a detailed map of the region was published.

A report and map by W.S.W. Kew (3) of the United States Geological Survey was published in 1924. This embodied the results of a survey of the geology and oil resources of a part of Los Angeles and Ventura Counties; and is still widely used as a general reference.

A study of the Vertebrate fauna in the Mint Canyon beds, made by J.H. Maxson (4) was published in 1930. He assigned the series an Upper Miocene age. Some of the identifications and interpretations put forth there were criticized by R.A. Stirton (5), in a paper published in 1933. Stirton advocated a Lower Pliocene age for the strata.

R.H. Jahns (6) in 1939, gave a description of the stratigraphy in the Easternmost Ventura Basin; and continued the work

on the vertebrate fauna. On stratigraphic evidence he subdivided the Mint Canyon formation, calling the lower part of the section the Tick Canyon formation, from the type locality, and retaining the name Mint Canyon formation for the remainder. Jahns places the Tick Canyon Series in the late Lower Miocene or earliest Middle Miocene, and the Mint Canyon formation in the Upper Miocene epoch.

C.D. Cooksey (7) in 1934, presented a refinement of a portion of Kew's map in a Master of Science Thesis submitted to the California Institute of Technology.

R.E. Wallace (8) made a study of the tuff beds in the Mint Canyon formation and presented his interpretations in a Master of Science Thesis to California Institute in 1940.

Bibliography:

(1) O.H. Hershey - Amer. Geologist Vol. 29, 1902.
Some tertiary formation of Southern California.

(2) G.H. Elridge and Ralph Arnold - U. S. Geol. Surv. Bull. 309, 1907
The Santa Clara Valley, Puente Hills and Los Angeles district of Southern California.

(3) W.S.W. Kew - U. S. Geol. Surv. Bull. 753, 1924.
Geology and Oil Resources of a part of Los Angeles and Ventura Counties, California.

(4) J.H. Maxson - Carnegie Inst. Wash. Pub. No. 404, Paper VII, 193(

(5) R.A. Stirton - Amer. Jour. Sci. vol. 26, 1933.

(6) R.H. Jahns - Carnegie Inst. Wash. Pub. No. 514, Paper IX, 1940

(7) C.D. Cooksey - California Institute of Technology Thesis, 1934.

(8) R.E. Wallace - California Institute of Technology Thesis, 1940.

Scope of the report

The present paper deals primarily with structure. A study of the formations adjacent to the Santa Clara River was undertaken in the hope that through detailed mapping, Mint Canyon beds south of the Santa Clara Valley could be correlated with some of those on the north side of the valley. This was soon found to be impossible, due to (1) the general parallelism of the strike of the strata with the course of the river valley, (2) the lenticular nature of the Mint Canyon beds, (3) scarcity of outcrops immediately adjacent to the valley. During this early work, an hitherto unreported fossiliferous formation was encountered, and the complexity of the structure in the underlying formation became apparent. It was deemed worth while to study and report these features.

Lists of fauna are included here. Tentative ages, deduced from these lists, are assigned to certain formations.

Tuff beds in the Mint Canyon formation serve effectively as marker beds. They give some clues as to possible structural interpretations; but are lenticular and hence must be used with caution.

Twenty-four field days were devoted to mapping in an area of approximately 11 square miles. The results of the investigation are here submitted in partial fulfilment of the requirement for the degree of Master of Science in Geology to the California Institute of Technology, Pasadena, California, 1947.

Acknowledgments

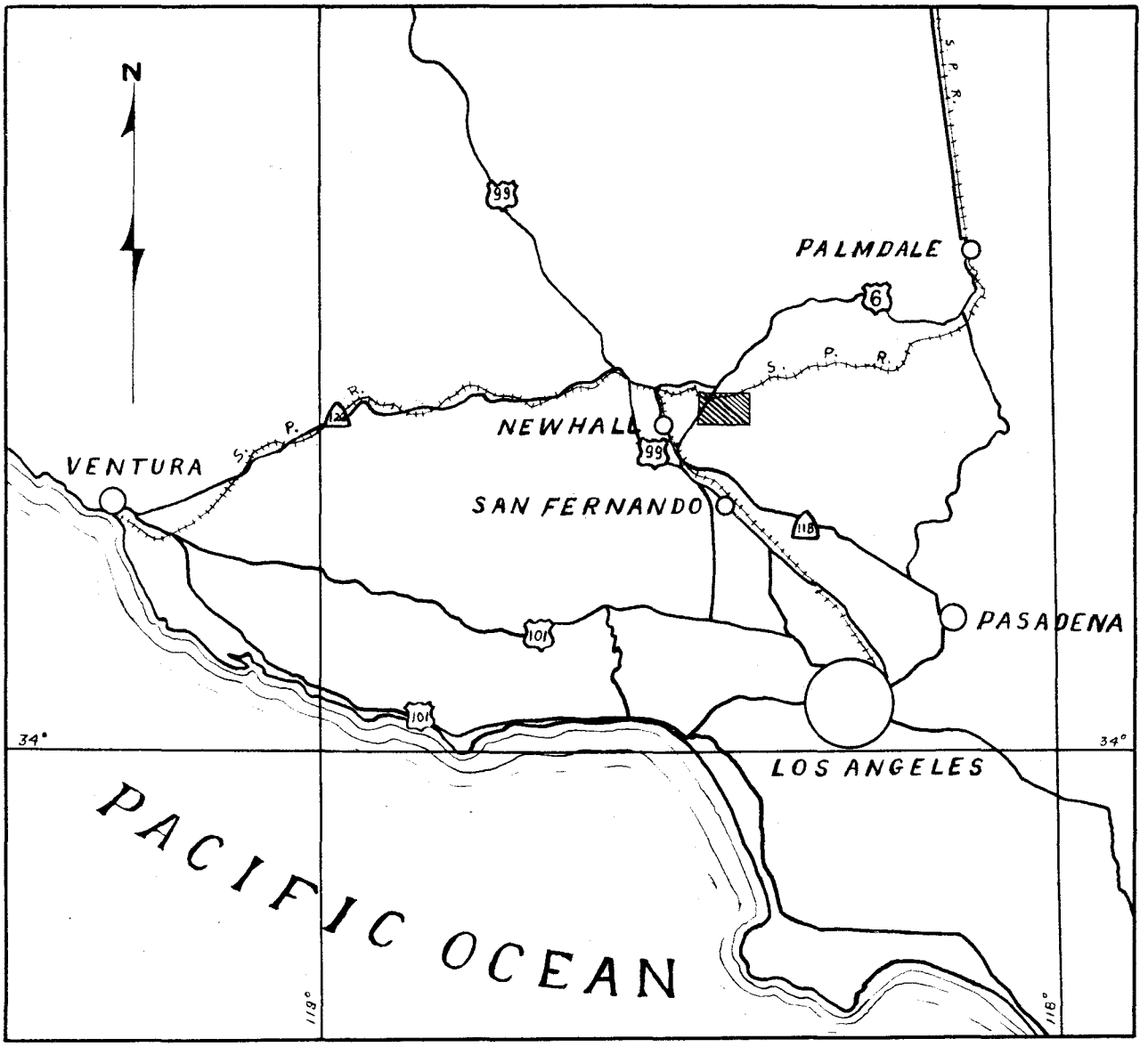
The writer is indebted to Dr. R. H. Jahns of the California Institute of Technology for helpful advice and supervision during the course of the investigation. Sincere appreciation is expressed to Dr. J. Wyatt Durham, also of the California Institute of Technology for his valuable suggestions and for the faunal identifications which he most kindly supplied. Dr. C. Stock supplied the necessary data on the vertebrate fauna found and sincere appreciation is hereby expressed.

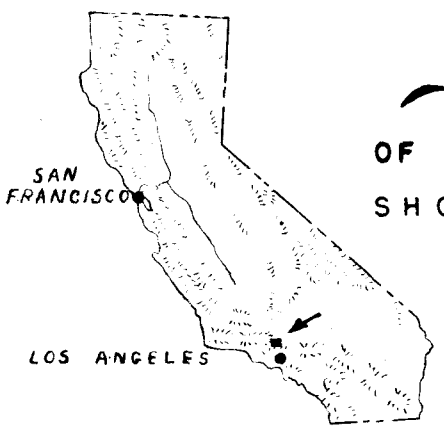
LOCATION

The Humphreys Station area lies in the northwestern part of Los Angeles County, California, and occupies portions of the southern part of the Humphreys and the northern part of the Sylmar quadrangles. It is approximately 25 airline miles north of Los Angeles and is easily reached by highway (U.S. Route 6) and by the San Joaquin Valley route of the Southern Pacific Railway. Los Angeles County Forestry Department roads and other side roads render good accessibility.

The mapped area is bounded on the north by the Santa Clara River, on the south by the Angeles National Forest boundary and Reynier Canyon, and on the east by Sand Canyon. No natural boundaries occur on the west side, where the area extends to a point about one and one-half miles west of Solamint in the northwest corner and to U.S. Route 6 about a half mile north of Placerita Canyon in the southwest corner. This boundary was arbitrarily chosen so that the major portion of the exposed Mint Canyon sediments in the immediate vicinity could be included in the mapped area.

The towns of Newhall and Saugus lie a few miles to west. Humphreys, a small station on the Southern Pacific Railway, is in the northeastern part of the mapped area.





INDEX MAP

OF A PORTION OF SOUTHERN CALIFORNIA
SHOWING THE LOCATION OF THE
HUMPHREYS STATION AREA

0 5 10 15 20 25 30 35 40 45 50
MILES

R. J. MacNeill 1947

GEOGRAPHY

Inasmuch as a rather complete description of the geography of the area is available in the literature, a brief statement will suffice here.

Climate:

The climate is semi-arid, annual rainfall being about 17 inches. Precipitation occurs almost entirely during the winter months. Most streams are intermittent. The mean annual temperature is approximately 60° F.

Vegetation:

Yucca, sage, manzanita and juniper grow in abundance on the upper slopes. Sycamore and live oaks are present along many canyon bottoms, where there is more moisture.

Sharp ridges, south slopes, grassy meadows, and alluvium-covered stream bottoms make up the only feasible traverse courses. Most north slopes and box-canyon bottoms are impassable.

Physiography:

As compared with the rugged San Gabriel mountains to the south, the Humphreys Station area is a low series of hills. However, elevations range up to 2400 feet with a maximum relief of approximately 1,000 feet. Slopes as steep as 40° (±) are common, and some steeper cliffs are found.

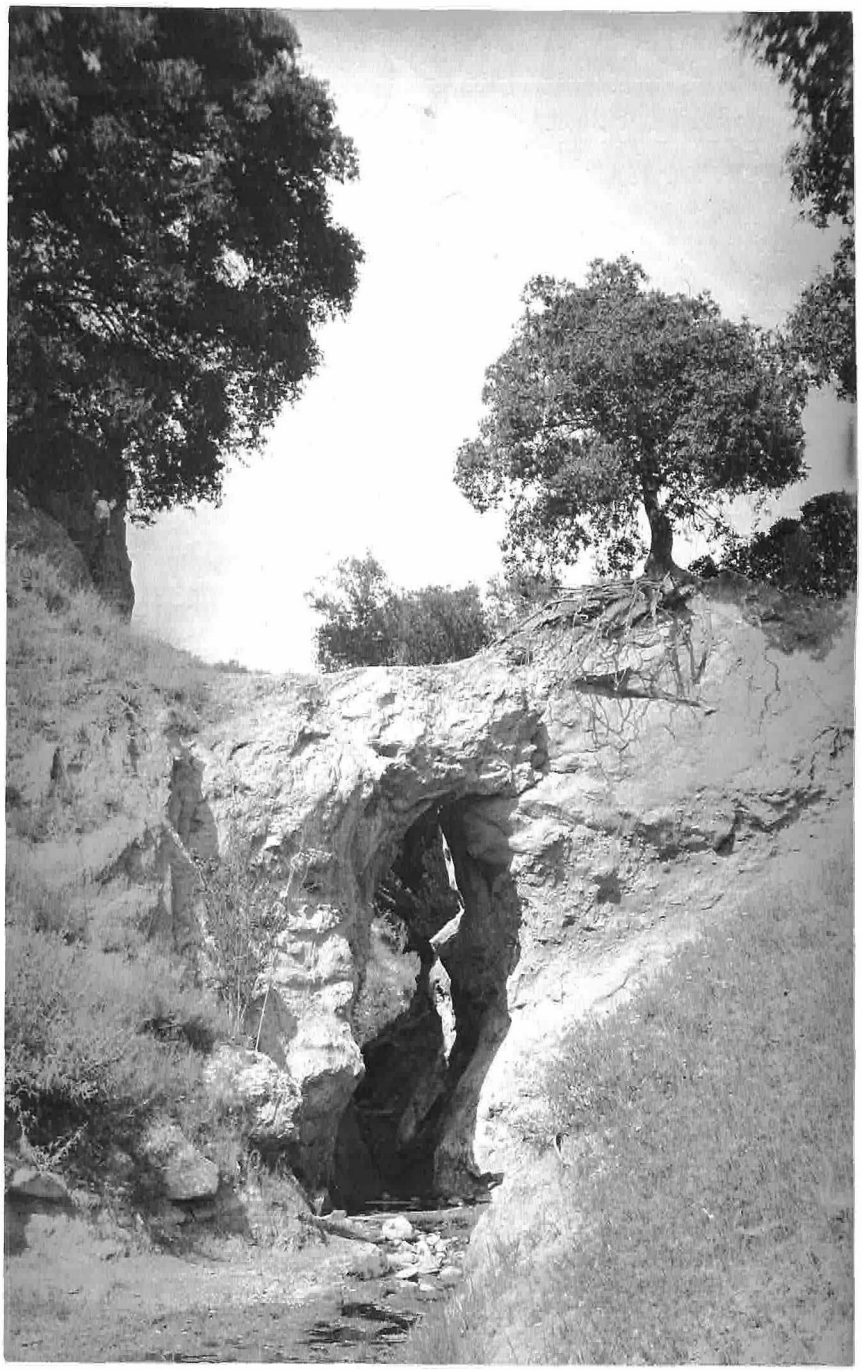
Structure does not appear to control the main drainage to any great extent, although several subsequent streams have cut gorges along the traces of fault planes and fault zones.

For the major portion of the area, the topography is one of early maturity. The main streams show signs of having almost attained grade. Small meanders have been established on the larger aggraded valley floors. The drainage system on the uplands is perfect.

The stream in Sand Canyon is antecedent relative to the structure in the Humphreys Station area; and subsequent tributaries empty into both it and the Santa Clara River.

Youthful features indicate a recurrence of downcutting accompanying recent uplift. Quaternary terraces are dissected, but are neither tilted nor offset by faults. Minor streams are downcut in narrow arroyos into their own alluvium.*

* North of the Reynier Canyon road, just off the mapped area, is a very interesting topographic feature. Here a small stream flows westward beneath a natural land bridge (See photograph next page).



A small natural arch over a westward-flowing stream immediately north of the Reynier Canyon Road. View facing eastward.

STRATIGRAPHY

Mint Canyon Formation:

The Mint Canyon formation, of both lacustrine and fluviatile origin, consists, in the Humphreys Station area, predominantly of sandstone and siltstone, with interbedded conglomerate, fanglomerate, clay, shale and tuff beds.

The conglomerates and fanglomerates are composed chiefly of igneous and metamorphic cobbles and pebbles. They vary in color from red-brown to buff to grayish. Most of the sandstones are buff. Brown-buff members are common and a few gray beds are present. Both these and the conglomerates are well consolidated. The siltstones, of a greenish cast, are relatively incoherent and grade locally into shaly and clay-rich members.

The tuff beds have been described in detail by Wallace (op. cit.). They are interbedded with the above members and in places are gradational both vertically and laterally into sandy tuff and tuffaceous sandstone and siltstone. The entire assemblage varies laterally and is cross-bedded. Ripple marks are common in the lacustrine facies, especially in some of the tuffaceous siltstones.

Subaerial deposition seems indicated for most of the formation here exposed although some subaqueous deposition undoubtedly occurred. A fluviatile origin for part is probable , judging from the sharp lateral and vertical variability, the prevalence of lenticular, often oxidized, conglomerates, and current ripple marks. Most common evidences for lacustrine

conditions are fresh water gastropods, oscillatory ripple marks and large delta formations.

Fresh-water lacustrine invertebrates have been found at two localities, one in the northeast corner of the area near section D-D' (plate I), the other on the easternmost anticline in section A-A'. At the first locality are found detaic forset and topset beds (figure I), and with the latter oscillation ripple marks. These two localities, well out in the major Mint Canyon syncline, point to the existence of lakes at the time these sediments were laid down. Whether or not the lakes were joined remains problematical; but the possibility undoubtedly exists.

In Mint Canyon time, the Humphreys Station region probably was part of a valley surrounded by uplands composed chiefly of granitic and metamorphic rocks. Rivers deposited the products of erosion from the uplands into local lakes. Rapid deposition resulted in alluvial fans and deltas, and a consequent shifting in the positions of the lakes as they became filled.

"Modelo" Formation:

Nonconformably overlying the Mint Canyon formation is the "Modelo" formation. Kew (op. cit. p. 67) thought that the "Modelo" from this area was probably to be correlated with the upper part of the "Modelo" of the type section. The formation is assigned to the Modelo group here because of its upper

Miocene age, as determined from invertebrate fauna, and its stratigraphic position. It is termed "Modelo" because it does not, as Jahns (op. cit. p. 166) points out, correspond in age to the Modelo stricto sensu of Hudson and Craig.*

Previously mapping in this area evidently has not disclosed the full extent of this formation.

* F.J. Hudson and E.K. Craig, Bull. Amer. Assoc. Petrol. Geol., vol. 13, pp. 509-518, 1929.

FIGURE (I)

View facing south from near the north end of section D-D' Mint Canyon Delta form dipping southwestward. Slumped foreset beds truncated by topset beds.

A major fault strikes northwesterly across the Humphreys Station area. North of this fault, and beneath a greenish-brown marine formation called Pico, appear wedges of creamy buff to rusty colored pebble conglomerate, sandstone and siltstone. Limy concretions and conglomeratic beds are locally rich in fossils. These wedges lie at an angular discordance of a few degrees from the overlying brown formations. Descriptively they resemble the lower section of the Pico as described by Kew (op. cit. p. 73) from west of Towsley Canyon.

Although certain faunal species collected here indicate an affinity to the conventional Lower Pliocene, two types have never been recorded from strata younger than Upper Miocene. This fact, in conjunction with the angular relations, is the reason for their being included here with the "Modelo". Some of these wedges have the characteristics of reefs. From one of them, the invertebrate and vertebrate fossils listed below were collected (see Figure II). High angular discordances characterize the contact between these wedges and the underlying Mint Canyon formation.

Two small areas, just east of U.S. Highway 6, are questionably shown as "Modelo" on the accompanying map. They are composed of brownish and greenish-gray thin bedded shales and siltstone with sandy members. Although no fossils were found in them, their stratigraphic position adjacent to the downthrown side of the fault, their more compact nature, (as opposed to the Pico shales) and their attitudes, suggest a correlation with the "Modelo". Possibly they represent a slightly more seaward facies.

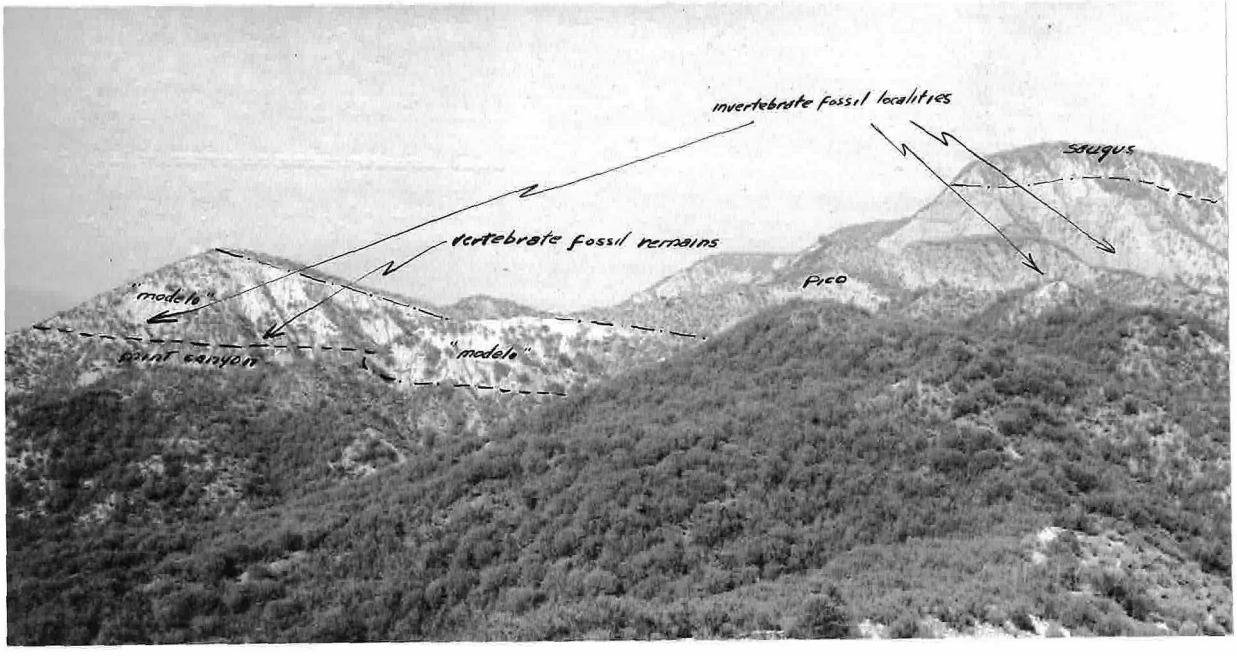


FIGURE (II)

View facing northeastward along section C-C'. Mint Canyon is foreground. Creamy wedge of "Modelo" shale, siltstone and conglomerate, overlying the Mint Canyon formation, and capped capped nonconformably by Pico and Saugus formations.

The large exposure of "Modelo" formation that describes an arc in the southeastern corner of the area forms steep bluffs as much as 200 feet high (Figure 3). The beds reach thicknesses of 10 and 15 feet (Figure 4). Buff and tan colors with rusty streaks predominate. Sandstone and siltstone with shaly layers make up most of the strata. Limy concretions, elliptical in shape, are common at certain horizons, generally in siltstone beds. Clayey diatomaceous shale beds also are present.

The "Modelo" formation was deposited under brackish-water and marine conditions, when an arm of the sea transgressed over this region in Upper Miocene time.

Pico Formation:

Four exposures of the Lower Pliocene Pico formation have been recorded on the accompanying map. In the large one, toward the east side of the area, the Pico formation unconformably overlies the "Modelo" formation in a broad synclinal basin with very gently sloping sides. The northwestern edge of this exposure forms high bluffs with a badland topography, and, as shown in figure 2, overlies the wedges of "Modelo" shale, siltstone and conglomerate with an angular discordance of only a few degrees. The southeastern part of this exposure is not as thick stratigraphically as the above portion. It may be seen in figure 4 overlying the "Modelo" cliff in this region.

The next exposure westward lies between two faults and rests directly upon Mint Canyon beds. It is a rather thin capping on a ridge. The third exposure, near the fire department road on section B-B', forms northward facing cliffs. It cannot be traced for any great distance.

FIGURE (III) View to northward from near the south end of section E-E'. "Modelo" formation bluff, capped by darker Pico formation.

FIGURE (IV) View westward along the southeastern "Modelo" formation bluffs illustrating the thickness of the beds. Pico formation in upper right corner.

Near the northwestern corner of the mapped area, a cut-bank of the Southern Pacific Railroad right-of-way is in the fourth exposure of Pico. Here the lithological character is somewhat different from the above three; but it is correlated with them on paleontological evidence.

The first three are composed of brown siltstones and sandstones. Greenish siltstones and green and grey shales are common. Toward its upper edge, where it is in contact with the Saugus, beds of pebble and cobble conglomerate appear. These are rather persistent in lateral extent. Fragments and veinlets of gypsum are widespread throughout the formation. Small limonitic concretions feature the clayey sandstones. Limy concretions containing fossils occur chiefly in the lower strata.

The fourth exposure consists of greenish, greenish-blue and brown siltstones and shales, and is perhaps a more seaward facies.

The Pico formation in the Humphreys Station area evidently was laid down in quiet marine waters relatively near shore. The presence of the conglomerate layers indicates periods of rapid detrital transport.

Saugus Formation:

The Saugus formation overlies the Mint Canyon "Modelo" and Pico formations with pronounced nonconformity. Marine analogues to the west yield invertebrates of late Pliocene and

early Pleistocene affinities. Consequently the Saugus of the present report is assigned these ages. It has been described by Hershey (op. cit. pp. 359-362) as "a great series of unlithified sand, gravel and clay whose physical characters are unmistakably those of an alluvial deposit, a river delta, progressively sinking."

In occuping the western and southern boundaries of the Humphreys Station area, the Saugus beds rest directly upon the Mint Canyon formation. In the eastern syncline they truncate the Pico formation at low angles. This eastern part of the formation is composed of rusty colored conglomerates, and gray buff and yellow sandstones. Judging from topography alone, the eastern portion of this synclinal area north of 34° 24' may possibly be Quaternary terraces such as those described below. It is impossible to confirm this, however, owing to lack of exposures. Along the fire department road and adjacent to the San Gabriel fault, the Saugus formation is rusty and conglomeratic, with some grey sandstone bands and lenses of green shale.

The large re-entrant that crosses U.S. Highway 6 has a lighter colored aspect in its upper part and is distinctly gray in its lower portions. Possibly some Pico sediments occur here, but they have not been recognized as such by the author. Toward the southwestern end of section A-A' the rusty conglomerates predominate. West and northward from here the coarse conglomerates become less abundant and red beds several feet in thickness appear. Thick beds of loose

buff colored sandstone are common. Saugus strata are poorly consolidated and the sandstones in places appear to be rather arkosic. The conglomerate fragments grade in size to cobbles and boulders as much as two feet or more in diameter. Boulders of Mint Canyon sandstone and conglomerate are present locally. Limonite-stained fractures and joints cut the formation.

The Saugus formation probably is entirely of terrestrial origin. Cross bedding, lateral variability, irregular grain size all suggest the probability of an alluvial fan or similar type of deposition.

The Saugus formation in some areas to the westward has been found to be marine. That described here can be assumed to be nearer the source of the sediments.

No fossils were collected from the Saugus formation during the course of this investigation.

Terraces:

Quaternary terraces have been recognized in only two localities in the Humphreys Station area. One lies just east of U.S. Highway 6 and south of the San Gabriel fault, and the other is near Solamint at the north end of section A-A'.

As pointed out above, there is a possibility that the material mapped as Saugus beds northernmost on section D-D' may actually be terrace deposits.

The deposit near Solamint is only exposed in a road cut. It is a brownish pebble conglomerate with sandstone layers, and is apparently flat lying.

Key to map next page that illustrates the relationship of topographic features to the predominating lithologic types.

Alluvium

Very poorly consolidated sandstone and conglomerate.

Poorly consolidated arkosic sandstones and conglomerates.

Predominately gypsiferous, poorly consolidated siltstone with interbedded shaly, sandy, and conglomeratic beds.

Shale and siltstone, poorly consolidated.

Predominately siltstone, less sandstone, and minor pebble conglomerate and silty shale. Moderate degree of consolidation.

Well consolidated sandstone, siltstone, conglomerate and fanglomerate.

Scale 1:24000

1 0 1 Mile

500 0 500 1000 1500 2000 2500 Yards

1000 0 1000 2000 3000 4000 5000 5000 7000 Feet

1 .5 0 1 Kilometer

Contour interval 5 feet and 25 feet (see diagram)

Datum is mean sea level

25 ft

5 ft

ROUTES USUALLY TRAVELED

HARD IMPERVIOUS SURFACES

OTHER SURFACE IMPROVEMENTS

U. S. ROUTE 1944 STATE ROUTE

The terrace south of the San Gabriel fault has a slight dip to the southwest, and is composed of unsorted coarse subangular conglomerate and gravel in a sandy matrix. Reddish brown is the predominant color.

These thin deposits of terrace conglomerates can only be distinguished from Saugus conglomerates on the basis of their flat dips, their flat erosion surfaces, their poorer degree of sorting and consolidation, and their relative incoherence.

Deposition, under flood plain conditions, of detrital material derived from the nearby basement complex, is the probable mode of origin.

Alluvium

Recent alluvium forms broad flats in the larger canyons. Tributary creeks have deposited recent sediments as tongues leading into these canyons. In most cases, the streams at present are entrenched a few feet into these deposits.

PALEONTOLOGY

Mint Canyon Formation

Two localities within the Humphreys Station area have yielded Mint Canyon fossil remains during the course of this investigation. Cooksey (1) reports three fossil localities, one yielding prosthennops and another the low jaw of Hypohippus.

One fossil locality found by the present author was examined by Dr. J. Wyatt Durham of the California Institute

(1) (op. cit. p. 16)

of Technology. It occurs in the northeastern corner of the area near section D-D', as shown on plate I. The fauna from there is listed in C.I.T. location #1667 and has been identified by Dr. Durham as:

Sphaerium sp. (pelecypod)
"Hydrobia" sp. (gastropod)
Ostracod sp. (rare)
Lime secreting algae
Worm(?) tubes

Age indeterminate. Apparently represents lacustrine deposition.

The other, on the anticline toward the north end of section A-A' yielded fresh water gastropods.

"Modelo" Formation

Invertebrate remains are common in the "Modelo" formation. From one locality (C.I.T. 1663), in a stratigraphic wedge just west of section C-C', Dr. Durham has identified the following list. The comments regarding age which follow the lists are his also.

Crepidula princeps Conrad
Norrisia (?) sp.
Turritella cooperi Carpenter ?
Trophosycon ocoyana (Conrad)
Crepidula sp. indet.
Ostrea titan Conrad, var.
Mytilus coalingensis Arnold?
Lyropecten estrellanus (Conrad)
Chlamys n. sp.
Mytilus sp.

Anadara trilineata Conrad?

Lucina sp.

Chione fernandoensis English

Pododesmus macroschisura (Deshayes) ?

Pecten wattsi Arnold?

Patinopecten s. sp.

Chelonian materials

Terebratalia transversa caurina Gould

Age - upper Miocene, in conventional Pacific Coast terminology, based on the occurrence of Lyropecten estrellanus (Conrad) and Ostrea titan Conrad, var. Some of the other species indicate an affinity to the conventional lower Pliocene, the Elsmere Canyon fauna, but the above two species have never been recorded from strata younger than upper Miocene.

In another "Modelo" exposure northeast from this point some of the same species may be found. Correlative types have been collected from the "Modelo" bluffs in the southeastern tip of the area by Mr. Lauren Wright.

Vertebrate remains occur at both the first two localities mentioned above. Dr. Chester Stock of the California Institute of Technology examined the site at C.I.T. Location 1663, and reports the following:

> Although several fragments of bone were collected at the site of the fossil Sirenian, the only determinable element comprised the proximal portion of the forearm, namely the articulation formed by the radius and ulna. These two elements were fused. The specimen

evidently represents a large, heavy-limbed type of sea cow. Unfortunately, the genus cannot be definitely determined on the basis of the available material and the comparisons it permits. Consequently no geologic age identification can be reached. Sea-cows other than Desmostylus are known from the Miocene of California. For that matter Desmostylus itself is known from the upper Miocene. No skeletal remains have yet been referred to this form.

At the location to the northeastward between sections C-C' and D-D', bones tentatively identified as being from a turtle have been collected.

Cooksey (1) reports the skull of a Cetothere incarcerated in a calcareous boulder, from the Pico formation just west of the road leading south from Humphreys Station. It is described as showing primitive characteristics of lower Miocene. Perhaps this came from one of the wedges herein recognized as "Modelo" formation.

Pico Formation

Invertebrate remains are scattered abundantly throughout the Pico formation. Toward the northwest end of the main syncline south of Humphreys Station, collections from two localities have been identified by Dr. J.W. Durham.

(1) (op. cit. p. 21)

The first of these, C.I.T. location #1664, has yielded:

Cardium sp. indet.

Patinopecten healeyi (Arnold) ?

Marcoma cf. secta (Conrad)

Trophosycon ocoyana subsp. contignata (Grant and Gale)

Forreria avita (Nomland)

Cancellaria sp. indet.

Cancellaria cf. gemmulata Sowerby

Turritella cooperi Carpenter?

Megasurcula n. sp.

The occurrence of Patinopecten cf. healeyi, and Trophosycon ocoyana subsp. contignata indicates that this fauna is not younger than Lower Pliocene.

The second, C.I.T. location #1665, has yielded:

Trophosycon ocoyana Subsp. contignata (Grant and Gale)

Neverita reclusiana (Deshayes)

Nassarius moraniana (Martin)

Kelletia sp.

Terebra sp.

Olivella pedroana (Conrad)

Solen sp.

Dosinia sp.

Chione sp.

Apolymetis sp.

Anadara sp. (Young)

Undetermined gastropods and pelecypods.

On the basis of the Trophosycon this fauna appears to be no younger than Lower Pliocene.

From the small outcrop of Pico beds on section B-B', shark teeth, gastropods and other marine fossil fragments have been collected.

A collection made from the railroad cut near the northwest corner of the mapped area yields the following forms which have been identified by Dr. J.W. Durham.

This is C.I.T. location #1666.

Patinopecten healeyi (Arnold)

Macoma secta (Conrad)

Indet - maticoid

Lyropecten cf. estrellanus var. terminus (Arnold)

Chione sp. indet.

Age apparently Lower Pliocene, based on presence of Patinopecten healeyi and Lyropecten cf. estrellanus terminus.

No fossils have been found by the author in any formations younger than the Pico.

STRUCTURE

General Statement;

The Humphreys Station area exhibits results of crustal movements as are characteristic of the California Coast Ranges as a whole. Tertiary and younger formations have been buckled and broken by stresses probably of both compressive and tensional nature.

This area, a small segment of the Ventura Basin, may be considered as having been down dropped relative to the granitic masses to the southward and eastward. It lies in a roughly V-shaped re-entrant between two major faults upon which the San

Gabriel mountains have moved upward. These faults are off the southern and eastern boundaries of the accompanying map. Prior to this Pleistocene orogeny, the tertiary beds had been folded and faulted by stresses from the north. The Pleistocene tilting has modified these earlier effects.

The structural axes exhibit two distinct trends, one typified by the San Gabriel fault and the fault approximately paralleling it on the north (for convenience called fault A); the other typified by the small thrust fault (for convenience called fault B) cutting fault A, and the axis of the major basined syncline south of Humphreys Station. Axes of the minor folds trend approximately parallel to either of these directions. The southern half of the area is tilted northward between the San Gabriel fault and fault A.

Faulting

Fault A, the oldest major fault in the area, offsets Mint Canyon and "Modelo" strata. It is steeply overthrust from the north, as shown on the accompanying sections (plate II). The fault plane is apparent at only one locality - the highway section on A-A'. From here it trends southeastward; and the vertical offset upon it presumably increases in that direction. This assumption is based upon the increase in offsets in the "Modelo" strata.

The base of the "Modelo" formation is apparent in a steep gorge immediately north of the fault on section D-D', where the strata dip gently northward. The dips of the "Modelo"

south of the fault are utilized here and in section E-E' to calculate the probable offsets in that formation. Overthrusting is assumed from the following evidence: (1) Vertically beneath the Mint Canyon tuff bed paralleling section E-E' on the east are "Modelo" sediments. The Mint Canyon formation must have been thrust upon the "Modelo" at this point. (2)Overturning of the south arm of a small anticline occurs immediately north of the fault on section B-B'. The northwestern extension of this fault in the area cannot be traced. Neither is its position apparent between sections B-B' and C-C'. At this point it has been itself broken and offset by fault B. A post-"Modelo" pre-Pico age must be assumed, inasmuch as the "Modelo" formation is offset by the fault, and neither the Pico nor the Saugus formations along the trace of the fault are disturbed in any way.

Fault B is merely the break resulting from an overthrust anticline. It can be traced only by means of the sharp discordance in attitude of the sediments adjacent to its strike. Its lateral extent cannot be great, and indeed may not be as great as that represented on the accompanying map. Fault B closely postdates Fault A. The anticlinalfolding of which it is a consequence has not markedly affected the Pico beds between it and fault A. It is therefore assumed to be also post-"Modelo" and pre-Pico.

The San Gabriel fault, which cuts across the southwest corner of the area, is a tectonic feature of major importance. Dip-slip components have been the chief directions of movement

ascribed to it in earlier reports. The author found no field evidence which might cast doubt on this hypothesis. Undoubtedly the south side has dropped down relative to the north side along this branch of the fault zone (See sketch on following page). The dip of the fault is unknown but it is presumed to be essentially vertical. Mint Canyon and Saugus beds are dragged to highly tilted positions near the fault plane. Most of the movement, the results of which are now seen, occurred after the Saugus beds were laid down.

Little or no fault activity can have occurred since the deposition of the flat lying Quaternary terraces. These are quite close to the fault zone and should reflect any major movement of Late Pleistocene age on it.

No estimate of the vertical displacement was obtained during the present investigation, because the base of the Saugus south of the fault was not found. Several minor faults, associated with the major breaks, are shown on plate I.

Folding

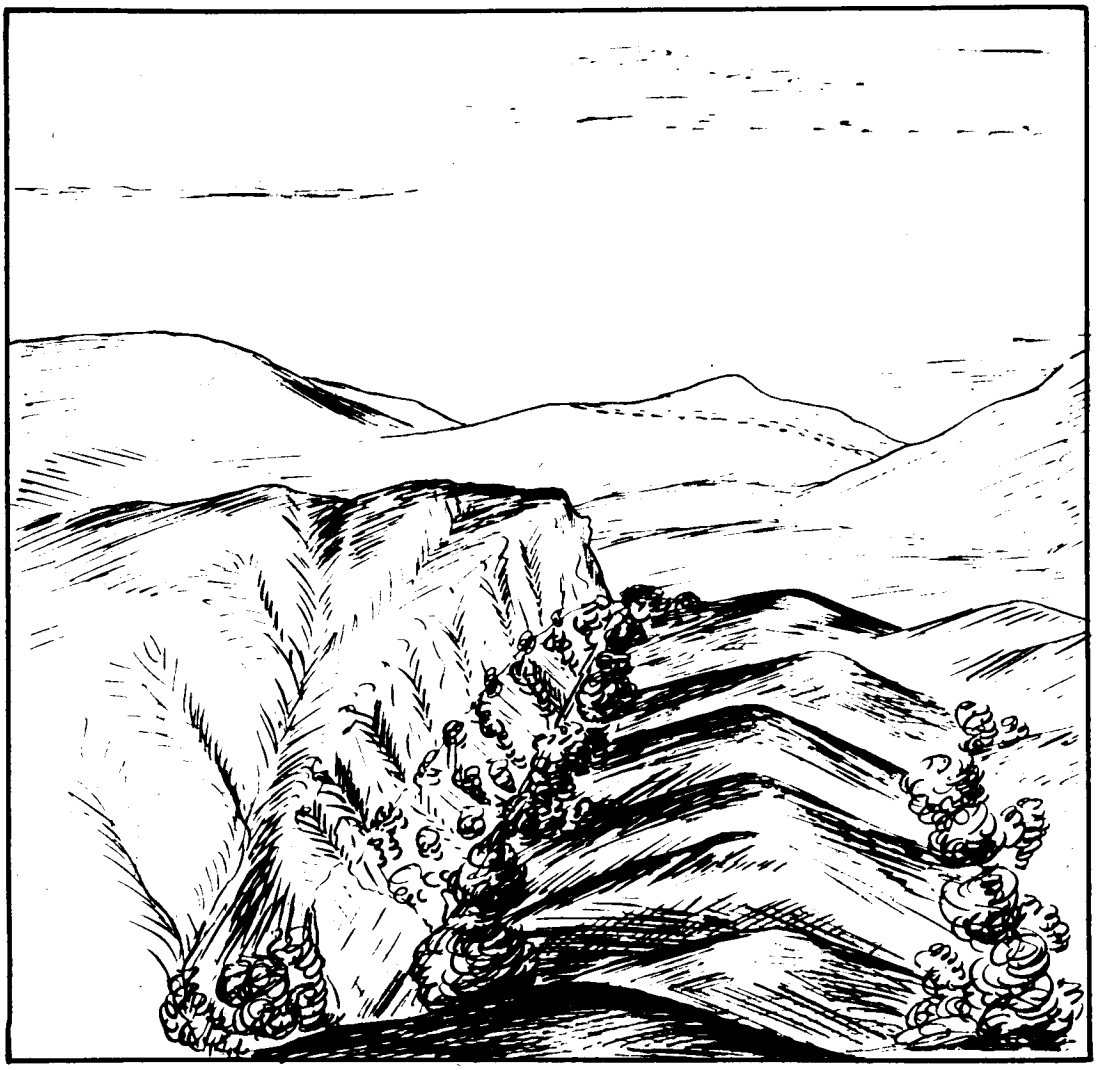
Two major synclines and two major anticlines have resulted from pre-Pliocene orogenic movements. These diverge as they plunge northwest, and apparently disappear beneath the alluvium just west of U.S. Highway 6. This effect is best seen by a study of the sections, (plate II), in which only one major anticline and syncline appear on the two eastward sections. The attitude of the Mint Canyon formation, where it disappears under the Saugus along the south side of the area, can only be deduced by projecting the dips and strikes seen in the southeast corner near section E-E'. Consequently, the structural picture presented here is highly hypothetical.*

* An alternative interpretation would be to consider this Mint Canyon anticline asymmetric, with its axis farther to the North beneath the area of no outcrops. This northward tilted anticline would necessarily die out before reaching the area of exposed Mint Canyon strata shown in the southeastern portion of the map, where attitudes which would conflict with this hypothesis are recorded.

Field sketch facing southeastward along the San Gabriel fault.

The south block, on the right side of the sketch has been downthrown relative to the north side.

The steeply dipping beds and fault scarp, and the break in topographic profile and types, all are distinctive features.



Broad open flexures in the Pico and Saugus formations are superimposed upon the above mentioned folds.

The syncline shown crossing the highway in the large Saugus re-entrant is illustrated in figure 5. The lower beds in this photograph may well be Pico. They differ in lithologic character from those in most of the Saugus studied.

The Saugus-Mint Canyon contact immediately south of this point is in doubt also.

The large syncline in the Pico-Saugus formations south of Humphreys Station apparently is broadly basin shaped, with a shallow plunge southeastward at its westward extremity.

Highly complex folding occurs in the Mint Canyon from section A-A' to section C-C'. Drag folds (figure 6) and overturning (figure 7) may be seen. Tuff beds studied in aerial photographs prove to be some help in unraveling the picture. Amplitudes of these folds remain problematical and the picture as shown on the accompanying sections must be considered as diagrammatic only.

Tuff beds:

Wallace (op. cit.), in his study of the Mint Canyon tuff beds, made a tentative correlation with tuff beds exposed north of the Santa Clara River, in an area where Jahns (op. cit.) had measured a section in the Mint Canyon formation. This correlation indicates that that portion of the formation exposed west of section B-B' (plate II) belongs in the upper 1,000 feet. That in section E-E' is, of course, much lower in the sequence.

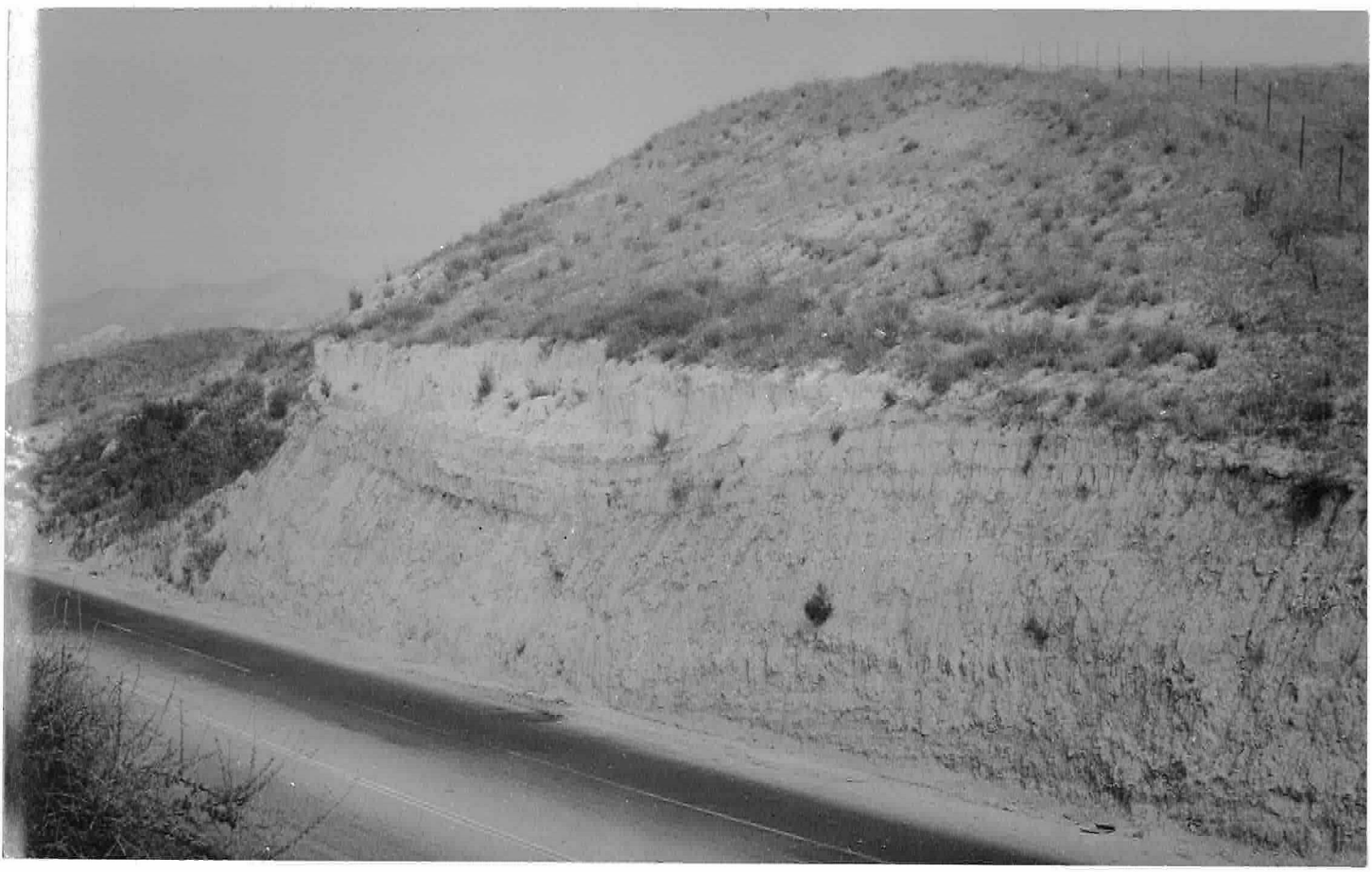


FIGURE (V) Syncline in the Saugus formation exposed on east side of U.S. Highway 6 half a mile north of the San Gabriel fault. Possibly the lower half of the photograph is in reality Pico formation.

FIGURE (VI) View to northward from broken anticline on section B-B'. Large scale drag folding made apparent by a Mint Canyon tuff bed.

FIGURE (VII) Overturned anticline at fault A on section B-B'. View facing westward.

Only the tuff beds shown on plate I have been diagrammatically represented on the sections, (plate II). Doubtless several more tuffaceous horizons occur in the Mint Canyon formation, and possibly in the "Modelo" formation also.

Jahns (op. cit.) describes ten tuff beds in the Mint Canyon formation north of the Santa Clara River. It is reasonable to assume that ashy representatives of most of these periods of volcanism reached at least this short distance south. Lacustrine and stream currents may have effectively dissipated some of these pyroclastic materials and concentrated others into lenticular beds.

Eight tuff horizons, denoted by Roman numerals, are shown on plate I. The first seven appear in the sections (plate II) where tentative extrapolations are self-explanatory.

Note:- As an alternative hypothesis--

There exists a strong possibility that tuff bed I, from east of Sand Canyon may swing sharply northwestward to correlate with tuff exposures shown in the northeastern corner of the area. Should this be the case, structure sections D-D' and E-E' must be more steeply south dipping in their north central portions. This would mean that the north arm of the syncline is steeper than shown, and that the Mint Canyon beds there are consequently farther down in the sequence. This possibility, and its consequences, is illustrated by the broken red lines on sections D-D' and E-E'.

GEOLOGIC HISTORY in tabular form

Recent: Alluviation and minor uplifts.

Upper Pleistocene:
(2) Uplift and dissection of terrace deposits
(1) Terrace deposition on broad floodplains

Major block faulting - San Gabriel fault

Lower Pleistocene-Upper Pliocene: Continental Saugus sedimentation as alluvial fans and shallow lake deltas.

Minor folding and erosion

Lower Pliocene:
(2) Recession of marine waters
(1) Transgression of the sea - Pico sedimentation in deep waters. Many climatic disturbances resulting in periods of rapid detrital transport.

Erosion

Uppermost Miocene:
(2) Uplift with recession of the marine waters and compression from the north - Fault A. Further compression resulting in steep folding and overthrusting - Fault B.
(1) Transgression of the sea - "Modelo" marine deposition in the subsiding basin.

Erosion

Middle-Upper Miocene:
(2) Uplift accompanied by folding
(1) Mint Canyon sedimentation as alluvial fans and deltas. Basin gradually subsiding, 4,000' (±) of continental sediments.

Volcanism in adjacent areas - deposition of pyroclastic material ?

Uplift and erosion?

Early Tertiary:

(2) Deposition of pre-Mint Canyon sediments (not exposed in the Humphreys Station area)

(1) Major orogenic movements - at which time the basin of deposition for the above sediments was formed.

CONCLUDING REMARKS

The "Modelo" formation, tentatively correlated with true Modelo, has a greater lateral extent in the Humphreys Station area than was formerly known. Possibly this is true also in other areas in the eastern Ventura Basin, especially to the west. Thrusting or reverse faulting, parallel to the San Gabriel system, has occurred much earlier in geologic time than the San Gabriel faulting.

No probability of oil accumulation is held for the area, as Mint Canyon strata, not believed to be source beds, underlie the later formations at no great depths. Detailed mapping in an area a few miles north has shown that beneath the Mint Canyon beds, and immediately above the basement complex, is a series of continental sediments - the Vasquez formation. Probably these sediments underlie the Mint Canyon strata in the Humphreys Station area, as well. They are not believed to contain source beds for petroleum.

A correlation with strata exposed on the north side of the Santa Clara valley, is potentially possible only in the northeast corner of the Humphreys Station area.