GEOLOGY OF THE HASKELL CANYON REGION, SOUTHERN CALIFORNIA

by

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In Partial Fulfillment of the Requirements for the Degree of Bachelor of Science

California Institute of Technology
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Contents

ILLUSTRATIONS

INTRODUCTION

Location of the Area

The Haskell Canyon region, located in the northeast portion of Los Angeles County, California, occupies a rectangular block of approximately 10 square miles in area, the center of which is some 50 miles northwest of Los Angeles (Plate 1). The region may be described as that portion of the Sierra Pelona Mountains[1] which occupies the area bounded by latitudes 118°30' and 118°27' and meridians 34°32' and

[1]The writer has extended the term Sierra Pelona (Bald Mountain Range) to include that part of the Peninsula Province generally referred to as the Ridge Route Mountains whose boundaries are, roughly, the Tehachapi Mountains and the Antelope Valley on the north, the Mojave Desert on the east, the San Gabriel Mountains and the Santa Susana Mountains on the south, and the San Ynez Mountains on the west.

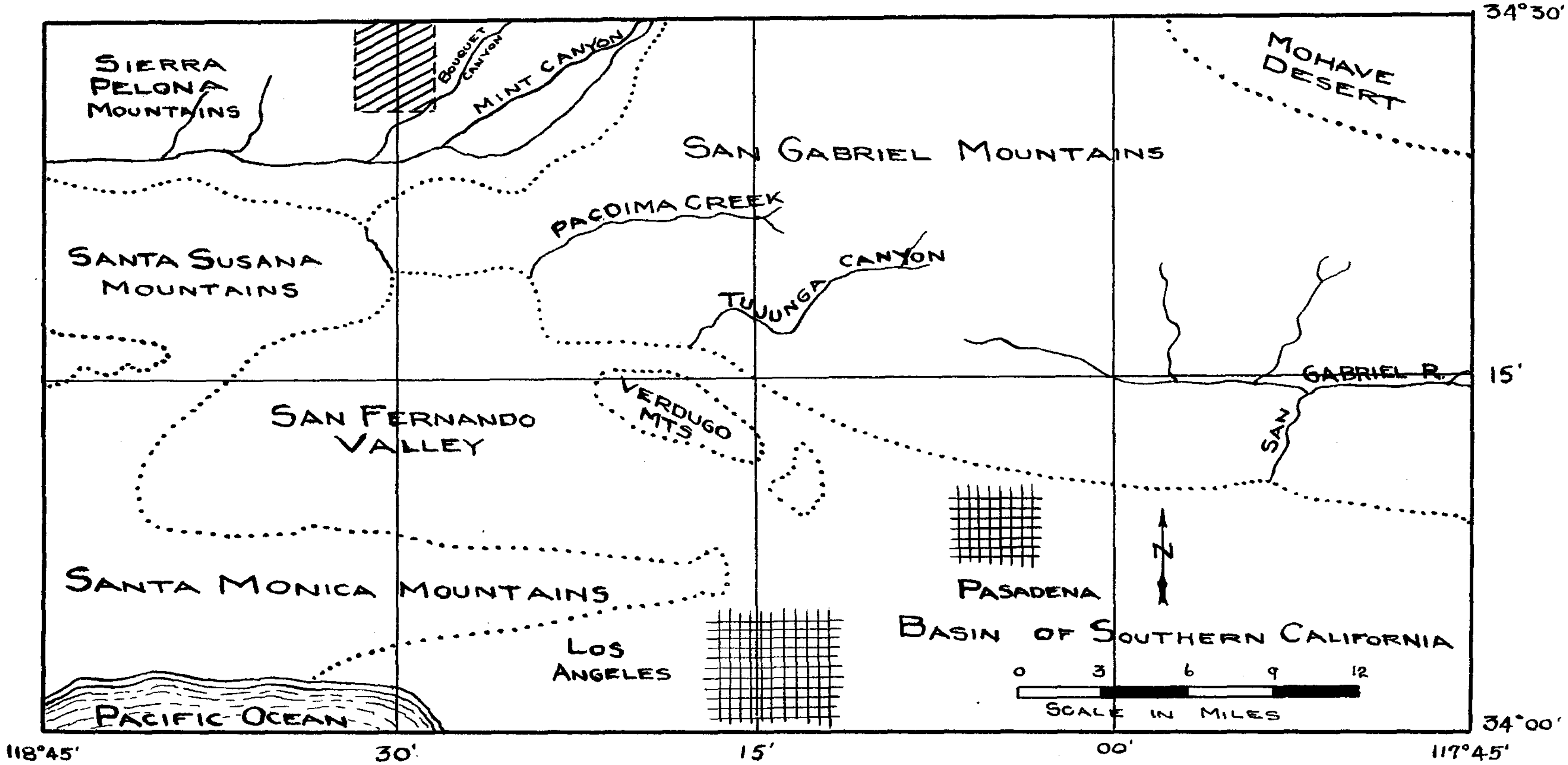


Plate 1 Index Map

Location of Plate 2 is shown by the shaded area.

34°28'. The area mapped extends from Bouquet Canyon northward the length of Haskell Canyon, a distance of about $4\frac{1}{2}$ miles. It may be readily reached from Saugus, a small town ($1\frac{3}{4}$ miles to the southwest) on the main line of the Southern Pacific Railroad to San Francisco and on U.S. Highway Number 99. All parts of the area are readily accessible for numerous roads cut ~~the~~ it. ~~area~~.

<u>Purpose and Scope of the Investigation</u>

A detailed study of the area was undertaken as partial fulfillment of the requirements for the degree of Bachelor of Science at the California Institute of Technology, Pasadena, California.

The writer was primarily interested in a stratigraphic problem was fortunate in having such an area accessible.

In 1924 the area was mapped on a small scale base map (1 mile to the inch, with a 50 foot contour interval) by Dr. W.S.W.Kew[1]. This work was done in connection with the mapping of certain oil-bearing or potentially oil-bearing districts of Los Angeles and Ventura Counties and little or no detailed mapping was carried on in the Haskell Canyon region.

At the suggestion of Dr. John H. Maxson of the California Institute of Technology, the writer remapped the Haskell Canyon region. It is the writer's belief that such a remapping was justified for now large scale maps of the Saugus and Humphreys Quadrangles are available. (These topographic maps have a scale of 2000 feet to the inch and a contour interval of 5 and 25 feet.) Moreover, new roads have been built, in connection with the maintenance of the Los Angeles Aqueduct Reservoir and the Edison

[1]Kew, W.S.W. Geology and Oil Resources of a part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull. 753, 1924.

power distribution system, which facilitate the interpretation of a somewhat complex structure.

In the northern portion of the area there occurs a series of igneous and metamorphic rocks which, while interesting and offering opportunity for detailed petrological study, will be but briefly considered. The writer was principally interested in the sedimentary rocks lying to the south of this igneous and metamorphic complex, and practically all of the detailed mapping was done in these Tertiary formations.

Method of Investigation

As a base map for recording observations maps obtained from the United States Geological Survey were used. In having a scale of 2000 feet to the inch and a contour interval of 5 and 25 feet, these topographic maps proved very satisfactory inasmuch as their detail made the plotting of field data extremely rapid and accurate. The region was surveyed in 1929, thus all of the present cultural features, except for several roads, are clearly represented.

Aerial photographic maps of the region are available[1], and were referred to by the writer in the investigation of certain structural features of the sediments. However, topographic maps were used as a base map inasmuch as the author believed that no further accuracy could be gained through the use of aerial maps.

The nature of the problem necessitated accurate recording of field observations, yet it did not appear necessary to employ the plane table method of surveying. Furthermore, the time available for field work was limited. In view of these facts the Brunton compass method of surveying was used.

The field work was done intermittently during the months from October 1932 to May 1933, about three weeks being spent in the field.

[1] Fairchild Aerial Surveys Inc. 224 east 11th Street, Los Angeles, California

Acknowledgements

To Dr. John H. Maxson, who supervised the field work, the writer owes a debt of gratitude for without his suggestions and his willingness to discuss field problems the author would have encountered many unsurmountable obstacles.

Mr. Frank W. Bell and Mr. Willis P. Popenoe of the California Institute of Technology did the paleontological work of this report. Mr. Frank W. Bell identified the members of a foraminiferal fauna collected from a Modelo (?) outcrop in Dry Canyon. Mr. Willis P. Popenoe described some of the invertebrate fossils collected intermittently throughout the Modelo (?) formation.

GEOGRAPHY

Topography and Drainage

The accompying topographic map (Plate 2) clearly shows the topographic features of the region. In view of this fact only the more important features will be considered in the present discussion.

The hills of the Haskell Canyon region have a moderate relief, rising some 500 feet above the floor of the canyon. In general the hills trend in a north-south direction. They emerge from the floor of Bouquet Canyon at an elevation of 1500 feet, gradually increasing in elevation to maximum of 2000 feet at the northernmost border of the region, then decreasing again further northward.

The canyons branching from Haskell Canyon and Dry Canyon(to the west)are seldom over 500 feet deep. Those in the igneous and metamorphic complex tend to be narrow and steep walled, while those in the sediments follow no generalization for some are narrow and steep walled and others are

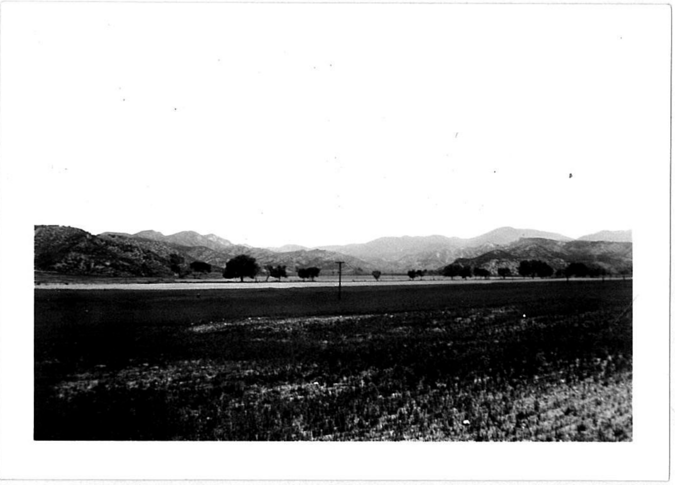


Fig.1 Haskell Canyon. Looking north from the intersection of the Haskell Canyon road and the Bouquet Canyon road. The low hills in the foreground occupy the Saugus formation. The Sierra Pèlona Mountains can be seen ~~rising~~ in the distance.

wide and flat bottomed (Fig.1). The latter feature might be explained as follows. The soil is generally loose, dry, and porous. Rainfall, moreover, usually occurs in rather sudden bursts. The result is rapid run-off and hence rapid erosion. Wherever the soil is bare or the vegatation sparse, gullying occurs. The streams, which are generally dry, are subjected to sudden floods, their waters are very muddy. Thus, because of the low rate of weathering of their side walls, coupled with rapid downcutting by their streams, the valleys are steep sided, and in addition some of them are flat bottomed because of excessive deposition.

Due to the fact that the sedimentary rocks of the region consist for the most part of rather soft, unconsolidated material, they are easily cut by rain wash and gullying. The result is that at the higher elevations the land is dissected by numerous gullies, and ravines, with spurs, and sharp ridges separating them; while at the lower elevations the land is round and rolling (Figs.1 and 2). This type of topography, badlands at the higher elevations with rounded hills at the lower elevations, is quite characteristic of the behavior of unconsolidated sediments in a semiarid climate.

Figure 5 shows another feature commonly seen in semiarid or arid regions. The photograph shows the hills at the southern end of Haskell Canyon ending rather abruptly in the nearly level plain of the Bouquet Canyon wash. As mentioned previously, this feature can be abscribed to excessive deposition.

No large rivers are present in the area, the drainage being carried southward by two small streams, one in Haskell Canyon and the other in Dry Canyon, to the Bouquet Canyon river which passes further southward to connect with the Santa Clara River. In the rainy seasons these tributaries carry large quantities of water, but for most of the year they are dry.

Climate

The climate of Southern California is such that field work may be carried on through both the winter and summer seasons. The rainfall is not only small but is, moreover, confined to

Fig.2 Haskell Canyon. Lookin south from a point midway up the canyon. Note the nearly horizontal terrace in the background.

Fig.3 Typical valleys and topography.The hills in the foreground are comprised of Modelo ? shales and sandstones, the exposure in the backgrpund is Saugus, Looking south-west from a point in Haskell Canyon

short periods, usually several days in length.

The region is of the typically semiarid type, having an precipitation of about 17 inches. Practically all of the rain falls during the months from November to March, inclusive, though a shower may come in summer. Snow falls, occasionally, to the extent of several inches in the higher parts of the San Gabriel Mountains to the south, and infrequently in the Haskell Canyon region

The mean annual temperature of the region, though higher than that of Los Angeles, is near 62°F. However, during the summer months the mean temperature is some 20° higher, and not infrequently it rises to above 100°F. Yet, the heat is somewhat tempered by low humidity and by the cool west winds that blow during the late afternoon.

Natural Vegetation

The lack of abundant rainfall permits only a sparse natural growth, the nature of which depends largely on the type of soil prevailing.

grass or a light growth of sage is found on the shaly soils. Chaparral grows thickly on the sandy members, and is in places, particularly in the bottoms of canyons so dense that it is almost impossible to penetrate. Cacti and various short grasses thrive well on almost every rock type.

The presence of numerous water loving trees,such as the sycamore, the wild walnut, the California holly, the wild oak, and the cottonwood,in Haskell Canyon and its larger tributaries is an interesting effect of the structure of the area on the position of the water table.

Culture

This region is by the nature of the topography and the rock types not readily adaptable to agriculture. Some attempts have been made, however, to cultivate the more level portions of the area with some small degree of sucess. Figure 2 shows a portion of the lower section of Haskell Canyon that is sown with wheat and barley. About midway up the canyon a fairly sizeable grape vineyard has been cultivated.

Pasturing of cattle, like agriculture, is an unimportant occupation in Haskell Canyon. Nevertheless, that some attempts have been made in this field is evidenced, not by the presence of cattle but, by the existence of numerous fences.

Though all of the roads penetrating the region are dirt roads, some of them, particularly the maintenance roads for the Los Angeles Aqueduct Reservoir and the Edison Company power distribution system, are in excellent conditions. Most of the side roads, while they are frequently very rough, are passable.

Inasmuch as the Haskell Canyon road is not a through road it is not the scene of much traffic. The Mint Canyon road, to the south of Haskell Canyon, is, on the other hand, a state highway. Motor stage service over the Mint Canyon Highway offers the best means of transportation to the area for those who do not operate a car.

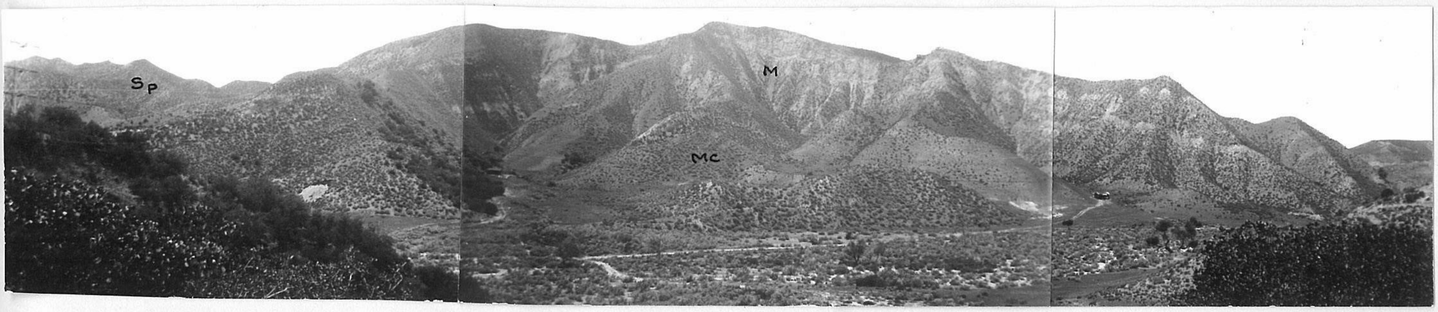


Fig.4 The Haskell Canyon Anticline. Looking west from a point on the east side of the canyon. M=Modelo (?), MC=Mint Canyon, and Sp=Saugus formation.

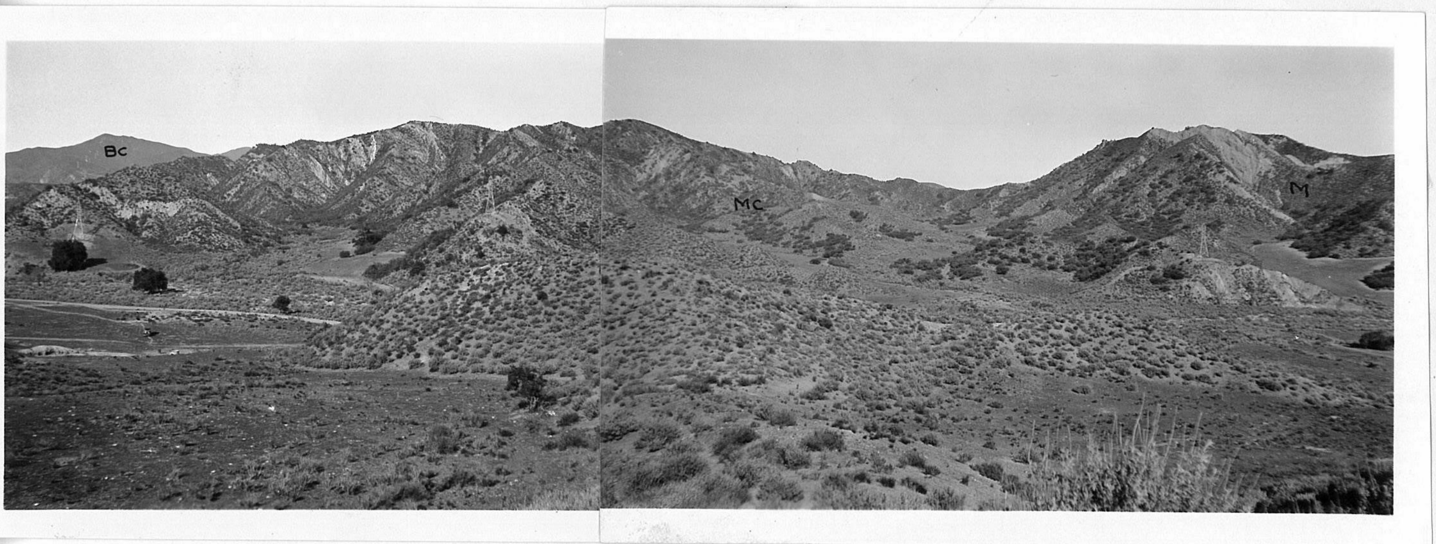


Fig.5 The Mint Canyon formation as seen from point on the west side of Haskell Canyon near the exposure of the Haskell Canyon anticline (above). Looking east. MC=Mint Canyon formation, M=Modelo (?) formation, and BC=basement complex.

GEOLOGY

Stratigraphy

General Character of Formations

The Tertiary sediments in the area range in age from upper Miocene to Recent and comprise the Mint Canyon formation (upper Miocene), Modelo (?) formation (upper Miocene), Saugus formation (upper Pliocene and Pleistocene), and river terraces and valley alluvium (Pleistocene and Recent).

The origin of these sediments may be ascribed to an area of acidic and subacidic rocks for quartz and untwinned feldspar grains predominate in the sandstones and shales, while boulders and pebbles ranging from pegmatite to anorthosite in composition occur in the conglomerates.

In the northern part of the area a complex of igneous and metamorphic rocks outcrop. In general the "basement complex", as it is usually termed, is composed of quartzite and schist into which is intruded granitic rocks of various kinds. It is believed that the metamorphics are all of pre-Jurassic age and that granitics are of late Jurassic or early Cretaceous age.

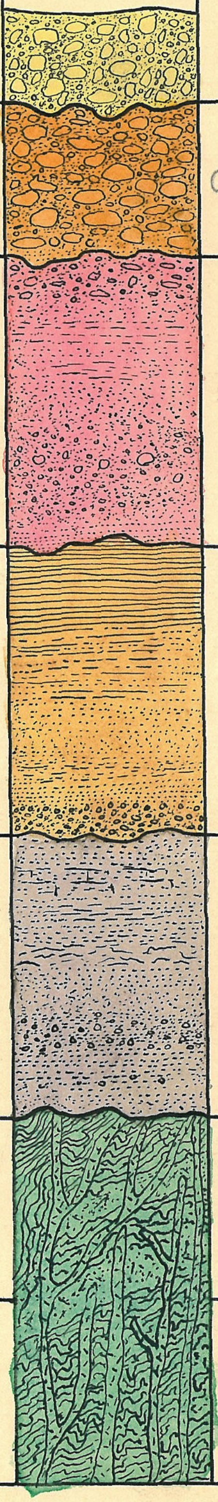
System	Series	Formation	Symbol	Columnar section	Thickness	Character
Quaternary	Recent	Alluvium	Al		0-75'	Unconsolidated sand and gravel along stream beds.
	Pleistocene	Terrace deposits	TA_R		0-100'	Partially consolidated conglomerate and sandstone forming terraces now dissected.
Tertiary	Upper Pliocene	Saugus Formation	S_P		800±	Poorly consolidated conglomerate and sandstone, with a little shale. Nonmarine.
	Upper Miocene	Modelo(?) Formation	M_M		500±	Tan colored siliceous shale and poorly consolidated sandstone. Coarse conglomeratic sandstone at base of the section. Marine.
	Upper Miocene	Mint Canyon Formation	MC_M		900±	Light gray conglomerate and sandstone, with interbedded clay and tuffaceous material. Nonmarine.
Mesozoic	Jurassic	Intrusive Granitics	BC			Granites and associated types.
?	pre-Jurassic	Metamorphics	BC			Mica schist and quartzite intruded by granitics.

Plate 3 GEOLOGIC COLUMN

The Mint Canyon Formation
(Upper Miocene)

The series of land-laid sediments that lie stratigraphically below the Modelo (?) formation in the Haskell Canyon region and above the Sespe (?) in the vicinity of Texas Canyon (to the east) was first described by O.H.Hershey[1]. Hershey divided the series into two distinct groups[1], probably on the basis of lithological differences, the "Lang division" and the "Mellenia series" of which he says "the Mellenia series comprises a group of fresh-water strata, 1,700 feet thick, composed of conglomerates, shales, and sandstones, underlying the Lang division, a great bed of gravel and sand of buff color approximately 3,000 feet thick". Dr.W.S.W.Kew[2] some twenty years after Hershey's

[1] Hershey, O.H. Am. Geologist vol. 29, 1902, pages 349-372.

[2] Kew, W.S.W. Am. Assoc. Petroleum Geologists Bull. vol.7, pp. 411-420, 1923

work in the Santa Clara Valley described Hershey's twofold division as one formation which, "rests unconformably on beds that are probably equivalent to the Sespe formation and is overlain by strata tentatively correlated with the Modelo formation". In a subsequent publication[1] Dr.Kew substituted the term Mint Canyon formation for"Mellenia series" because the word"Mellenia" is not geographic. Moreover, he says in the same publication, "the 'Lang division' of Hershey is thought by the writer to be equivalent, in greater part at least, to the upper part of the Mint Canyon formation".

With the exception of the Quaternary terraces, and the relatively restricted outcrops of the Modelo(?) and the Saugus formations immediately west of Haskell Canyon, the Mint Canyon formation definitely outcrops as far east of Haskell Canyon as Bouquet Canyon. It consists of alternating beds of sandstone and conglomerate, interbedded with

[1]Kew,W.S.W. Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull.753, 1924.

clay and fine sand, and tuffaceous material.

The sandstone members are variable in composition, containing, in various quantities, angular to subangular grains of quartz, feldspar (both twinned and untwinned), hornblende, augite, biotite, sericite (muscovite), epidote, magnetite and garnet. Roughly these minerals are present in the following proportions; quartz 75-90%; feldspar 5-15%; hornblende, augite, mica, and epidote 5-15%; garnet and magnetite less than 5%.

The color of the coarser sandstone members ranges from a dull gray to a fairly brilliant red. Close examinations has led the writer to the following conclusions concerning the origin of these colors. The gray is due largely to the presence of unaltered iron silicates as hornblende and augite. The green seems to owe its existence to the presence of green colored hydrous silicates (alteration products),as chlorite and epidote. The varied shades buff, brown, and red are due to ferric oxides more or less hydrated, as hematite (red) and limonite (yellow-brown).

Fig.6 Interference ripple marks in the Mint Canyon formation at location 12. The photograph shows an exposure of about 4 feet.

Fig.7 A oolitic bed in the Mint Canyon formation. Locality 22.

The hardness of the sandstone members varies within wide limits, some beds are soft and crumbly while others are quite hard and resistent (Fig. 7). This variation is a direct expression of the type of cementing material. The softer beds have calcareous or limonitic cement, while the more resistent beds have a siliceous cement

Interbedded in the sandstone strata are numerous beds of conglomerate and sandy conglomerates. The matrix of these conglomerates have a mineralogical composition similar to that of the sandstone members. The interesting feature of the conglomerate member is the variety of rock types which are found as pebbles and boulders throughout the member. These rocks include extrusive, hypabyssal, and plutonic types. Andesites similar to the type found in Tick Canyon (to the east), basalts, quartz vein material, pegmatites, graphic granite much like that found in the San Gabriel Mountains (to the south), plutonic types ranging from granite to anorthosite, and, schists and quartzites are found. The fragments are quite angular and vary in diameter from less than an inch to 8 or 9 inches. In most cases the material is quite fresh and unaltered.

Figure 9 shows a bed of volcanic ash, found in the Mint Canyon series. Unfortunately, time did not permit a detailed microscopic study of this ash. The presence of this bed is interesting for it points to sub aerial conditions during at least part of the time of deposition of the section. Moreover, its hardness and its light gray color together with the fact that it is between 10 and 20 feet thick has caused it to"stand out" with reference to the soft buff colored sandstone members. In view of this, the bed was carefully located on the geologic map (Plate 2), in order that the structure of Mint Canyon formation might be more clearly shown(the bed is designated by location number 16).

An interesting feature of the sandstone members is the presence of interbedded lenses of oolitic sandstone. The bed shown by figure is rather hard and is nowhere over 10 feet thick.

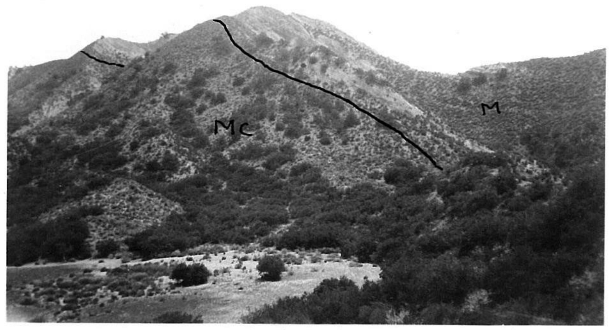


Fig.8 The Modelo(?)-Mint Canyon contact. Looking east from a point near the Haskell Canyon anticline on the west side of the canyon.

Fig.9 A hard siliceous tuff bed in the Mint Canyon formation. The bed which is located on the geologic map. Looking south-east from a point 1/8 mile west of Haskell Canyon.

A stratum which outcrops near the exposure showing interference ripple marks (Fig.6) is some tens of feet thick, and unlike the first mentioned bed it is very soft. The oolites are small (1/8 inch in diameter) spheroidal grains built up of successive coats of calcareous material. They are so numerous in both of the mentioned cases that they form the chief bulk of the rock, in which case the more proper name for the rock would probably be Rogenstein. In addition to the concentric-shell arrangement, there is frequently a more or less evident radial structure in each grain, and close examination shows that the minute elements which build up the successive layers are set in some cases radially, in other cases parallel to the layers. The concentric layers have been formed upon a nucleus, who nature is not definitely known, but may be a chip of shell, or other organic body, a quartz granule, or merely a pellet of fine calcareous mud. Close examination has furthered shown that some of the oolitic grains have apparently been broken and subsequently coated fresh layers of calcareous material; or two or three contiguous grains may have enveloped in one mantle and become a compound grain. The latter led the writer to believe that the oolites were foraminifera.

Mode of Deposition

From the study of the mineralogical composition of the Mint Canyon series it can be inferred that the deposition took place under sub-aerial conditions and in a semi-arid climate. The structures within the sandstone and conglomerate members such as lensing of sandstone strata, cross bedding, variation in thickness of individual beds, tendency of material to accumulate in discontinuous layers, seem to indicate that part of the section was deposited as large alluvial fans. In all cases the grains and pebbles are angular to subangular. Moreover, plate 5 shows that the material is, as a rule very poorly sorted. This feature, too, is characteristic of large alluvial fans. The sorting of some of the material, particularly of the finer grained sediments, is fairly good (Plate 5) which in view of the presence of interferance ripple marks and oolitic beds suggests that some of the beds were deposited as lacustrine beds.

PLATE 5

CUMULATIVE CURVES

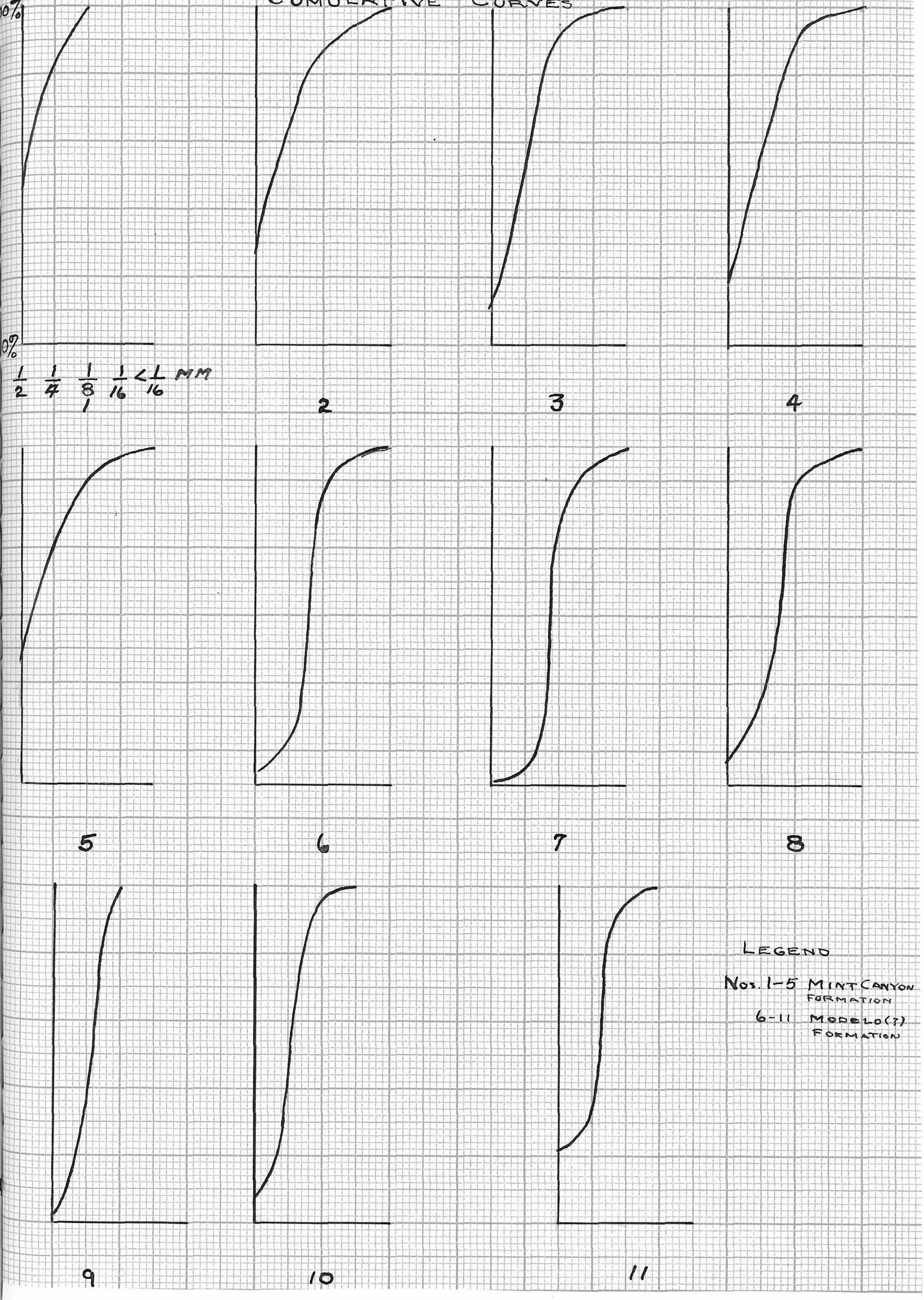
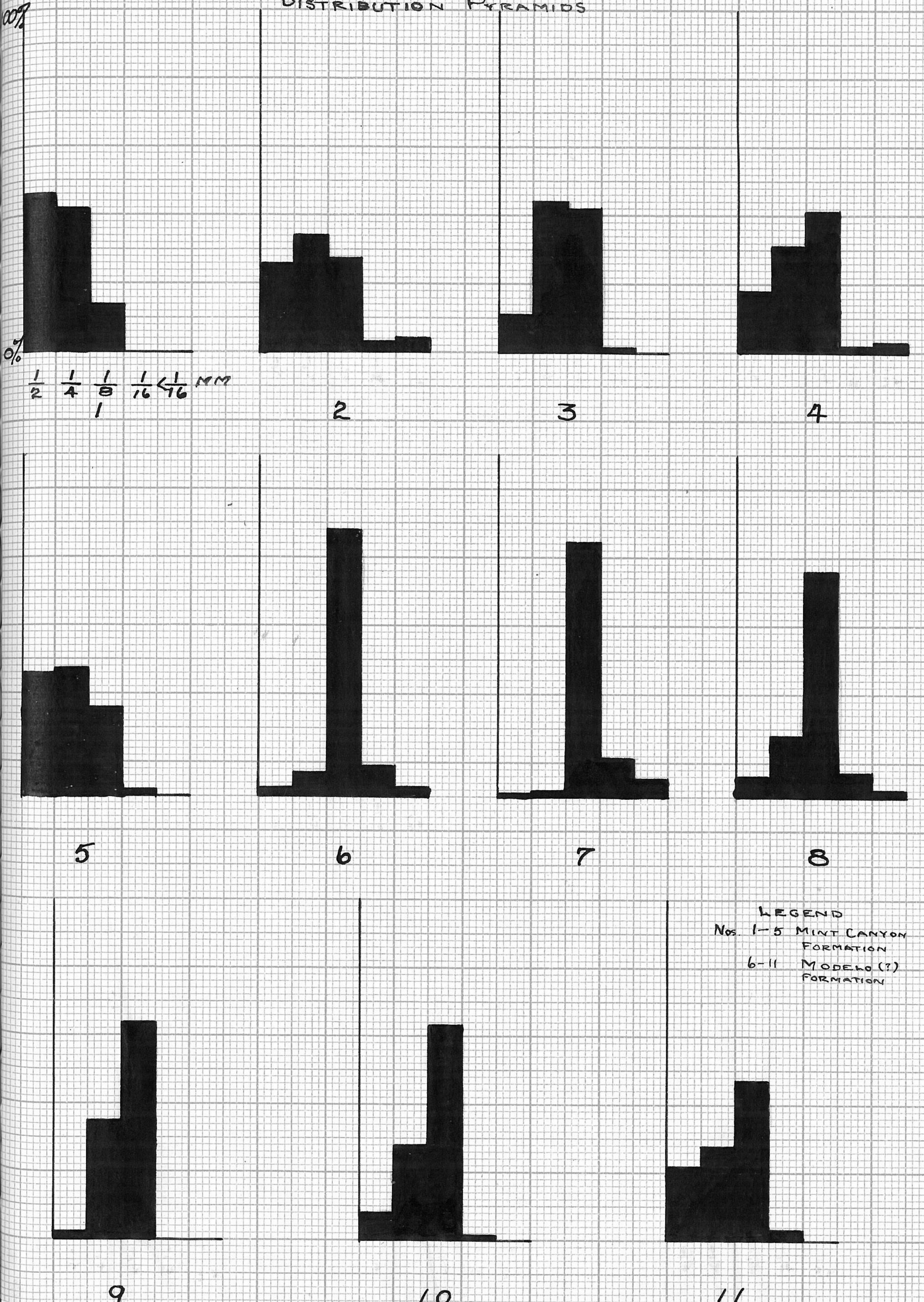


PLATE 5

DISTRIBUTION PYRAMIDS



Origin

The angular shape of the rock fragments, and the evidence that the rocks composing the sediments are quite fresh (Nearly unaltered feldpars, and biotite) indicates that the sediments did not undergo long transportation before deposition, thus, we may assume that the mineralogical composition of the sediments is closely related to that of the parent rock.

The high percentage of quartz, with lesser amounts of feldspar, augite, hornblende, and biotite, together with magnetite and garnet (may be of metamorphic origin) suggests a grantic type of igneous rock, similar to those found in the San Gabriel Mountains (to the south) and the Sierra Pelona Mountains[1] (on the north).

The composition of the rock pebbles and boulders of the conglomerate indicates the same

[1] The work of Mr.R.W.Webb showed that such types existed in this region.

types of igneous rocks. The composition of the larger fragments of the conglomerate members suggests that the Sespe (?) formation and the lava series in the vicinity of Mint Canyon outcropped during the time of deposition of these strata.

It might be inferred from these observations that the region in which the Mint Canyon formation was deposited was a large valley surrounded by mountains. A condition very similar to the present Santa Clara River Valley.

Age

Dr. John H. Maxson[1] says the following concerning the age of the Mint Canyon formation. "Faunal (vertebrate) relationships suggest that the Mint Canyon formation is younger than the Mascall, Virgin Valley, and Cedar Mountain occurrences, while close to although somewhat younger than the Barstow. The Ricardo is slightly younger than the Mint Canyon. This evidence appears sufficient to assign an upper Miocene age to the formation".

The Mint Canyon formation is unconformably (10-15 degrees discordance) overlain by a marine series believed to be correlated with the upper upper Miocene. This evidence corroborates the work of Dr. John H. Maxson on the stratigraphic position of the Mint Canyon formation[1].

[1] Maxson, John. H. A Tertiary Mammalian Fauna from the Mint Canyon Formation of Southern California. pages 85-86

Modelo (?) Formation

Upper Miocene

The series of marine strata that lie stratigraphically above the Mint Canyon formation and below the Saugus formation is here described, tentatively, as the upper part of the Modelo formation. They consist primarily of brown and buff sandstone, sandy shale, and minor amounts of conglomerates. In general these beds bear a close lithologic resemblence to the Modelo formations.

The Modelo (?) formation outcrops both to the east and the west of Haskell Canyon. In vicinity of the Haskell Canyon anticline it can be seen to overlie the brown sandstone and conglomerate members of the Mint Canyon formation with an angular discordance of 10° to 15° (Figs. [illegible] and 7). In section exposed by the anticline, the series is seen to comprise about 500 feet of tan colored shales and sandsyones. The basal member of the section is a very coarse conglomeratic sandstone. Above the conglomerate bed, the section is essentially a sandy formation made up of poorly bedded sandstone strata, interbedded sandy shale lenses, and siliceous shale beds.

The mineral content of the sandstone members is very similar to that of the sandstone beds of the Mint Canyon formation, consisting of angular to subangular grains of quartz, feldspar, with minor amounts of hornblende, biotite, and augite.

The most prominent differences between the Modelo (?) and the Mint Canyon formation are that the Modelo sandstones are usually light gray, while those of the Mint Canyon are highly colored; the Modelo strata yield numerous large lamellibranch shells, while the Mint Canyon is barren of such types.

The basal conglomerate of the Modelo (?) is interesting because it is the first bed of the marine section to contact the terrestrial strata of the Mint Canyon formation. The larger fragments are very angular and restricted to less than 1 inch in their maximum elongation. The conglomerate is frequently fossiliferous and

Fig.10 An outcrop of Modelo (?) sandstone and shale in Dry Canyon. Locality 25

Fig.11 Same as above, showing position foraminiferal shale in outcrop.

contains numerous near shore types of inverte-
brates.

The shale member of the series is tan colored and conspicuous as compared to the coarse sandstone of either the Mint Canyon or the Saugus formation. It forms the uppermost strata of the section, and occupies most of the area west of Haskell Canyon (as far west as Dry Canyon).

Mode of Deposition

From plate 4 it is evident that the degree of sorting of the Modelo (?) is very high, a characteristic of marine deposits. Moreover, close examination shows the grains to be fairly well rounded, though a few particularly of the lower members are subangular to angular. Cross bedding and lensing are not uncommon. The bedding as a whole is fairly good in the case of the sandstone, the bedding of the finer material is very good.

The nature of the sorting, the lithology, and the incidental structures indicate that the section was deposited as a near shore phase of a marine cycle. The sequence suggests an transgressing sea. Moreover, the presence of the coarse basal conglomerate might suggest that the Miocene sea once had as its most western extent somewhere in the proximity of the present contact.

Origin

The reworking action of the Modelo (?) sea so completely obliterated the characteristics of the parent rocks, that no definite statement can be made as to the source of the Modelo(?) strata. Since it is known that the Mint Canyon strata formed a positive land mass during the deposition it is believed that a large portion of the material was derived directly from these strata.

Age

Mr. Frank Bell of the California Institute found the foraminifera fauna collected in Dry Canyon (Location 16) to include the following forms (see figures 10 and 11).

Ovigerina leei ms.sp.[1]
Cebicides americanus Cushman var.
Bolivina n.sp.

Mr. Bell adds the following remarks. "This fauna is found in the radiolarian mudrock (uppermost Miocene) exposed at Malaga Cove, Palos Verdes Hills California." R.D. Reed[2] has stated that the radiolarian mudrock contains the highest Miocene fauna known in California. The writer believes that the exposure in Dry Canyon may on closer examination yield more varieties of foraminifera, and for this reason has carefully located the exposure on the

[1] A manuscript name used by oil company micropaleontologists in Los Angeles Basin.

[2] Reed, R.D. A Siliceous Shale Formation from Southern California. Journal of Geology vol. 36, pages 342-361, 1928

accompanying geologic map.

Mr. Willis Popenoe has indentified the following invertebrates from the formation.

Pecten (*Lyropecten*) *magnificus* Sowerby,
var. *crassicardo* (Conrad)

Ostrea, cf. *Ostrea titan* Conrad

Pecten sp.

Terebratulid brachiopod.

Of this fauna he says, "I have not been able to indentify the small *Pecten* and the braciopod. Of the others, *Ostrea titan* is a charcteristic Miocene form, and *Pecten crassicardo* is considered to be a reliable marker for the upper Miocene in California. Thus, the rather meagre fauna indicates a probable upper Miocene age for the beds in which it is found."

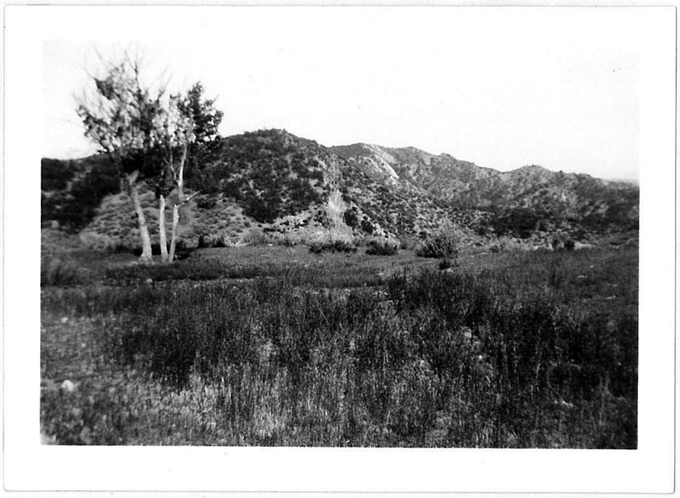


Fig.12 A sag pond ? in the Modelo(?) shale. 1/8 mile west of the upper part of Haskell Canyon. The hill in the foreground is also Modelo (?), those in the distance are Mint Canyon.

Fig.13 The Modelo (?) formation as seen from the Bouquet Canyon Road $\frac{1}{4}$ mile west of Haskell Canyon Road.

Saugus Formation
(Upper Pliocene)

The Saugus formation was first described by C.H.Hershey[1] as "a great series , 2,000 feet thick, of unlithified sand, gravel, and clay, stratified, waterworn, and water deposited". In this report the writer assumed, on the basis of the work done by W.S.W.Kew[2], that the section of unconsolidated conglomerate and sandstone south of the Modelo (?) formation is to be correlated with the Saugus formation.

In the Haskell Canyon region this series unconformably overlies the Modelo (?) marine section with an angular discordance of about 15° and is overlain unconformably by the Pleistocene terrace gravels.

No detailed work was done in the Saugus formation largely because it does not play an important role in the stratigraphic problem of the relation between the marine upper Miocene series and the terrestrial upper Miocene beds.

[1] Hershey, C.H. Am.Geologist vol.29, 1902, pp349-372.

[2] Kew, W.S.W. Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull. 753, 1924

Lithologically the formation is quite uniform consisting largely of gravels and sands derived from the pre-Pliocene sediments and the basement complex. In general the conglomerates are very poorly sorted and consolidated.

The Saugus gravels are much like the overlying terrace gravels, but may be distinguished by their light color. Moreover, these beds are quite strongly tilted while the Pleistocene deposits dip very gently.

The nature of the strata suggests that they are of alluvial-fan or fluviatile origin. The uniformity of the section indicates that the basin of deposition (a large river delta ?) sank progressively during the accumulation of the gravels and sandstones.

The age of these strata is taken directly from the work of W.S.W.Kew[1] because they are barren of fossils in this region. Kew has taken the Saugus to be upper Pliocene in age.

[1] Kew, W.S.W. Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull.753, 1924.

Terrace Deposits

At various places throughout the region Pleistocene terrace deposits can be seen overlying unconformably the Saugus sediments (Fig.14). The dip slightly (10-15°) to the south and are composed of poorly sorted, unconsolidated conglomerate, together with minor amounts of sand and soil. They are reddish to white in color and represent fanglomerates deposited by Pleistocene streams. Their present difference in elevation and difference in dip suggests that they cannot be ascribed to a single period of time. Furthermore, as a consequence of uplift in Recent times, erosion has proceeded very rapidly, and has nearly completely removed them. In view of their present rather restricted distribution and their lack of individualistic characteristics it is not possible to correlate them.

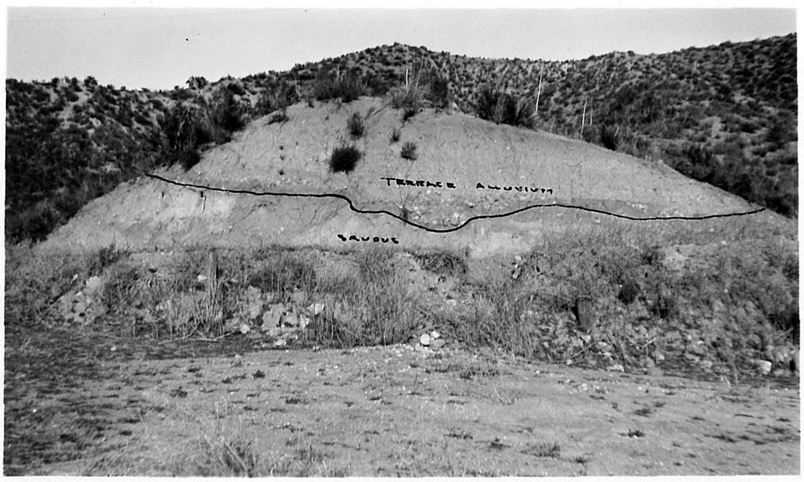


Fig.14 An outcrop showing the Saugus-terrace deposits contact. Looking west from a point near the mouth of Haskell Canyon.

Alluvium

The present streams are transporting and depositing large quantities of material derived from the soft sediments in the valleys and stream beds. It is composed largely of coarse and fine unconsolidated sands with beds of gravel. The material is everywhere flat lying.

Igneous Rocks

Basement Complex

The crystalline rocks which outcrop in the northern part of the area include various types of grantic and metamorphic rocks. The latter consists of schist and quartzite into which has been intruded leucocratic and meso-cratic plutonics of various kinds. The schist included both para- and orth- schists. The planes of schistosity dip very steeply toward the south (75°-80°). The plutonic types include pegamatite, graphic granite, granite, and granodiorite. As has been previously mentioned these rocks have not been differentiated because the time allotted to field work was limited and their differentiation did not play an important role in the stratigraphic problem presented in Haskell Canyon.

Structure

General Features

The dominant structural trend of the area is east-west, roughly at an angle of 90° with the trend of the topographic forms. Folding is common, especially in the less competent Modelo series. Only one major fault can be traced in the region. In addition to the fault which is traceable in the field, one fault has been postulated on the basis of structural features.

Folding

The dominant structural feature of the area is a series of east-west trending folds, the more important of which occupy the part of the region west of Haskell Canyon.

The Haskell Canyon anticline is without doubt the most important of these flexures. The axis of this anticline extends eastward from Haskell Canyon definitely as far as Dry Canyon (as far as it was traced) and probably eastward for some distance from there (see figures 4 and 10). It is a symmetrical fold with its limbs dipping between 60° and 70°. From field observations, which suggest that the dip of the limbs of the anticline increases with depth, and that the beds appear to be thickened in the axial region, the Haskell Canyon anticline is classified as a similar fold. The axial line of this anticline plunges steeply westward about 25°. From the geologic map it can be seen that this fold ends abruptly in Haskell Canyon, and as will be shown later in this report, this break suggests the presence of a fault in the canyon.

North of the Haskell Canyon anticline is a easily traceable syncline. It runs at angle of 45° (N45E) with the anticline near Haskell Canyon but further westward it is roughly parallel. It also plunges westward but a low angle, not more than 15°. Unlike the anticline, the syncline is asymmetrical with its southern limb dipping about 40° and its northern limb about 30°. This fold offers two interesting aspects. First, it, like the Haskell Canyon anticline, is confined to the west side of Haskell Canyon; and, second, inasmuch as its axis passes through the section of Saugus conglomerate, its age is post-Pliocene.

Another syncline parallels the Haskell Canyon anticline to the south. This flexure is essentially a symmetrical syncline with its limbs dipping about 25°. It also plunges westward at an angle of about 12°. It was definitely located on the west side of Haskell Canyon but no trace of its extension could be found to the east. The termination of this fold might be ascribed to its dying out westward, yet is not likely that a fold dipping west 12° would die out completely in less than 2000 feet. The only alternate explanation is the postulating of a fault in the Haskell Canyon.

South of the above mentioned syncline is another anticline. It is roughly parallel to the syncline on the north, and trends nearly east-west. It, too, a symmetrical fold with its limbs dipping about 25°. The lack of outcrops makes the determination of its plunge difficult, but it is thought to plunge westward at about 10°.

North of the Haskell Canyon anticline is a series of folds which trend roughly N80W. The series comprises the upper canyon anticline, the upper canyon syncline, and the upper canyon monocline. The anticline and the syncline are similar folds, which plunge gently westward (5°to8°). The dip of their limbs about 15°. The monocline also dips at a small angle (14°to 17°). These flexures illustrate two points, first, that there is no fault passing through the northern part of Haskell Canyon, and second, the folding occurred before the deposition of the terrace gravels inasmuch as the folding has only effected the Mint Canyon formation.

West of Haskell Canyon there are two folds, neither of which are important. Both of these symmetrical flexures trend east-west. While both the anticline and the syncline are quite evident near their western end (viz near the Modelo-Mint Canyon contact), they die out rapidly to the west. Even though neither of the folds are of a sufficient size to be structurally important, they are the only folds which pass across the Modelo-Mint Canyon contact.

Faulting

The major fault in the region has been termed the upper Haskell Canyon fault. Its complete linear extent is not known, but it has been definitely traced from Haskell Canyon eastward to the eastern border of the region. It forms the contact between the "basement complex" and the Mint Canyon formation. Due to the fact that the Mint Canyon formation is composed largely of poorly consolidated sediments while the "basement complex" is made of hard granitics and metamorphics, the trace of the fault is very easily followed. The present scarp of the fault is of the fault line scarp type.

The following is a summary of the direct field observations and the inferences drawn from them concerning the upper Haskell Canyon fault.

1. The existence of the fault is attested by the observation that the Mint Canyon sediments dip "off" the "basement complex" at angles varying from 15°-27° (which might be explained as primary dip), and the presence of a zone of fractured and crushed rock.

2. The fault dips southward at a large angle (85°). The trace of the fault across the rugged topography bears

this out. Moreover, attitudes taken by the three point method of what was considered to represent the fault plane showed south dips of 80° to 85°.

3. The fault is of the reverse type. The sediments are known to overlie the grantics and metamorphics.

4. The vertical component of the motion is at least some thousands of feet. In the Mint Canyon area Mr. Ygnacio Bonillas[1] has the Escondido series (Oligocene ?) to be deposition on the "basement complex, and the writer has observed the Mint Canyon formation overlying unconformably the Escondido series. Even though the sedimentary section may be quite a bit thinner in the Haskell Canyon region, the displacement of the fault must be quite sizeable to expose the grantic material.

5. The age of the fault cannot be definitely determined, but movement has taken place on it since upper Miocene since the sediments are of upper Miocene age.

[1]Oral communication

6. The forces which produced the fault were probably compressional. It is generally believed by most structural geologists that high angle reverse fault are due to compressive forces.

The other fault in the region is a conjectured fault, and is referred to, for convience, as the Haskell Canyon fault. There is evidence for and against the posulation of a fault in Haskell Canyon, hence the writer will attempt to present both views. The following is a summarized description of this supposed fault.

1. The fault passes from the mouth of Haskell Canyon (Bouquet Canyon) northward through the canyon as far as the Haskell Canyon Anticline, then it diverts either north-east or north-west.

2. It is a vertical fault.

3. The dominant displacement has vertical.

The structural relations existing on the west and east sides of Haskell Canyon as shown by the structure sections (Plate 4), indicate that there is a definite termination of all the folds at the canyon. The topography, moreover, is different at a point directly west of the Haskell Canyon anticline. Figures and were taken from points directly in a east-west line on opposite sides of Haskell Canyon.

If it is conceded that a fault exists from the mouth of Haskell Canyon as far north as the Haskell Canyon anticline, a question arises as to whether fault turns to the north-east or the north-west. Since we have noted that three folds cross the upper Haskell Canyon, the fault cannot be extended northward. The evidence seems to suggest that it turns to the north-east, for in the first canyon branching to the northeast there are two beds which apparently terminate (Figs. 7 and 9). On the other hand, the Haskell Canyon syncline ends rather abruptly in the first canyon branching to the north-west. Moreover, topographic forms resembling sag ponds are to seen in this canyon. There is also the possibility that a fault passes up each canyon as has been represented on the geologic map (Plate 2).

The most serious objection to the postulation is that the nature of the displacement must have been unique. It must have had a vertical component large enough to expose the non-folded Mint Canyon and Saugus beds, and a horizontal component just large enough to prevent a "break" in the Modelo-Mint Canyon contact. Though the abrupt termination of the Haskell Canyon Anticline cannot be explained by saying the folds die out, the argument can be applied to any other fold.

It can be said that the upper Haskell Canyon fold dies out, and the apparent sag ponds are due to slumping in the shale member of the Modelo formation. Furthermore, no zone of fracture can be found in this canyon.

In the canyon trending north-east, the attitudes of the various beds do not show sufficient differences to justify the presence of a fault.

The writer has attempted to weigh this evidence carefully, and has come to the conclusion that three faults are necessary to explain the structure of the region. These three have been described and are represented on the accompanying geologic map (Plate 2). It is evident that movement occurred on these faults after the folding of the sediments and before the deposition of the terrace gravels, inasmuch as the folds are terminated by the faults, and all of the terrace gravels have approximately the same attitude (N80W10S). Furthermore, the mechanics of the motion might be described considering three blocks, one containing Haskell Canyon Anticline, one containing the upper Haskell Canyon series (anticline, syncline, and monocline), and one containing the area east of Haskell Canyon. Each of these blocks were tilted westward in late Pliocene or early Pleistocene time.

Origin of Forces

The problem of determining the nature and origin of the forces effecting an area is frequently difficult and quite speculative but a few generalizations can be made concerning the forces effecting the Haskell Canyon region.

1. The forces were compressional this is shown by the existence of a high angle reverse fault and numerous folds.

2. The forces acted in a north-south direction. Inasmuch as the general trend of the folds is east-west, the compressive forces must have acted in a north-south direction.

3. The forces which produced the Upper Haskell Canyon fault were transmitted largely through the underlying "basement complex". The sedimentary rocks are too incompetent to transmitt forces great enough to produce a movement of some thousands of feet on this fault.

GEOLOGIC HISTORY

The following is a summary of the previously discussed evidence upon which has been based the interpretation of the geologic history.

Proof of the intrusion of granitic material into a section of metamorphic rocks and subsequent erosion of both the metamorphics and the intrusives is found in the northern part of the area where the "basement complex" outcrops. Alternate submersion, deposition, and erosion of pre-upper Miocene beds is clearly indicated in the area east (Texas Canyon) of the Haskell Canyon region. In the Haskell Canyon region, however, no beds of pre-upper Miocene outcrop, but they are probably represented at depth.

The actual history begins with the deposition of the Mint Canyon formation. From a reconnaissance in the region of Texas Canyon, these beds seen to overlie unconformably a series of beds tentatively correlated with the Sespe formation by Kew[1].

[1] Kew, W.S.W. Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull. 753, 1924

A study of the lithology of the Mint Formation indicates that it was deposited under subaerial conditions similar those existing in many large valleys of California today. The transition from a red conglomerate at the base of the Mint Canyon formation (in the vicinity of Mint Canyon) to gray and buff sandstones and clays suggests that the earlier portion of the series was derived from an area of topographic youth or maturity and the later from a region of late maturity.

The unconformable contact of the marine Modelo formation with the Mint Canyon formation indicates that before the invasion of the upper Miocene sea there was a slight uplift of the area, followed by erosion of the terrestrial beds.

A study of the Modelo-Mint Canyon contact, together with the lithology and paleontology of the Modelo indicates a overlap of a sea coming from the west.

After the deposition of the Modelo shale and sandstone series, uplift and erosion of the beds must have occurred for unconformably overlying this material is the Saugus formation. Like the Mint Canyon formation, the Saugus conglomerate and sandstone is of terrestrial origin. The presence of igneous types varing from pegmatites to anorthosites, and sediments derived from the Mint Canyon and the Medelo formations suggests that not were the present San Gabriel Mountains a positive land mass but the pre-Pliocene sediments as well stood at elevation.

Diastrophism occurred late in Pliocene time, as indicated by folding and faulting of all pre-Pleistocene sediments in the region. This orogenic disturbance is probably correlated with the well recognized post-Fernando deformations that affected the Coast Ranges and the Sierra Nevada Mountains and is believed to mark the end of the Pacific Coast Tertiary.

In Pleistocene time erosion of the then rugged northern Sierra Pelona Mountains occurred, with the formation of large alluvial fans. The remnants of which can now be seen forming the large Quaternary terraces.

The most recent movement has been a general uplift, followed by dissection of the terraces, erosion of the hills, and deposition of the valley fill and alluvium.

The geologic history of the Haskell Canyon region may be briefly presented chronologically in the following.

1. Metamorphism of the pre-Jurassic sediments of the "basement complex".

2. Intrusion of granitic rocks into the pre-Jurassic metamorphics of the "basement complex" possibly in Jurassic time.

3. Erosion of the material covering the "basement complex" and possibly erosion of the complex itself.

4. Alternate submersion, deposition, elevation, and erosion of possible pre-upper Miocene sediments present in the region at depth, but not outcropping.

5. Deposition of the upper Miocene conglomerate and sandstone (Mint Canyon formation).

6. Slight uplift and erosion of the Mint Canyon series.

7. Slight submergence, followed by the invasion of the upper Miocene sea, and the deposition of the marine section (Modelo formation).

8. Elevation of the region causing the withdrawl of the Modelo sea, and erosion of the dry land mass.

9. Submergence, followed by the deposition of the Pliocene conglomerate and sandstone strata.

10. Folding and faulting producing general uplift.

11. Formation of the Quaternary terraces.

12. Slight general uplift.

13. Erosion and deposition of alluvium and valley fill.

PHYSIOGRAPHY

As a consequence of a long period of erosion the present hills of the Haskell Canyon region bear little resemblance to the hills of the original post-Fernando uplift. In general the physiographic forms seem related solely to the hardness of the various strata and to the more significant structural features.

Two divides, symmetrically located with reference to Haskell Canyon, traverse the region from north to south. Both of these divides seem to be due solely to the fact that the easiest course for the stream in Haskell Canyon was in a direction at right angle to the trend of the structure. This suggests that the present stream bed is an expression of a previous one that was deeply intrenched in the Quaternary alluvium. The divide to the west of Haskell Canyon rises from an elevation of 1200 feet at its southern extremity where it contacts the alluvium to 2000 feet in the vicinity of the Haskell Canyon anticline. The divide to the east rises from 1200 feet at its southern end to 1900 feet half way up the canyon.

The different rock types of the area do not give rise to characteristic topographic forms, yet it might be said that the shale beds tend to weather into relatively rounded forms, in comparison to the hard sandstone members which form protruding ledges or the soft sandstone and conglomerate beds which develop a rugged bad land topography.

Due to the fact that most of the sediments are of a soft and poorly indurated numerous small narrow, steep walled (up to 75°) canyons are formed.

The streams of the area are both of consequent and subsequent types, the former being the more abundant. The subsequent streams are controlled largely by the difference in hardness of the several types of sediments. Streams of both types may be seen on the accompanying geologic map.

Several saddles are to be found along the upper Haskell Canyon fault. These are due to ease with which erosion can remove this crushed material.

ECONOMIC CONSIDERATIONS

For many years the unconsolidated sand and gravel of the Saugus formation and the Quaternary alluvial terraces has been a source of placer gold in Southern California. In the Haskell Canyon region this sort of mining has gone on for many years. The "biggest find" in the region was the one made by the man after whom the canyon is named J.Haskell. Some thirty-five years ago as the result of Mr.Haskell's "find", numerous miners came to the area some of which still have land in the canyon. Figure/5 shows the original Haskell mine, now being operated by Mr.Haskell's sons, from this shaft Mr.Haskell is claimed to have removed some 30,000 dollars worth of gold without any helpers in one year.

Most of the miners who have recently become acquainted with the area are truly amateurs, for most of them are mining for the love of mining not for the gold.

Inasmuch as the rocks which comprise the pebbles and boulders of the placer gravels have been derived in part from the "basement complex"

Fig.15 The Haskell Mine. Located on the west side of the canyon about $\frac{1}{2}$ mile from the mouth.

some individual have attempted to find gold in the large veins of quartz in the northern part of the area. One group of persons have dug a shaft some 35 feet deep in this rock. Whether or not they have found gold in sizeable quantities, the writer was unable to determine.

The possibility that the region may be a potential oil bearing district is rather unlikely even though the structural conditions might suggest such a possibility. If a fault passes through Haskell Canyon as postulated, it might be conceived that sufficient closure exists to cause the pooling of oil. However, the nature of the sediments is not that generally associated with oil bearing strata.

The source of the oil in the Newhall district is to be in the diatomaceous and foraminiferal shales of the Modelo formation. Evidence shows, however, that the Modelo formation is not petroliferous everywhere, and that where the Modelo is petroliferous it contains diatoms and foraminifera. In the Haskell Canyon region no diatoms were found in the Modelo and the foramifera were very restricted. Thus, it is concluded that Modelo in this region does not offer a likely source of petroleum. Furthermore, the Mint Canyon formation because of its stratigraphic position below the Modelo formation is probably barren of oil. The Saugus series inasmuch as it has been found to be oil bearing in some localities might be considered, but as Kew[1] points out the Saugus formation because it consists largely of coarse material has acted as a reservoir for oil which originated in the Modelo formation.

BIBLIOGRAPHY

Kew, W.S.W. Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California. U.S.G.S. Bull. 753

Hershey, O.H. American Geologist Vol.29, 1902

Kew, W.S.W American Association of Petroleum Geologists Bulletin. Vol.7, 1923

Maxson, J.H. A Tertiary Mammalian Fauna from the Mint Canyon Formation of Southern California.

Reed, R.D. A Siliceous Shale Formation from Southern California. Journal of Geology Vol.36, 1928.