# THE GEOLOGY OF A PORTION OF THE RAPETTO HILLS

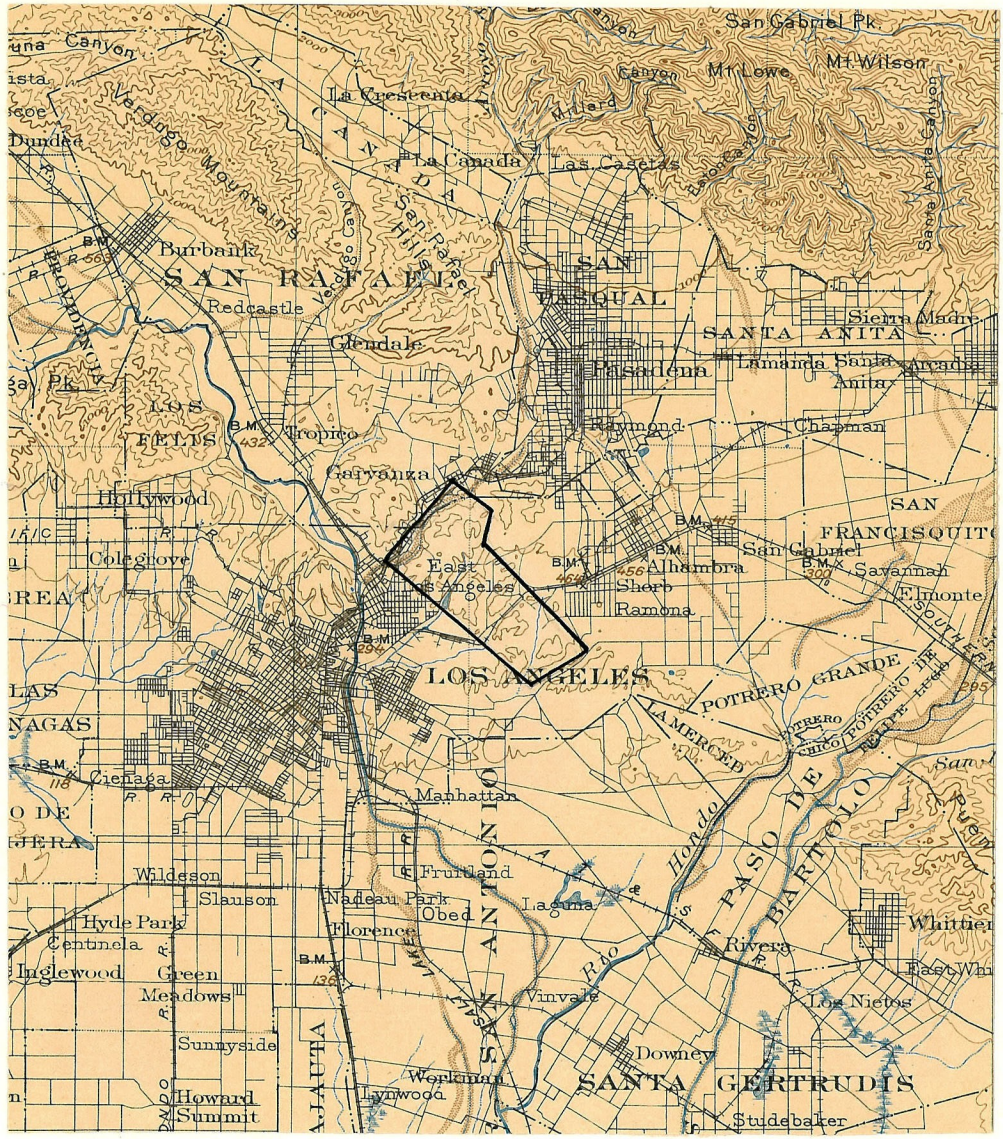
Senior Thesis

of

Robert W. Wilson

1930

MAP SHOWING THE GENERAL LOCATION OF THE AREA MAPPED



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## Introduction

The area under consideration is located in what is known as the Rapetto Hills. It is located in the city limits of Los Angeles, and may be reached by going out North Broadway to Mission Road. From Pasadena the area is reached by way of Huntington Boulevard. The area is approximately six square miles in size. The base maps used were taken from the Alhambra, Los Angeles, Altadena, and Glendale sheets.

In parts of the area it is quite solidly built up with homes, in other parts a little farming is attempted, mostly of barley and oats. Some of the homes, especially in the northern part are very nice, but the majority of them evidently belong to a very poor class of people. Lincoln High School is located in the extreme western part of the area near the intersection of North Broadway with Mission Road.

The purpose of the investigation was to determine the geological formations and structure of a limited area in order to prepare a senior thesis as a partial fulfillment of the requirements for graduation.

The base maps used were excellent Los Angeles County ones, with a scale of 2000 feet to the inch. Locations of outcrops, contacts, and the like were chiefly by topography, but in some cases the Brunton compass was used for purposes of location. The work was carried out completely on foot as a car was not available for the author. The nature of the country was such that it was extremely difficult to walk the contacts, and it was necessary to rely on roadcuts almost exclusively.

There has been several previous reports issued on this

area. One of these is U.S.G.S Bulletin 309. This bulletin only shows the geology in a very rough way, and is more of a hinderance than a help. Eaton has also issued in the "Bulletin of the American Association of Petroleum Geologists" a paper on the "Geology of the Los Angeles Basin". This deals with the geology of the area which was undertaken in an even rougher manner than Bulletin 309. When the field work was nearing a close the author found out that C.L. Gazin, J.W. Daly, and M. H. Sperling, of the Institute, had previously mapped most of the area undertaken. Reference to Gazin's paper was made in order to use the same formational names, and thus avoid needless confusion. The paper by Daly and Sperling has not been examined by the author.

## Summary

The region is characterized physically by low rolling hills, somewhat steeper in the northern than in the southern part of the area.

The area mapped consists entirely of sandstones and shales. It can be subdivided into two main divisions, a lower in which sandstone is the predominating rock with minor amounts of shale, and an upper division composed almost entirely of shale. It has been further subdivided for convenience in mapping and interpretation of the geologic structure. The formation names given here are purely local, and were selected by Gazin a few years ago when he worked in the same general vicinity.

The area outside of a Pico section near Coyote Pass is entirely unfossiliferous except for diatoms and probably foraminifera. Based on evidence from diatoms the formations represented here, with the exception of the Pico deposits, are of Upper Miocene age. The presence of deposits of Pico age in the region near Coyote Pass was established chiefly on the basis of Ostrea vespertina.

The main structural feature of the region is a large southeasterly plunging anticline. The fold is of complex and composite type and is over turned to the west along all of its observable extent. Besides the main anticline there is a smaller one running parallel to the main one. It is of a simple and fairly symmetrical type. Only one fault was mapped. This fault occurs in the northern part of the area and is recognizable because of the sudden cutting off of some of the formations as well as by the displacement of the axis of the principal anticline.

Economic resources are limited to clays used for brick manufacture, and to gravel pits. There are some oil possibilities indicated by the structure.

## Physical Conditions

### Relief and elevations:

The area is a region of relatively low relief, the maximum elevation being 882 feet. The region in general slopes to the south. The lowest point in the area is a sink just east of the intersection of Broadway and Mission Road. Here the elevation is about 420 feet. Out on the alluvial plain the elevation is lower, but this was beyond the area mapped. The relief in general consists of gently rounded hills, more so however in the southern part of the area than in the northern. This will be discussed in more detail under the heading of topography and physiography.

### Topography and physiography:

As stated previously the topography is generally expressed in low rounded hills and grass covered slopes. In the southern part the valleys have worked back in many cases until they cause the formation of separated hills with low saddles inbetween them. The physiographic stage of the southern part would be expressed as late maturity or early old age. To the north the situation is different. Here the physiographic cycle is not as well advanced. There are long valleys but they do not cut through the ranges. The left bank of the Arroyo Seco forms a precipitous descent due to the cutting action of the stream in times past. It has all the steepness of a fault scarp but none of the other characteristics. The hills in the extreme western portion are remarkably flat-topped. The dip of the beds at this point is very high so that the mesa-like character could not be caused by horizontally lying beds. It appears to be an old land surface

that has been elevated except that there is some difference of elevation in the various "mesa" tops. The idea of an upraised land surface does not appear to be in consonance with the maturity of the land surface to the south, and what is perhaps more likely, is that it represents an old flood plain level of the Arroyo Seco. There is some evidence of terracing elsewhere, but not much. If this is the case all evidence of terrace material has been removed by erosion. In general the main features of the topography can be seen more readily by an examination of the map than by a written description.

Drainage:

The general drainage can be seen very clearly from the map. The streams run in a south-westerly direction to join the Los Angeles River. The drainage is slightly disturbed in places, tending to be offset to the east. There is no apparent explanation for this.

Vegetation:

Along the east bank of the Arroyo Seco are numerous California holly trees, but in general the vegetation is confined to grasses, such as mustard, wild oats, and the like. The grassy character of much of the area makes geologic work difficult. Vegetation could not be used very extensively for the determination of contacts. Gazin mentions, in his paper on the area, the use he made of the mustard plant in the determination of contacts, but the author noticed nothing definite about this. Gazin had pictures in his report showing the difference in contact due to the presence of mustard, and perhaps in the author's case the lack of anything definite lay in the fact that the season of

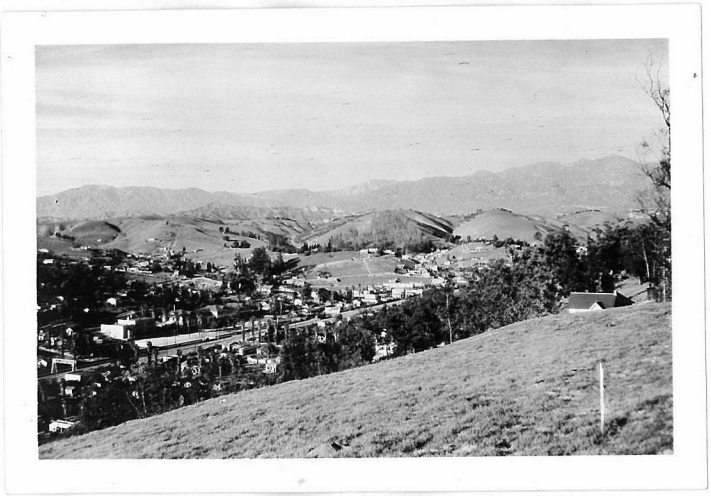
the year was less favorable. The only criterion that I could use was the presence of cacti in beds of a sandy or gravely nature. This was first noticed in the gravels deposits of the region near Coyote Pass. It was used to help determine the contact between sandstone (El Sereno) and shale (Ascot) in the region of Ascot Park.

Exposures:

Because of the low rounded character of the hills, and because of the abundant grass which covered their slopes natural exposures were in general very poor. Most of the country rock was buried by soil. The only thing that made the region workable was the numerous roadcuts which ran throughout the area. Contacts had to be drawn in almost entirely from isolated roadcuts, though in limited areas they could be traced.

View of locality #5 looking eastward. This shows the flat top of the hill due to terracing referred to in the report.

This view shows the flat top of another terrace.



General view of the area around Happy Valley and Newton Park showing the characteristic rolling hills.

## Stratigraphy and Petrology

General statement:

The area consists of sandstones and shales. The series can be divided into two large subdivisions, a lower in which the rock is predominantly sandstone with minor amounts of shale, and an upper division in which the rock is practically all shale. There are only minor patches of conglomerate and none of it can be traced. The area is absolutely lacking in any igneous or metamorphic rock.

It is the lack of any distinctive rock coupled with the complexity of structure which makes the area difficult to map. Many of the contacts are doubtful and are so indicated on the map.

The formational names are those given in a previous report by Gazin. The name Sierra Vista as used in the present report probably consists of both Gazin's Sierra Vista and Harmon. In the area under consideration separation was impossible.

The thickness of the formations given by the columnar section is probably much too large. The thickness given is probably the result of isoclinal folding, possible repetition by faulting, and the like.

Omaha Sandstones, Upper Miocene:

The Omaha sandstones have been exposed by erosion of the crest of the south-easterly plunging anticline, called in this report the Omaha Heights anticline from perhaps its best exposure on Omaha Heights. Its widest areal extent is to the west of the Happy Valley fault where it owes its wide extent to faulting action. From Omaha Heights east the outcrop decreases

rapidly in width. It disappears under the alluvium of the valley through which El Sereno Avenue runs. It is not exposed in the hills to the east of this valley. This narrowing out is caused by the plunging of the anticline. The outcrop's sudden widening on Omaha Heights can be traced to a sharp bowing up of the anticlinal axis.

The formation itself consists chiefly of a soft, massive, fine-grained, arkosic sandstone. The color is predominantly light brown, but is sometimes yellowish brown or grey. Little shale stringers run throughout the sandstone. The sandstone weathers to a slightly darker color than its true color. A hand sample from the type exposure was examined under the hand lens. The constituent grains are subangular to semi-rounded. The minerals recognizable are the feldspars, quartz, biotite, and some limonite. Another sample was taken from the exposures on the terraces bordering the Arroyo Seco. In general appearance the two samples were identical. In addition to the minerals mentioned above this sample contained muscovite and pyrite. As far as the author knows the sandstone is absolutely unfossiliferous.

Rose Hill Shales, Upper Miocene:

Lying conformably above the Omaha sandstones are the Rose Hill shales. These shales are exposed typically on Rose Hill, but perhaps just as good if not better exposures are to be found on the hill of locality number 2, as well as on the terrace to the east of locality number 5. East of the Happy Valley fault the shales are exposed on both the north and south limbs of the Omaha Heights anticline. Due to the plunging of the structure the two exposures eventually run together, the formation itself rapidly narrowing in the region of City Terrace

where it disappears under Pleistocene gravels.

The Rose Hill shales are predominantly white, sometimes becoming yellowish or greyish. Generally the shale consists of a somewhat soft massive shale, but sometimes the shale is found as a hard, finely cleavable variety. Most of the samples examined carried fish scales, and some carry fish vertebrae. All of the samples tested with acid were very calcareous, but some of the shale is diatomaceous.

Shale from locality 2 was given to Mr. K.E. Lohman for examination for diatoms. He reported the sample very rich in them, and as certainly Upper Modelo in age. It seems from this than in none of the area examined is there strata of older age than Upper Modelo or the middle to upper part of the Upper Miocene.

El Sereno Sandstones, Upper Miocene:

The El Sereno sandstones lie conformably on top of the Rose Hill shales. These sandstones are exposed east of the Happy Valley fault on both limbs of the anticline. They run eastward finally disappearing under the Pleistocene gravels and alluvium. The El Sereno is very similar to the Omaha formation. The sandstone is grey to reddish-brown in color. It weathers to a darker shade. Examination of a hand sample shows it to be a soft fine-grained, arkosic sandstone consisting of subangular to semi-rounded particles. It seemed that the El Sereno formation was coarser than the Omaha. The following minerals were noted in a hand sample; the feldspars, quartz, pyrite, muscovite, biotite, hornblende?, and some pieces of woody material.

Stringers of shale run through the formation and here and there are shale and granite boulders in the sandstone.

The formation generally becomes quite shaley at the top and bottom of the section.

The formation is unfossiliferous.

Ascot Shales, Upper Miocene:

Conformably on top of the El Sereno sandstones are the Ascot shales. The Ascot is the formation of widest extent as well as the most varied in the series. It is exposed on both limbs of the anticline, the type locality being at Ascot Speedway. Typically it is a grey shale with red-brown bandings and streaks due to the high iron content. Sometimes the shale is a greyish white as is the case at the Alhambra Brick Company pit at locality number 3. The shale is massive to quite thinly bedded, and rather firm. Sometimes the shale is sandy(in the region around Newton Park it is quite so), sometimes it is slightly chalky. The most noteworthy variations from the general type occur at locality 1 and at locality 4.

The formation at locality 4 represents the basal portion of the section, and is present as an ill-sorted conglomerate composed for the most part of semi-rounded granitic boulders ranging from fine gravel to boulders one and a half feet through. The thickness was not measured but must be between 75 and 100 feet. The lower portions are interbedded with grey and rusty colored sandstone. This conglomerate is not identifiably recognizable at any other locality. Besides the granitic boulders there were recognized shale boulders, gneiss, schists, lava, and some gabroid rocks. Because of the lack of the conglomerate elsewhere the formation probably represents the channel of a strong current in the sea of deposition caused by a stream entering the sea with considerable velocity.

In the author's estimation one of the most remarkable

occurences in the entire area is represented at locality 1. There is present a rather unconsolidated conglomerate grading from quite fine sand at the base up to sizable boulders at the top. At the top and bottom of this deposit is the regular Ascot shale. In the middle portion of the conglomerate there is a great deal of shale. This shale is present as shale boulders, showing some transportation, pieces of shale some of which are a foot thick and five or six feet long, and could not possibly have been transported more than a few feet, and many irregular sized pieces. Some of the long pieces of shale are twisted and contorted. The whole of the shale is jumbled up in almost inconceivable fashion.

There are several explanations for this, the first being that the shale and conglomerate were laid down alternately by fluctuations in the depositing current. Then afterwards considerable landsliding or faulting broke the deposit up into its present condition, surface waters helping to carry the finer sand through the deposit. This explanation does not show the reason however for the more rounded shale boulders which show transportation. The deposit might also have been laid down more or less as we find it today. In this case it might well have been laid down at the foot of a sea cliff. Pieces of rock from the cliff could have broken off and been deposited with out transportation. In this case the rounded shale boulders and the gravel would have to be carried in by currents along the base of the cliff from the outside. A third explanation might be a combination of the first two. The shale pieces might have been laid down at the base of the cliff and the conglomerate laid down on top at a latter date. Subsequent earth movements might have jumbled the deposit up into its present condition. These explanations are weak and the true explan-

ation may be very simple, but at present this is all the author can offer.

At the Alhambra Brick Company pit at locality 3, the Ascot is a good enough variety of clay to be used for bricks. Examination of a piece of shale from this pit showed it to be a greyish white to brownish grey shale, weathering slightly darker. The dark layers are sandy while the lighter colored layers are calcareous. It is a fairly hard and well bedded shale. It seemed to be a very poor quality of clay, and the author cannot see how it could be used very well for bricks.

The formation is as far as known unfossiliferous. It may of course carry diatoms or foraminifera.

Sierra Vista? Shales, Upper Miocene:

Lying conformably on top of the Ascot are the Sierra Vista? shales. These shales probably do not represent exactly what was considerered by Gazin as such. As mapped they probably represent both Sierra Vista and Harmon formations. In the area under consideration no distinction could be made. In passing it might be mentioned that the word Harmon is probably a mistake. As far as the author knows there is no region by that name in the area Gazin mapped. There is however a community known as Hermon which in all probability is to what Gazin referred.

The Sierra Vista? shales are exposed in the extreme northern portion of the area on the north limb of the anticline. They are not represented on the south limb, at least as far as mapped, presumably they are present but buried under the alluvium. The shales may be present in the hills to the southwest but it is not likely as at least as far east as the Los Angeles brick yard the formation is known to represent the Pliocene. It is not impossible that the shales are not pres-

ent at all on the south limb of the anticline.

Though there is nothing but shale present in this formation, the shale itself is quite varied. The most distinctive part of it is a very hard light yellow-brown to yellow calcareous shale which weathers to a slightly darker color. It is sometimes colored a bright red due to the oxidation of the iron content. This shale forms prominent outcrops. Interbedded with this are thinly bedded, hard, white shales. Farther up in the section is a series of dark brown gypsiferous shales weathering to a lighter brown. These shales in addition to the gypsum carry a considerable quantity of sulfur. At the top of the section mapped are two more lithologic types. One is a brownish grey shale carrying some woody material. It is one of the few shales in the entire region that does not carry some chalk. Interbedded with this is an extremely hard siliceous and calcareous shale. It is grey to buff in color, the colors being banded. It is too well cemented to be cleavable. The banding apparently represents past bedding planes. The fracture of this shale tends to be conchoidal.

Pico Formation, Lower Pliocene:

During reconaissance work the beds just northwest of Coyote Pass were visited. These beds are Pliocene in age though the location of the contact between these beds and the rest of the area mapped was not noted. Three fossil localities were found, two of which appear on the map and constitute the only fossils found in the entire area. The third locality was not noted because of the fragmentary condition of the fossils present. The fossil beds represent transported material for in one place the fossils are found in a hard matrix with well rounded granitic boulders. The matrix is hard enough to form a prominent

limey reef which sticks up at the edge of a road and cannot be missed. (locality 2f) The fossils found here consisted of pectens, oysters, and some gastropods. The second fossil deposit noted is a narrow bed consisting of several bands of fossiliferous material about six inches wide separated by unfossiliferous clay. The dip of the beds is apparently 70 degrees north. The fossils at this locality are pectens, a limpet-like gastropod, Ostrea vespertina, and several small pelecypods. The Ostrea vespertina occurs in great numbers, but the other fossils are few and fragmentary. Ostrea vespertina was identified by Doctor Woodring, and the age of the formation from this would be Lower Pliocene or Pico.

The beds in this locality seem to be generally a massive clay with some sandstone, and there is one small patch of conglomerate. There are several formations of limestone of fairly large extent, at least as indicated by their exposure along the stream banks.

The nature of the contact between the Upper Miocene beds and the Lower Pliocene ones is not certain. The most complete Pliocene section, according to Eaton, in the Los Angeles basin occurs in the Rapetto Hills. If this is true, its great thickness coupled with the great thickness of the Upper Miocene represented here hardly leaves room for any great structural unconformity between them. At the most it is probably an erosion surface. It is possible that such beds as the Ascot may represent part of the Pliocene in which case as far as could be determined the two formations would be conformable.

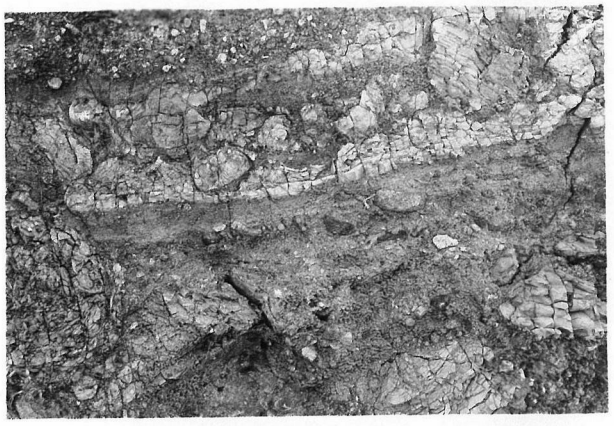
Pleistocene Gravels:

Pleistocene deposits consisting of unconsolidated gravels are quite wide spread in the more southern portions of the area.

They are unconformable with the underlying Miocene and Pliocene sediments. The fact that they occur on terraces leads to the conclusion that they are river terraces. On the other hand, the section exposed in the gravel pits near Coyote Pass looks like a marine deposit. At this locality there must be a maximum thickness of 100 feet. Here the deposit consists of layers of sand and gravel, the sand looking in every way like beach sand. It is just possible that these deposits do not represent the same formations as those farther north, and may be marine, yet these also are on terraces. At one place near fossil locality number 1f the gravels butt up against the Pico clays in the manner represented by a river bank, but this may only be a scour channel in the sea bottom. Taking all the evidence into consideration it is probable that these gravel deposits represent river terrace deposits.

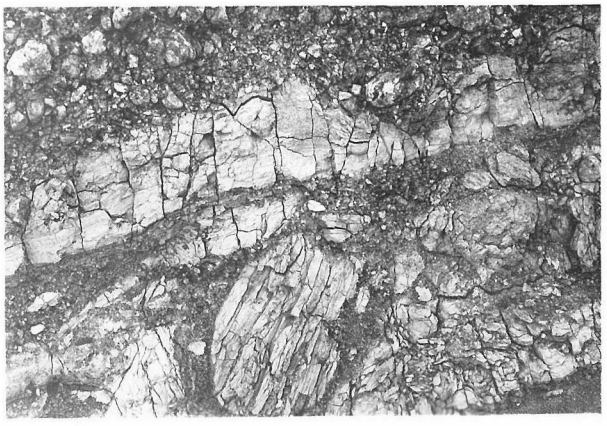
Alluvium, Recent:

At present the valleys are fast becoming filled with Recent alluvium. Many of the hills are of the inselbergen type, and soon will be completely covered by the alluvium.



Photograph showing the character of the gravel and shale of locality #1. Note boulders both above and below the shale, and the broken and twisted nature of the shale.

View showing a large shale boulder surrounded by gravel and other bits of shale. Locality #1.



These two views show very clearly the relations of the gravel to the shale. Note the rounded shale boulder and its relation to the long piece of shale above it. These two pictures overlap and form a continuous picture if matched by the points marked x. Locality #1.

View of the conglomerate at locality #4. This is a poor picture but some of the boulders can be made out.

View of the clay pit of the Alhambra Brick Co. at locality #3. These are Ascot shales.

View of the Pleistocene gravels at locality #8. There are generally more boulders in the deposit than are indicated in the photograph.

## Geologic Structure

The main controlling structural feature of the region is the Omaha Heights anticline. Besides this there is the important Happy Valley fault and the Ascot anticline. These structures will now be discussed in some detail.

### Omaha Heights Anticline:

This is a major anticline, running the length of the area, which plunges in a south-easterly direction. It is unsymmetrical, the south limb generally being much steeper than the northern. The anticlinal axis is also folded slightly both in a vertical direction and along the length of the axis. There are smaller folds on the flanks which makes the fold both complex and composite. The anticline is overturned to the west over all of its observable length. The cross section AA' shows the nature of the overturn at Omaha Heights. It was also found to be overturned at the next hill to the east (near locality 2), as well as in the vicinity of City Terrace.

The overturn at City Terrace is of interest in that the gentler sloping limb is composed of the relatively soft, incompetent beds of the Rose Hill formation. The steep overturned and isoclinally folded limb is composed of the more massive competent sandstone of the El Sereno formation. This seems to be the direct opposite of what one would expect.

There is some evidence of an overturned section at locality 6. This is based, however, entirely on what was taken for ripple marks in the Omaha sandstone.

The evidence for an anticline of any considerable extent was not at first apparent, the Ascot anticline being thought

of as the main anticline of the area. After detailed mapping of the beds was started the evidence for the existence of a major anticline, was however, incontrovertible. The presence of the anticline is very clearly shown in the areal pattern of the various formations. The best exposure of the anticlinal axis occurs by the Ascot reservoir on Omaha Heights.

Happy Valley Fault:

Though there are minor indications of faulting along the fault the only real proof of the presence of a large fault lies in the areal pattern of the beds and the apparent displacement of the Omaha Heights anticline. The first evidence for a large fault was met in attempting to trace the El Sereno sandstones through on the north limb of the anticline. The formation suddenly disappeared though at the last place it could be identified the outcrop was widening. It was not because of insufficient exposures that the formation could not be found for all along Montecito Drive above the Arroyo Seco were perfect exposures, and not a bit ofsandstone was found. The Omaha sandstone also pinches together to rapidily on Rose Hill to be due altogether to thickening and thinning or to bowing up or down of the anticlinal axis. Further, the exposure of the Rose Hill shales is missing from the hill near locality number 6. Besides these beds being cut off, the anticlinal axis itself is apparently offset.

The evidences other than those just cited are few. There is some indication of faulting in the dip and strike of the beds along Montecito Drive. Where the fault crosses the drive there is quite a difference in strike in a very short distance. Further, the western block seems to have suffered severe earth movements some distance to the south west along Montecito Drive.

Arnold shows a large fault on the northwest side of the Arroyo Seco which if continued would come across approximately where the Happy Valley fault seems to go.

It is possible that instead of following the dotted path indicated on the map after leaving the top of Rose Hill, the fault may follow what is indicated as the continuation of the anticlinal axis. The plunge and amount of compression indicated by the strike along the axis of the fold may be caused by faulting and not by folding. In this case the contact of the Rose Hill and Omaha would have to curve very sharply to the south to not show up on the hill to the northwest of Lincoln High School.

The movement on the fault was apparently vertical with perhaps some rotation. The west block has gone up, and the east block down.

Of course there is always the possibility in a region of as complex a structure and as similar a type of lithology as is represented here, of other relations than those indicated, but it is very difficult to see how any other relationships could explain the areal pattern of the beds. Gazin on his map runs the contacts in near the fault as dotted. He did not take in an area that extended as far over as the present one, and thus did not have to deal with the problem of carrying his contacts through the area of supposed faulting. Even so he told the author that he thought there was probably faulting in that vicinity. Daly has also done work on this area. In his senior thesis he presented the geology of the Mount Washington Hills, but also attempted to carry the contacts across to join with Gazin's area. This he stated to the author he was unable to do. He did not say though whether the difficulty was in joining with Gazin after once bringing the contacts

across the Arroyo, or in being able to carry them across the Arroyo in the first place. On the whole the presence of a fault is certain enough to warrant representing it as was done in the present paper.

Ascot Anticline:

The only remaining feature in the area mapped of any structural importance is the Ascot anticline. This anticline runs along the extreme southwest edge of the area mapped. It is a simple and fairly symmetrical fold for most of its length. In the hills to the southeast of Alhambra Boulevard it seems more complex. Here there appears to be some isoclinal folding along the crest of the anticline. There is an exposure of what was taken to be the anticlinal axis along the Pacific Electric tracks to the east of Mission Road. The anticline is here indicated as quite a small one, and appears to be dying out to the northwest.

There is a small syncline in the Sierra Vista? shale in the northern portion of the area as indicated by the dips and strikes taken there.

Any points left untouched can be clearly seen by reference to the map, cross sections, or the discussion under stratigraphy and petrology.

## Historical Geology

The first event in the history of the region mapped was the deposition of the Omaha sandstones. Whether the lands were already submerged before this event or whether the sandstone represents the first member of a new series cannot be determined from the region studied. There now followed deposition without interruption of the Rose Hill shales, the El Sereno sandstones, the Ascot shales, the Sierra Vista? shales, and probably the Pico. This last has been discussed under the stratigraphy of the Pico, and need not be repeated here.

The direction of the land surface which supplied the materials for the formation relative to the formations themselves cannot be determined. The Ascot shales seem to get more sandy toward the north, but the only conglomerate is in the southern part. Then too, the El Sereno sandstone exposed along Mission Road near Selig Zoo is finer than any representation of that sandstone elsewhere. This makes the available evidence contradictory. According to Eaton, in general, the formations get more sandy towards the north due to the proximity of the Santa Monica Mountains.

Now followed a period of intense folding. Considering the thickness of the Pico represented in the Rapetto Hills this could not have been until Upper Pliocene time. The axes of the folds are along a northwest line. It is not possible to tell the direction from which the folding force came as it is not known whether the force was at right angles to the axes of folding or tangential. From a consideration of the intensity of folding the force apparently came from somewhere in the south.

The Happy Valley faulting was at a later date than the

folding as the fault offsets the Omaha Heights anticlinal axis. This faulting probably took place in Lower Pleistocene time. There may have been uplift and erosion between the folding and the faulting but it is not possible to determine this.

After the period of the Happy Valley faulting there was uplift of the land surface. Streams started to cut, apparently going through the complete cycle to old age. The wandering of these old age streams formed the present terraces on the top of Montecito Drive. Renewed uplift of the land surface, at least in the northern part, started the streams cutting afresh. This event probably took place in the Upper Pleistocene. This might be correlated with the movement between upper and lower San Pedro. Now while the streams were cutting their way down to their present level, terraces and terrace deposits were being formed. It was during this period that the Pleistocene gravels of the southern portion of the area were being formed. The topography was approaching its present form.

The Recent period opened with the final uplift which caused enough renewed activity to incise the streams at their present levels. The present topography of advanced maturity or early old age was developed. At present erosion is carrying alluvium from the hill slopes and gradually filling up the valleys.

## Economic Considerations

The economic resources of the region are few. The chief material taken out is clay for bricks. There are two brick companies in the area. One, the Alhambra Brick Company takes clay from the Ascot shales. The pit is located at number 3. The other brick company, the Davidson Company is located at the southern end of the area near Coyote Pass. The clay for this company comes from the Pico.

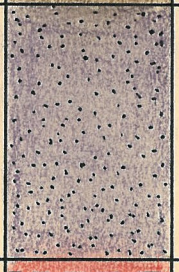
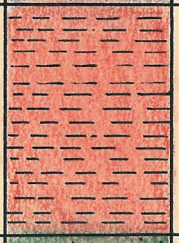
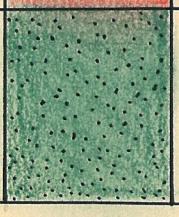
In addition to clay for bricks, large quantities of the Pleistocene gravel is also quarried. There is a quarry at locality number 7, and another one is near Coyote Pass in the gravels in that area.

As to the undeveloped resources the possibilities are slim. There may be oil possibilities on the Omaha anticline but the author is not enough of an oil geologist to tell. This anticline supposedly represents, at least according to Arnold, the continuation of the Elysian Park anticline. While no oil has ever been found east of the Los Angeles River , oil is found on the west limb of the Elysian Park anticline so that it might well be present on the west limb of the Omaha Heights anticline. No oil has ever been found on the east side of the Elysian Park one so that it seems that there would be a better chance of finding oil on the west side than on the east side of the Omaha Heights anticline. The formations are also analagous in that the oil in the old Los Angeles field is found in the Pliocene sediments there. Pliocene sediments are also present in the Rapetto Hills in approximately the same structural relations. There are, however, no oil seeps or other surface indications of oil.

As far as the author knows there are no other economic resources or possibilities in the area mapped.

# Generalized Columnar Section

Scale: 1 inch equals 1000 feet

| Age | Formation | Symb. | Section | Thick. | Description |
|---|---|---|---|---|---|
| Pleisto. | | Pg |  | 300' | unconsolidated sands and gravel |
| Upper Miocene | Sierra Vista? Shales | Tsv |  | 1300' plus | in general very hard calcareous, silicious shale, generally yellowish in color. |
| | Ascot Shales | Ta |  | 2800' | grey to reddish brown shales sometimes sandy. |
| | El Sereno Sandstones | Tes |  | 1300' | grey to reddish brown massive sandstone, interbedded with thin shale layers |
| | Rose Hill Shales | Trs |  | 1200' ?? | white to grey shale generally very calcareous carries diatoms |
| | Omaha Sandstones | To |  | 1000' plus | grey massive sandstone, interbedded with thin bands of shale |