The Geology of The Southeastern Portion of The Glendale Quadrangle and The Northeastern Portion of The Los Angeles Quadrangle.

SENIOR THESIS

by

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INTRODUCTION

The area described in this report is that part of the Glendale and Los Angeles Quadrangles bounded on the north by York Boulevard, on the west by the Los Angeles River, and on the south by North Broadway. This area is about six square miles. The maps used are the U. S. G. S. sheets of recent publication which have a scale of 2000 feet to the inch. The contour interval is 5 feet up to elevations of 500 and then it is 25 feet. The map is very satisfactory and is up to date except for very recent streets and buildings.

This area was included in Ralph Arnold's report, U. S. G. S. Bulletin 103, on the Los Angeles Oil fields. However, his report was only of a reconnaissance nature and was made on a map with a scale of one inch to the mile. Hence very little of the detailed structure of this area was shown. In 1928 Hampton Smith of the California Institute of Technology did some work of a detailed nature, but no finished report was made. The hills to the east of the Southern part of this area, lying in the Alhambra Quadrangel, were works of Mr. Lewis Gazin of The California Institute of Technology. His report was accessible to the writer, and consequently, as some of the same formations occur in both areas, the writer has used the same names for the formations as are used in Mr. Gazin's report.

The writer and his classmate, John Daly worked together, in doint the field work, however each kept separate complete notes and maps in order to make independent reports. The writer benefited from many discussions which arose over the questionable parts of the area. He is also indebted to Dr. J. P. Buwalda for many suggestions on the execution of the work.

The geological mapping was carried on with the aid of a Brunton compass. The mapping of locations was facilitated by the fact that the numerous streets and roads in the area are almost all shown on the map and are easily recognizable.

The problem was worked with a view toward maping the aerial extent of the formations, deciphering thus underground and geological history. The area was worked in as much detail as the map scale and the available time permitted.

The evidence of the underground structure was principally obtained from the numerous road cuts existing in most of the area. Natural exposures, due to erosion, are not plentiful, but are the only ones present in certain localities. The numerous buildings and retaining walls also hindered the collecting of data.

GEOGRAPHY

The topography of this region is eroded to a mature state. It might even be considered as entering old age. The hills are all well dissected and many are well rounded. Only on a few of the steep ridges are typical canyons found. For the most part, the valleys are wide and have a gentle stream gradient. The drainage is all taken by the Los Angeles and Arroyo Seco Rivers. However, both streams are practically dry for most of the year. The small canyons and valleys of the area likewise carry no water except during the immediate time of the occasional winter rains.

The mean elevation of the area is about 500 feet. The lowest point is about 350 feet in the Los Angeles River basis, while some of the ridges have an elevation of 900 feet.

The entire area is covered by a soil mantle which supports quite a varied vegetation. On the northern part, where the underlying rock is practically all shale, the topography is consequently more gentle and the soil mantle supports a dense growth of wild barley and mustard. On the contrary, the southern part is covered by some brush and small trees. However, the soil will also grow grass and barley and in many places the vegetation over the Omaha sandstones is like that over the Rose Hill shales. This makes it impossible to use the vegetation as accessory evidence in locating contacts.

Most all the more gentle slopes are crossed by streets while the steeper hills are cut by curved or winding streets and roads. Most all the area has been subdivided for residential purposes. These many roads on the steeper slopes have necessitated the cutting away of a great

deal of earth. This has facillitated the work greatly by exposing the underground structure and formation. The numerous roads also make the various points easily accessible by automobile. The more gentle slopes and valleys are quite thickly populated while the hills have only a few residential buildings. Both the Santa Fe and Pacific Electric lines pass through the area along the Arroyo Seco River. The Southern Pacific line lies to the west in the basin of the Los Angeles River.

Photographs 1 and 2.

These two photographs were taken from top of the main ridge in the southern part of the area.

The top one is a north view showing the nature of the topography and culture. The axis of the syncline is situated in the first canyon from the left side of the picture.

The lower photograph was taken in a northeasterly direction and shows the channel which has been cut by the Arroyo Seco. The large building seen across the Arroyo is the Southwestern Museum.

STRATIGRAPHY

The three sedimentary formations mapped are from the oldest to the youngest; Omaha sandstones, Rose Hill shales, and El Sereno sandstones. Besides the above formations the Quaternary aluminum was mapped more roughly, principally on a basis of slope change as this almost invariably determines its location.

Due to the fact that the Omaha sandstones contain a great number of shale beds and the Rose Hill shales often contain quite thick sandstone members; it was often difficult to trace the exact contact. The work was also complicated by the fact that the material and thickness of beds often changed along strike. Hence we see that what is apparently Omaha sandstone may grade into Rose Hill shale, either along strike or upward in the section. Therefore, the writer has had to generalize in many localities and hence, formation boundaries must not always be considered as having a definite position.

OMAHA SANDSTONES

This is the oldest formation exposed in the area, and also has the largest aerial extent, It is exposed over about three-fourth of the area, its general situation being in the southern part, It makes up the largest one structural feature, namely the syncline which has a northwest trend.

The thickness of this series is approximately 2200 feet across its largest exposure, namely the southwestern part of the syncline. The beds are well indurated and along most of the cuts stand with an almost vertical slope. They are of a dark brown color when weathered but fresh surfaces vary from buff yellow to light brown. The thickness of the beds varies from a couple of inches to

several feet. For the most part they range from six inches to two feet. The sand grains are of subangular shape and medium size. They are mostly quartz, feldspar, biotite and some muscovite. In some localities the beds are quite quartzose, the grains being well rounded and small size.

Interbedded with the sandstone strata are numerous shale members. For the most part they are slight buff when fresh and muddy brown when weathered. These beds are very argillaceous and usually have a thickness of an inch to a couple of inches.

Another important shale which is interbedded in this series and which composses a great deal of the thickness is the siliceous shale. It occurs in strata from one inch to two feet in thickness, always with sharp bedding planes and is consistently hard. It has a redish brown color when weathered, probably due to limonite, but on a fresh surface is a pale brown.

ROSE HILL SHALE

This series is composed mostly of thinly bedded soft shales alternated with sandstone strata and a few siliceous shale members.

The major part, which as stated above is finely bedded, is a very argillaceous material. The particles are very fine and for the most part indistinguishable with a hard line. However, some of the material appears to be fine, well rounded quartz particles. The strata are almost all very soft but some of the members which are quite arenaceous have a hardness approaching that of the sandstones. These thinly bedded shales are light grey when fresh and buff yellow to muddy brown when weathered. In general, they occur in strata with a thickness of less than an inch. The bedding planes

are not very sharp. The texture of the shales indicates that deposition took place in quite a deep basin in order to allow the fine silt to be separated from the larger particles which naturally settle in the shallower waters close to the edge of the basin.

The sandstone strata which alternate with the shale members are very similiar in texture to those of the Omaha sandstones. However, they seldom occur in beds of such great thickness. For the most part they are six inches or less but this is often exceeded. These beds also seem to be quite arkosic and have a considerable hardness. Their color and shape is very similiar to those of the Omaha sandstone. In many places the thickness of sandstone members exceeds that of the shales. In such cases it is difficult to distinguish this formation from the Omaha sandstone series.

The occurrence of siliceous shales in this formation is equally or more frequent than in the Omaha sandstones. In many places it constitutes a greater part than the argillaceous shales. The origin of the silica in these siliceous shales is often believed to have been derived from diatones. However, several samples of diatomaceous appearing earth were given to the writer's classmate, Kenneth Loman, who submitted them to a mycroscopical examination and found no diatone remains. Hence, one is more apt to believe that the siliceous beds owe their presence to waters carrying silica in colloidal suspension. This theory was proposed by E. F. Davis. This same explanation would be necessary in accounting for the siliceous shales of the Omaha sandstones which are apparantly of the same general texture and composition.

The main exposure of Rose Hill shales is in the northern part of the area. The greatest exposed thickness is approximately 1200 feet. Its straigraphic position, above the Omaha sandstones,

accounts for its smaller aerial extent as it has been eroded away on the higher topographic features. No evidence was gathered which would suggest an unconformity between it and the under-lying Omaha sandstones.

EL SERENO SANDSTONE.

This formation has the least aerial extent of any in the area. It is exposed in the very northeast part of the area and also in the southeast, in the vicinity of Lincoln High School. The greatest section exposed indicates an approximate thickness of 1000 feet. However, very few altitudes were obtained due to the scarcity of exposures, hence the thickness is only a rough approximation.

This formation apparently lies conformably on the Rose Hill shale series, but the writer experienced much doubt due to the fact that few exposures were obtained at the contact and at all of these the El Sereno sandstones were unstratified. Much of the contact in the northern part of the area had a fault relationship so that the relationship of this formation to the underlying Rose Hill shales was quite doubtful. However, the sandstones overlying the Rose Hill shales in the vicinity of Lincoln High School were stratified, and conformable. This sandstone was very similiar to that of the northern part of the area except that no conglomeratic series was present. For these reasons the writer concluded that they were the same formation and hence the series to the north was conformable on the Rose Hill shales.

The presence of conglomeratic material in the north while it is absent in the vicinity of Lincoln High School, indicates that the deposition was from the north. Cross bedding also substantiates this fact. Conglomeratic pebbles are also found at the base of the section next to the Rose Hill shale.

Fresh exposures of the fomation are a light grey color. The material is a well washed sandstone, very fine, decidedly quartzose with feldspar and some biotite.

The conglomeratic horizon has a matrix of sand like that described above. The boulders vary from mere pebbles to boulders of eight and ten inches diameter. They are all either subangular or well rounded. They consist mostly of granite, also sandstone, shale pebbles, and lava pebbles which are probably andesite.

In some places the weathered beds have a red color which is very likely due to limonite formed as an alteration product in the weathering.

In general, the beds are all very soft and loose. Pieces of the rock can be crumbped in ones hands.

The formation in the north part of the area is massive and practically no bedding can be found. As one goes south, well stratified beds are encountered indicating that one is further from the source of deposition. In the last mentioned part, one also encounters a few argillaceous shale members which are only of small thickness.

QUATERNARY ALUVIUM

This formation consists of soil in place over the various hills, valley alluvium, and stream gravel along the Los Angeles and Arroyo Seco Rivers.

Photograph 3.

This picture shows the nature of Rose Hill shales when movement has taken place at any close distance. This was taken along a cut a little way south of the uncertain fault that trends along the word "Angle" on the map. The picture appears indistinct but as a fact it is the bedding that is indistinct. The shales have been twisted and contorted in every direction and it is impossible to obtain any idea of their attitude. This is quite a general condition of this formation.

Photograph 4.

This photograph was taken along a road cut just below the letter N in the word "Angles" on the map. There has been no faulting at this point but nevertheless the shales are fractured and contorted. The beds stand at all angles and some are even overtruned. This is another example of what happens to incompetent beds when an area is subjected to diastrophism.

STRUCTURE

General Condition

The structural relations of this area are very complicated. At a first glance of the map, one would say that the folding and fauling has taken place at random without any regularity or continuety. This is indeed, very true, but by generalizing one is able to divide the area into a few main features, which contain many minor details within themselves.

Much difficulty was encountered in mapping the faults and the writer was not pleased with the results obtained. However, the evidence available was noted and the results given accordingly. One of the main difficulties was that no key beds were recognizable in order to facilitate the tracing of faults, obtaining their altitude, and direction and amount of movement. Another difficulty was that the entire area has been shattered so that in many cases there has been relatively little movement but just fracture planes which has allowed some movement of the blocks to relive deformational stresses. Hence faults might be recognized at one point but not be traceable. Another consideration is that all the formation are quite incompetent, especially the Rose Hill shales.

Due to the above difficulties many of the faults were mapped as questionable and give some aid even if the attitude and movement is not known.

The following main structual divisions are made:

That part of the area south of the Arroyo Seco constitutes a block with a structure entirely different from that on the north side. It is undoubtedly separated by a fault situated some where in the Arroyo Seco wash and roughly paralleling it. The structure of this block has in general, a north south strike with an east dip which varies from about 30° on the west side to 20° on the east.

This block is cut by a fault of south east trend which accounts for the change in strike of the beds.

Another main structural feature is that block north of the Arroyo Seco which contains a well defined syncline. It is bounded on the southwest by the Arroyo Seco and on the Northeast by a series of faults of major or minor importance having a northwest trend. That is, the fault or series of faults going from the secnond A. in Rafael and between the N and G of Angles. This block has general strike of about North 50° west, as has also the axis of the syncline and the connecting faults which are on the northeast side. The southwest limb of the syncline is cross faulted in two places while the northeast limb is very irregular and cut by several faults. The syncline is asymetrical. The northeast limb having a dip of about 20° while that of the southwest is approximately 50°. It is also likely that there has been faulting in some places along the axis of the syncline as there are abrupt changes in the strike of the beds on one side of the syncline without any change on the other. This syncline continues to the aluvium on the northwest margin of the area. This block is composed of Omaha sandstone except for a small amount of Rose Hill shale on the N. W. end.

Another structural block is that one comprising the area remaining to the east of the above described block and southeast of the fault running through the word "Highland Park". This locality is composed of Omaha sandstones and the structure is fairly constant except west of the minor fault which cuts the block in a general N - S direction. The strike of the beds is roughly E- W with a 20° south dip. A small antecline and syncline of east west strike crosses the eastern block of this major block.

The remaining area covered chiefly by Rose Hill shales has

a general north dip. However, folding and faulting has inclined some of the smaller blocks toward the south, a well defined syncline and antecline are mapped in this block. These shales are intensely folded, in many places the beds are vertical and in other the folds have been overtruned. Most of the folding is too inconstant to map except for the one antecline and syncline. Due to the intensity of the folding the structures probably do not extend down to a great depth but are quite local surface expressions of the relieving of various stresses which these incompetent beds would not stand.

Along the questionable fault, which follows the word "Angles" and then trends southeast, we notice many good examples of drag folding. There has probably been but little vertical movement along this fault but it has served as an adjusting place for the many stresses due to the folding. Along this line the shales are folded and contorted into almost all imaginable structures. Atlitudes mean very little in these shales but the strike is roughly N 40° W and the dip 45° N. The area N. of this fault contains the above mentioned syncline which has a strike of N 75° E.

The block containing the El Sereno sanstones has been separated from the others by fauling and the beds have a strike of about N 45° and a dip of a approximately 45° S. However, the evidence for these faults was very scanty so that direction of movement or attitude of fault plane could not be determined.

Photograph 5.

This photograph was taken on Griffith Avenue just south of Avenue 35. This point is on the west side of the area south of the Arroyo Seco. It shows a fault with a low angle dip to the right while movement of the right block has been up and to the left. In the movement it has formed an overturned fold. If one follows the thick sandstone bed below the pick, they will see that it turns through an angle of approximately 180° and parallels itself. The beds further to the right have been broken and contorted. This formation is Omaha sandstone.

Photograph 6.

This picture was taken on Cleveland Street, just east of Division Street. The view is north. It shows the fault which trends southeast from the letter G in "Angles." It has a dip of about 55° north.

In the picture the Omaha sandstones are on the left and dipping left, while on the right side of the fault we have the badly contorted and broken Rose Hill shales which have a dip to the right nearly paralelling the fault. The drag shows movement has taken place in both directions but in the net relative movement the right block (northeast block) must have moved down in order to explain the stratigraphic relation of the formations.

AGE OF FORMATION

English in his report of the "Puente Hills Region", U.S. G. S. Bul. 768, assigns the Puente formation to middle and upper miocene. His basis is chiefly on stratigraphic relations and lithologic correlation.

The lithologic similarity with the Puente Hills, and the sequence of the formations of this area both tend to lead the writer to believe that the group should be classed as Puente, which stands as upper-middle or lower-upper miocene.

Ralph Arnold included all the formations of this area in the Puente miocene. Lewis Gazin in his report on the Alhambra Quadrangle grouped everything above the El Sereno sandstones as upper Puente and that below as lower Puente. If this is correct, then the age of all three of the formations which were mapped is lower Puente, Hence, there age is probaly upper-middle miocence.

A fossiliferous locality was found in the El Sereno sandstone of the north part of the area. It was located along the street cut one block west of Avenue Fifty, however, all the material that was found, was of a nature unfit for use.

GEOLOGICAL HISTORY.

The Puente sea which covered this area during Miocene time must have been of considerable depth. The reason for inferring this is the vast occurrence of shale beds. One cannot easily conceive such well stratified members of fine sediments being deposited close to shore in shall water. However, the variation of the beds from shale to sandstone and again to shale indicate that the depth of the basin was rising and falling or else land conditions were varying so as to cause a change in the materials carried by the errosive streams. In general, the sandstone deposition must have occureed in a fairly shallow depth for it is impossible for streams to carry coarse material far into the ocean.

After the deposition of the Rose Hill shales there was some uplift and erosion previous to the deposition of the El Sereno sandstones. The reason for this is the presence of shale pebbles in the base of the section of El Sereno sandstones. This period of uplift was probably a short one as the El Sereno Sandstones appear to be confprmable on the Rose Hill shales. In general, there was probably a small regression of the sea with erroded shale pebbles being deposited with the El Sereno sandstones conformably on the Rose Hill shales.

The presence of conglomerate in the El Sereno sandstones in thenorth part of the area while it is absent in those exposed in the southern part indicates that the source of deposition was from the north. This occurrence of conglomerate also indicates that after the regression mentioned above, there was an advancement of the sea as far or further north than York Boulevard, in order to permit conglomeratic deposits on the Rose Hill Shales.

After the El Sereno sandstone depositon there was

obviously uplift of this whole area and no further submergence as no later Puente or Fernando formations are found. It is possible that such have all been erroded away but this is quite impossible.

The exact age of the folding and faulting cannot be deciphered from the local data. All one could say, is that it was after the El Sereno sandstone deposition. From other adjacent areas, evidence shows that such deformation was post Fernando. This is very likely applicable to this area when one considers that the late Pliocene and Plustocene periods are characterized by extensive mountain making all along the California coast.

PHYSIOGRAPHY

In general that part of the area covered by Omaha sandstones has a higher relief and sharper topography than that capped by Rose Hill shales. This is mostly due to the greater resistance of the sandstone to erosion. However, this does always hold true as the attitude of the bids is also an influential element.

One of the few places where topography indicates the underground structure of the beds is along the syncline northwest of the Arroyo Seco. Here the ridges are practically strike ridges while the axis of the syncline follows the canyon.

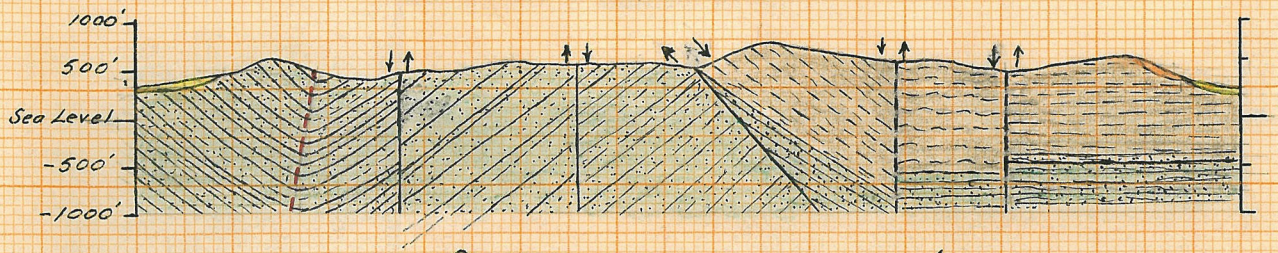
The axis of the syncline in the north part of the area follows a ridge. Hence, we see that it is easily possible to have a synclinal ridge as well as an anticlinal one.

In general the canyons, tend to follow the faults wherever the natural drainage is close to the weakened zone caused by the movement. However, this does not hold in this area except to a small extent. Saddles are also formed occasionlly where faults cross ridges.

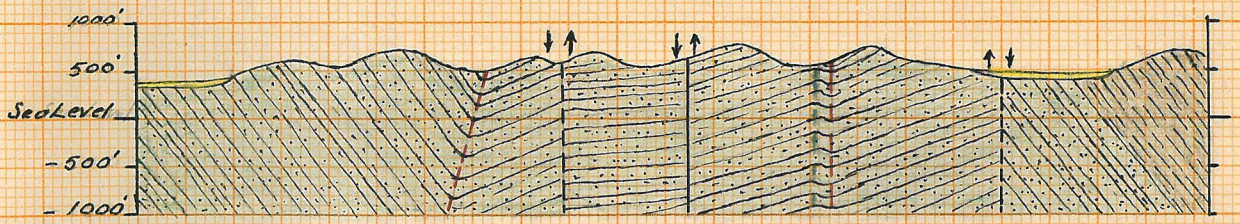
The Arroyo Seco is most likely an antecedent stream which has maintained its course throughout the uplift and folding. However, the present topography and structure has influenced its course as has also the fault which is believed to be under the present stream course.

STRUCTURE SECTIONS

Horizontal scale = Vertical scale = 1/24000.



Section along line A-A'



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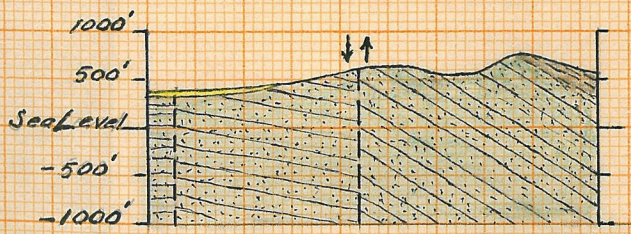

Section along line C-C'

MOSS Omaha Sandstones

MESSS El Sereno Sandstones

MRHSH Rose Hill Shales

Qal Quaternary Aluvium