GEOLOGY OF A PORTION OF THE LOMPOC QUADRANGLE

OF

SANTA BARBARA COUNTY,CALIFORNIA.

by

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THESIS

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INTRODUCTION.

In the southern coastal region of California the Tertiary formations are extensively developed and present many problems of geological interest. The development of their petroleum contents make them of marked economic interest. An area in the Santa Ynez Range was chosen with a view to working out in some detail the structure and stratigraphy of this division of the coast ranges.

The earliest reports of the geology of the Santa Ynez Range are to be found in the Pacific Railroad Exploration Reports and the Geological Survey of California. Thomas Antisell and Albert H. Campbell described the main topographic features, and noted the presence of asphaltic rocks.[1] The Tertiary age of most of the sedimentary rocks was recognized, but the structural features and the relations of the rocks were in the main misinterpreted. Fairbanks in his paper on the "Geology of Northern Ventura, Santa Barbara, San Luis Obispo, Monterey, and San Benito Counties" discussed the Santa Ynez Range. "There can be no doubt that the main portion of the Santa Ynez Range is Miocene with a general anticlinal

1) Pacific Railroad Reports, Vol.7, 1857, Chaps. 8,9,10.

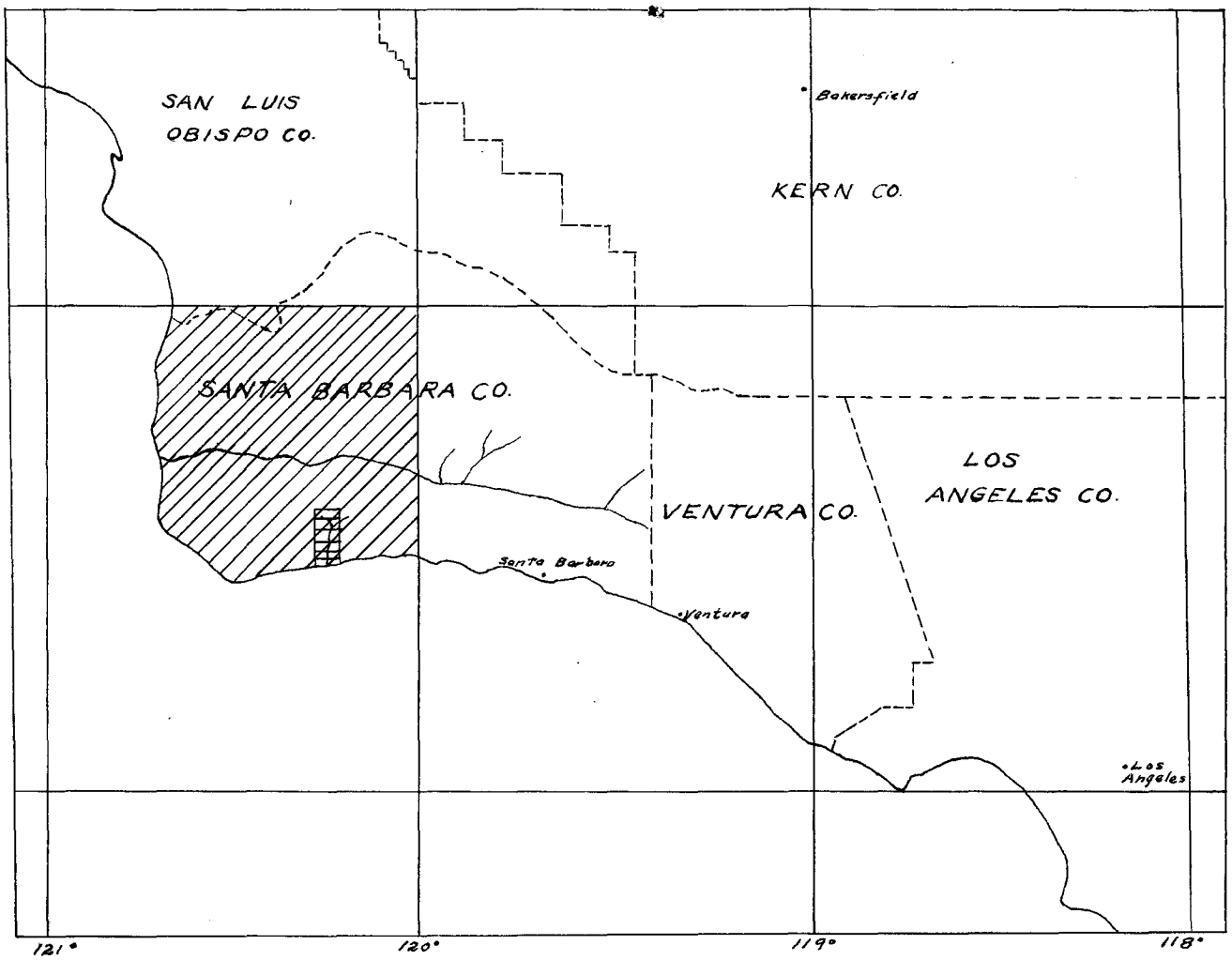
structure, well shown in San Marcos Pass"._____"The normal type of anticlinal structure is also marked by an east west compression, producing features,however,of secondary importance._____

"As viewed from the south at various points the range consists of heavy bedded sandstones dipping at a high angle to the south." J.D. Whitney,[2] Blake,Diller, and Eldridge,[3] have made reports on the general region of the Santa Ynez Valley.Arnold and Anderson have covered this area in their report on the Santa Maria Oil District of California.

LOCATION OF AREA.

The Santa Ynez Mountains are an east west structural feature which forms a prominent elbow on the California coast. On the north the range is bounded by the westward flowing Santa Ynez River and on the south by the Santa Barbara Channel. It is a long narrow range extending from Point Conception east for about 70 miles until it meets the southern end of the southeastward trending San Rafel Range and is lost in the mountainous region to the east where the ranges in this part of California converge forming a very structurally complex region. The range has an average width of nine miles. To the east of Gaviota Canyon the range attains an elevation of 4000 feet and offers an even sky line, to the west,however, the crest of the range is seldom over 1500 feet and is irregular.

2) Geological Survey of Califronia.Geology; Vol.1, 1865,pp 135-38
3) Twenty-Second Ann. Rept.of U.S.G.S. pt.1, 1901,pp 424-441
4) U.S.G.S. Bull.322



Area mapped and discussed in this report

Area covered by Santa Maria Report U.S.G.S. Bull. 322.

5M 0 5M 10M. 25M. 50M.

Scale

The area mapped and discussed in this report is approximately 15 miles east of Point Conception or 30 miles west of Santa Barbara.

The eastern boundary is a north south line 1½ miles east of the mouth of Gaviota Canyon, the western boundary a north south line thru the mouth of Agua Caliente Creek. In a north south direction the area extends from the summit of Santa Rosa Hills in the north to the sae coast. The areal extends is approximately 30 square miles. Six weeks were spent in the field during the summer of 1929.

The base for the work was the United States Geological Survey Lompoc Quadrangle enlarged four times giving final scale of 1" equal ½ mile with a contour interval of 100 feet. Airplane photos which extended two miles back from the coast with a scale of 1" equals 1380 feet were used in mapping that part of the area.

CLIMATE & VEGETATION.

The climate of this area is that of the coastal region of California. It is equable the whole year round, excessive heat or cold are rare. The average rainfall is 15 inches. However, due to the moisture and protective blanket offered by the numerous heavy fogs dry farming is carried on successfully.

Some parts of the area are covered by a dense growth of brush. Sagebrush, buckthorn, greasewood, manzanita, California holly and lilac, and live and white oak bushes form the greater part of this type of vegetation. These plants favor the sandstone and conglomerate areas. Much ofnthe area, particularly that in the north is clothed with a scattering of large white

and live oaks. Monterey shale seems to form a favorable soil for them as a large part of this formation is covered by these trees. Large sycamores,willows,cottonwoods, and water maples are found in the canyons, Grass and tarweed cover the hills in many places and are indicative of shale as the underlying formation.

RELIEF.

The relief to the east of this area is somewhat greater than to the west. Gaviota Peak near the eastern border of the area has an elevation of 2451'.Fifteen miles to the east the range rises abruptly from the coast to Santa Ynez Peak having an elevation of 4292. West of Gaviota Canyon the crest of the range has an altitude of between 1500 and 1700 feet. The elevation of the Santa Rosa Hills in the northern part of the area is approximately 2000 feet.In general it might be said the region has a moderate relief.

Gaviota Canyon is the largest stream in the area; it drains south to the coast flowing across the axis of the range.In tthe vicinity of Las Cruces it branches to the west and Canada de Las Cruces which flows due south enters the main canyon which has a northeast southwest direction north of this point. The lower course of this stream has water in it the year round and is one of the few in the area that do.The consequent streams up the flank of the range such as Aqua Caliente Creek or Canada Omentero carry little water and usually be come totally dry in the summer or contain only standing pools of water.

Nojoqui Creek drains the northern part of the area flowing in a northward direction and joining the Santa Ynez River at the town of Bulleton.The Santa Ynez River flowing in the valley of the same name heads in the mountainous region where the Santa Ynez and San Rafael ranges meet.It flows westward emptying into the ocean about eight miles north of Point Arguello.

STRATIGRAPHY AND AREAL GEOLOGY.

The rocks in the area covered by this report range in age from those that are questionably Cretaceous to Pleistocene, with the exception of Oligocene and Pliocene. A short distance to the north Pliocene rocks occur and are refered to the Fernando Group by Arnold.[1]

The Cretaceous? shales and sandstones are succeeded by a great thickness of shales and sandstones called Santa Rosa which contains fossils that belong to the middle Eocene. In the southern part of the district the Santa Rosa is overlain conformably by a series of sandstones and sandy shale to which the name Lower Gaviota has been given. The Upper Gaviota rests conformably on the Lower Gaviota and also carries Eocene fossils. Intercalated with this formation are the red beds and conglomerates of the Sespe formation. The Upper Gaviota is followed by sediments of Miocene age. These are divided into the Vaqueros, consisting of conglomeratic material, the Lower Clay Shale, which is predominantly shale with a few sandstone and cherty lenses in it, and the Monterey Shale which is composed almost entirely of material of organic origin. The Pleistocene is represented by terrace deposits along the coast and alluvial deposits in the valleys.

1) Santa Maria Bull. op. cit.

EOCENE UNDIFFERENTIATED.

The structure of the Santa Ynez Range east of Gaviota Canyon is monoclinal. The beds dip south at an average angle of 30 degrees thus making the total thickness of sediments exposed approximately 14000 feet ~~thick~~. The north face of the range is very steep and is covered with heavy brush consequently the exposures are poor except in the bottom of steep canyons. The range was crossed about three quarters of a mile to the east of Gaviota Peak. The base of the Lower Gaviota was marked by a few black nodular concretions which contained numerous shell fragments. The high degree of induration of the concretions and the fragmentary condition of the fossils made it impossible to make a collection. Below this horizon no fossils were found, however, there is a distinct change in the lithology. The section is composed of finer grained detritus, 60 to 70% is shale, sandstone beds up to three feet thick intercalated with shale form the remainder of the section. In lithology it is very similar to the Santa Rosa but no fossils were obtained as proof of its identity. Another and somewhat more distinct change in lithology takes place at the head of the canyon that drains west and joins Gaviota Canyon at Las Cruces. The change is from the olive green to reddish brown, somewhat siliceous, thin bedded shale of the Santa Rosa as seen in the core of the anticline in the western part of the area to a very hard, black, thin bedded shale intercalated with hard greenish sandstone beds from a few inches thick up to two or three feet. Below this general horizon the beds become coarser and reef forming sandstones

predominate. Most of the sandstone has a dark greenish black color but occasionally a dark ~~bluff~~ buff colored bed is encountered. Several hundred feet below the top of this somewhat older looking set of strata is a coarse conglomerate which is approximately a hundred feet thick. The conglomerate is very well indurated as shown by the fact that when broken it breaks thru the boulders and not around them. The boulders are composed chiefly of chert, quartzite, and rocks of shallow intrusive origin. Below this conglomerate is a series of sediments similar to that found directly above it. Toward the base of the section the amount of shale increases until it forms the major portion of it.

A half a mile north of the area along the State Highway ~~it~~ outcrops of strata similar to those above described are found. The hard, brittle, black shale is refered to by Arnold and is considered to be Eocane.[1] Fairbanks speaks of sandstone and shales, of "undoubted Cretaceous age" between Gaviota Pass and the Santa Ynez River. He also states that an angular unconformity can be seen in a small canyon coming into Nojohui Creek from the west. This canyon is the one at the end of the word Creek of Nojohui Creek. The unconformity can be seen in the most northern branch of this canyon about a mile from the highway. (see Fig.) The shale below has an attitude of N[illegible]W and 28S and the buff colored sandstone of N10W and 14S. This break in the section was not observed in the south part of the area. Above the buff sandstone is a hundred feet

or more of conglomerate. No paleontologic evidence of the age of the shale or sandstone was gained. It is highly probable that the shale of Cretaceous age. In the south-eastern portion of the area part of the section below the lower Gaviota appears to be Eocene due to its lithology and position but the limits of the Eocene were not known and the black shale section was included in the Eocene Undifferentiated. More intensive study of the general region surrounding thia area should make it possible to determine the age an relations of these older strata.

1) Santa Maria Bull. page 12, 30.

SANTA ROSA

This formation is best exposed in the northern portion of the area. The upper 3200' of it consists mainly of olive green to almost black thin bedded shale intercalated with fine sandstone layers which vary in thickness up to 3'. Some of the beds are extremely hard and contain fossils. The lower part of the section is composed of massive sandstone layers intercalated with ananaceous shale layers.

On the west side of Nojoqui Creek N43W from the first bridge crossing it north of Gaviota Pass and approximately 150' above the floor of the valley is fossil locality C49. At this point there are several thin hard limy lenses in a massive, yellowish brown sandstone. Small lenses of conglomerate material occur in the sandstone, a few well rounded pebbles 3" in diameter were noted. Collecting from the hard limy lenses was very good and the following forms were a few that were identified.

Ficopsis hornii Gabb ____ Reported from the type Tejon only

Ficopsis remondii Gabb__ Reported from the type Tejon and LaJolla formations.

Sinum obliquin _____ Reported from the type Tejon and Domingene Macrallista conradiana

Amaurallina (aff. clarki stewart very similar to the one found in the Domengine in Simi Valley

Exilia sp. very similar to E. Microphygina Gabb from type Tejon.

A half mile N23W from this locality is locality C61. ANartia triangulata Gabb was collected at this locality. This form is reported from the Domengine formation of Simi Valley and near Coalinga[1] and also from the La Jolla formation.[2] About 5/8 of a mile due west of Hill 1921 which is at the head of Canada de Las Cruces is locality C 64. A fine to medium grained sandstone with a few cobbles scattered thru it is overlain by several very hard concretionary beds of sandstone containing numerous fossils.

1) Clark,B.L., The Domengine Horizon,Middle Eocene of California.University.Calif.Publ.Geol.Sci. Vol.16 pp.

2)Hana,Marcus, A., An eocene Invertebrate Fauna From the La Jolla Quad.Cailfornia U.C. Vol.16 247-398.

Globularia sp. and Amarallina aff. clarki Stewart which were collected were found to be very similar to forms in the middle Eocene in Simi Valley which Clark called Domengine.

To the north of this locality 200 yards and slightly lower stratigraphically a Ficopsis hornii Gabb and several specimens of Amurallina clarki, also specimens of Turritella variata were collected. The above listed fauna indicates that these beds are approximately middle Eocene in age but correlation with any known horizon will not be made. The types that occur in the type Tejon and also in this set of strata may have a downward range into the middle Eocene if not farther. However, it would seem that these strata are approximately middle Eocene in age. Further collecting and discovery of new localities, careful study of the forms and comparison with type material would be necessary before any reliable conclusions couldbe drawn. The time and scope of this paper does not permit of such study. In as much as a satisfactory correlation could not be made with other known Eocne horizons with evidence at hand the name Santa Rosa is proposed for thses beds.

LOWER GAVIOTA.

To the series of sandstones and sandy shales below the Crassatella beds and above the conglomerate which is exposed on the ridge to the east at the head of Sacate Canyon the name Lower Gaviota has been given. The best exposure of the Crassatella beds, of which there are three, can be seen about about a mile and a half west of Las Cruces on the north side of the canyon which is the most southerly branch of Gaviota Canyon. Each bed is approximately 3 feet thick and carries a great many shells, the majority of them being specimens of Crassatella collina Conrad. A large Cardium which is probably the one Arnold calls brewerii is fairly abundant, numerous Glycimeris, and a few specimens of the following forms are scattered thruout the beds; Venercardia hornii, Turritella variata, Pecten sp. The percentage of the various forms is quite different localities. The Crassatella bed exposed just west of the first bridge across Nojohui creek contained a greater number of species than any other locality noted. On the south side of the range the beds are not very well developed. The massive reef just south of the narrows in the canyon carry the Crassatellas but tracing this reef to the west it is found that the Crassatellas disappear and only a few oysters are found in the reef.

The conglomerate which is exposed at the head of Sacate Canyon pinches out to the east and a sandstone member takes its place and the base of the Lower Gaviota can not be definitely determined. The conglomerate as exposed in

at the head of Sacate Canyon is composed almost entirely of shale and chert pebbles. Succeeding the conglomerate is a fine, poorly indurated sandstone and a little shale followed by some coarseer members which form reefs. Above the reefs there is approximately 200 feet of sandy shale, overlying this is 100 feet of sand and shale at the top of which is the sandstone reef that in the area covered in this report carries the Crassatella beds. The thickness of the Lower Gaviota is calculated to be 1850 feet.

The Crassatella beds cross the highway at Las Cruces store. The strata are all dipping south and decreasing in amount until finally cut off by the fault which crosses Gaviota Canyon just above the narrows. Approximately 200 feet below the base of the Upper Gaviota there is a fine sandstone member which contains irregular limy layers six inches or so in thickness. Fossils are abundant in the limy layers and also in the sandstone. A collection was made from this horizon at the locality which is near the "y" in Gaviota Canyon. Conglomerate pebbles are found on the surface but they are not at all common. Oyster beds, conglomeratic lenses, and a coarse whitish sandstone and a very fine light greenish shale forms the upper part of this formation as exposed just north of hill 1007 on the west side of Gaviota Canyon. A small area of Sespe is shown overlying the Upper Gaviota and in fauly contact with the Lower Gaviota. Its position is in the general fault zone and it is impossible to determine whetherbit is in depositional contact or whether it is faulted down against the Upper Gaviota.

UPPER GAVIOTA AND SESPE.

The Upper Gaviota in the northern part of the area as exposed along the Las Cruces- Lompoc road is only 100 feet thick. Sespe is found overlying the Upper Gaviota. Three fossiliferous horizons were found about 75 feet above the Crassatella beds. Very hard nodules carried the fossils and due to the extreme induration it was almost impossible to obtain good specimens. Turritella variata(?) was the most abundant of the easily recognized forms. The best outcrop of this fossiliferous horizon is found a mile west of B.M. 927 on the east side of the first large canyon entering the main valley from the southeast. A collection made a few feet above the top Crassatella bed does not contain the same forms that were found at locality C46 in Gaviota Canyon .

A quarter of a mile east of the first bridge across Nojohui Creek north of Gaviota Pass the beds directly overlying the Crassatella bed there exposed are very fine, soft, greenish, sandy shales and sandstones. The beds are a foot or so thick and contain a few fossils. A thorough examination of the forms collected was not made but apparently the fauna found here is a different one than that found above the Crassatella beds in other parts of the area. Two small faults have cut of the Crassatella bed and sediments similar to those seen a few feet above it are found in fault contact with it, probably the displacement has not been

great. Near the bridge across Nojohui Creek Vaqueros conglomerate can be seen to rest unconformably upon soft, greenish colored sandy shales. See figure 7. The Sespe has thinned out and been overlapped by the Vaqueros before reaching this point.

On the south side of the range the basal member of the Upper Gaviota is a medium to coarse grained sandstone composed chiefly of subangular fragments of feldspar and quartz in equal amounts with a little white mica and a few fragments of dark minerals. On a fresh surface the rock hasa yellowish brown color, the weathered surface is somewhat lightered colored. The reefs to the east of Gaviota Canyon appear nearly white although in some places they have a mottled appearance due to the oxidation of the iron compounds found in the sediments. A few feet above the Crassatella beds a fossilferous horizon was found. Locality C46 which is at the base of the dip slope on the west side of Gaviota Canyon and just south of where the reefs come down to both sides of the highway furnished very good collecting. Ficus mammillatus(Gabb), Nekweis sp., Turritella variata, Cardium brewerii Arnold and several other species which were not identified were collected. This same horizon was found in Canada Omentero which is abouta mile and a half to the east of Gaviota Canyon. Above this horizon is about a 100 feet of very fine sandstone. Succeeding this isa coarse,

massive, reef forming sandstone which contains a great many oysters. Two beds were noted that were about three feet thick and composed almost entirely of oysters shells.

In the area to the west, the geology of which Mr. Alex Clark was mapping at the same time the author was in the field, the sediments between the Vaqueros and the Lower Gaviota were all marine deposits. In Gaviota Canyon beds believed to be Sespe are found intercalated with the upper part of the Upper Gaviota. On the map the areas of the two narrow strips of Sespe are exaggered in oredr to see more clearlt the relations of the formations because the Sespe is approximately only a 100 feet and could hardly be shown on a map having a scale of two inches to the mile. In the marine beds found separating the Sespe beds fossils were found, chiefly oysters, However , to,the west, on the ridge between Gaviota Canyon and Agua Caliente Creek, at locality C35, a collection was made which contained several species of pelecypods and grastropods. Time did not permit extensive collecting at this horizon and the determination of the forms. However, a fauna typical of known Oligocene horizons was not found.

The exact contact of the definite known marine and the beds called Sespe could not beseen. Above the Sespe very coarse sandstone containing many oyster shells and conglomeratic

lenses are found. All of the material is poorly sorted and the major part of it is subangular. Cross bedding is evident in some of the snadstones. In many places the dark grey to buff colorad sandstone is mottled by brick red colored patches. The various colored chert, quartzite, and aphanitic igenous pebbles set in a sandstone matrix offer a peculiar appearance. Succeeding the conglomeratic beds are sandstone layers one tp three feet thick which are very fine grained, well sorted, and friable. Some of the layers are of a light grey color composed of quartz and feldspar, the quartz predominating, mica which has lostits elasticity but not its color is quite abundant. Two thin layers composed of nodules were found just below the highest Sespe beds. Such sediments were probably laid down in shallow water. Deposition in a large playa lake or along an oscillating shore line would probably produce such sediments.

A float boulder was found in between the Sespe beds which contained a Turritella variata Conrad. The position of the boulder was such that it would have been almost impossible to have been derived from any bed except the one upon which it was found. Farther to the west where the section is all marine a Turritella variata was found some 250 feet below the Vaqueros. A Venercardia hornii was found in Agua Caliente Cahyon 400 feet above the top of the reef which carried the Crassatella beds.

Only in the south part of the area is the Sespe found intercalated with marine sediments and in other parts of the area the Upper Gaviota is much thiner or is missing all together. The range of Turritella variata which was found associated with Vernercardia hornii, Ficopsis hornii, Ficus mammilatus tends to indicate that the Upper Gaviota should be considered a unit and that it is approximately middle Eocene in age. This makes the Sespe, at least the lower part as found in this area, Eocene in age.

The thickness of the Sespe increases to the east and in Refugio Canyon there is several hundred feet of it. In the Summerland district it is a thousand feet or so thick while still farther to the east in the South Mountain oil field it is thought the Sespe may be as thich as 5000 feet. Its age has been considered to be Oligocene and the uppermost 600 feet may be lower Miocene, according to Stock and Furlong,[1] who report veterbrate fossils, assigned to the genera Promerycochoerus Leptauchenia from the Sespe at South Mountain, Ventura County.

In the western part of the area a coarse, nearly white, very friable, massive sandstone, composed almost entirely of feldspar and quartz grains forms the basal member of the Sespe. Red and green very fine, massive sandstones form 75% of the section. Lenses of conglomerate with boulders up to a foot in diameter occur at irregular intervals in the sandstones. Chert is the chief constituent of the

1) Chester Stock and E.L. Furlong, paper read before the Geol. Soc. Amer. Cordilleran Section, Los Angeles, Dec. 1926.

conglomerates which might more properly be called fanglomerates. The boulders are held together in a matrix of oxidized ferruginous clay and angular sand. All of the material is angular. Such deposits are formed at the foot of an abrupt and rising scarp.

VAQUEROS.

On the south side of the range the strata below the Clay Shale and overlying the Upper Gaviota have been called Vaqueros. It outcrops on the south side of the range as a reef which in most places is covered by brush. The contact with the Clay Shale can be easily distinguished due to the sharp change in vegetation which also indicates the change in lithology. The Clay Shale is covered with grass. The first brush covered reef up Gaviota Canyon from the coast is the Vaqueros.

In Gaviota Canyon the contact of the Vaqueros with the underlying fine, poorly indurated, massive sandstone is very regular; there is no indication of any angular discordance. The lithology of the Vaqueros is distinctive in this part of the area. It is one massive pebbly conglomeratic bed. In some parts of the bed it is composed largely of coarse sandstone and at such places it appears to be stratified to some extent, cross bedding can also be seen at certain places. The pebbles are nearly all well rounded, a few 10±15% are subangular. They were derived chiefly from old Franciscan rocks and average about a half an inch in diameter. The matrix is a coarse sandstone composed for the most part of quartz and plagioclase feldspar fragments with a few grains of serpentine. The cement is calcite which was probably derived from partial solution of the many sheal fragments found through the formation. On a fresh surface the rock is nearly white and when weathered it has a dark grey color. The Vaqueros

varies in thickness in this part of the area between ten and twenty-five feet.

On the north side of the range the pebbly conglomerate is replaced by 10 feet of very coarse conglomerate. Chert limestone, quartz, quartzite, and boulders of rocks of hypabbysal orgin in the Vaqueros here. Broken shells are scattered throuout the conglomerate, those of oysters and pectens for the most part. East of the area near B.M 927 a Rapana sp. which is probably Arnold's Purpura vaquerosensis and a Pecten (Lyropecten) magniola Conrad were collected from the conglomerate. Above this bed is a fine , buff colored sandstone. The exposures are dark reddish brown in color.

North and west of Gaviota Pass good exposures of Vaqueros are seen. Sandstones and shales and also volcanic ash beds are found overlying a bed which is composed practically of nothing but fragments of the shells of some small species of oyster and Turritella inezana shells. At locality C54 which is about 200feet south of C49 and approximately the same elevation the bed containing the shells is well exposed. The Vaqueros has been faulted down against the Santa Rosa at this particular point and the paleontologic evidence served as proof of faulting. The unconformity of the Vaqueros on the Eocene can be seen from the first bridge crossing Nojohui Creek north of Gaviota Pass, See figure 7. The coarse conglomerate contains many shell fragments some of which appear to be Pecten shells. On the hill which has a

closed contour around it west of the church shown along Nojohui Creek, a fossiliferous boulder was found which evidently came out of the Vaqueros conglomerate. A Ficopsis and a Turritella were recognized in it. It is probable that the boulder came from the same horizon as represented at locality C49. This horizon is only about 35 feet below the base of the Vaqueros at this point.

Because of the general synclinal area and the gentle dip of the beds in Canada de Las Cruses the Vaqueros is exposed overa large area. The section found here is some what different than that in other parts of the area. The basal conglomerate, out of which one specimen of Pecten (Lyropecten) magnolia was collected rests directly on the Santa Rosa. This conglomerate does not continue to the east very far and becomes a coarse sandstone by the time it reaches Nojohui Creek. Following this conglomerate is 50 feet of coarse, poorly sorted, friable sandstone. Above this sandstone is another conglomerate very similar to the basal one in that it is composed of boulders of old Franciscan rocks that show little wear and vary in size up to a foot in diameter. These beds are on the north flank of the gentle syncline in this part of the area but do not appear on the south flank except for the basal conglomerate which outcrops just north of the highway along the road between Las Cruces and Lompoc.

On the east side of Canada de Las Cruces two small folds occur in the Vaqueros and the beds exposed are blood red sandstones and light bluish green beds of sandy shale. The beds appear as lenses and are irregularly colored, lenses of conglomerate are also found in them. Succeeding the red beds are sandstones of a light olive color. The massive, poorly indurated sandstones are intercalated with darker colored and more highly indurated beds which are finer textured. The total thickness of the Vaqueros as here exposed is approximately 500 feet.

The red beds were probably laid down in a large playa lake or along a rapidly changing shore line with a large river acting as a transporting agent. The angularity of the fragments, the massive characterof the beds, the poor sorting of the material, and the high coloring of the beds suggest continental deposition. The changing character of the beds when followed along the strike for any distane shows that conditions of sedimentation were not the same over a very large area.

LOWER CLAY SHALE.

The change from the pebbly conglomerate of the Vaqueros to the fine blackish clay shale which lies above it is a very sharp one, not only in lithology is the change sharp but in topography and vegetation as well. From the brush covered reef of the Vaqueros the change is to be rounded knolls and grassy slopes. On the south side of the range the contact of this formation with the Vaqueros is easily distinguished. The first brush covered reef up Gaviota Canyon from the coast represents the Vaqueros and the overlying it is the Lower Clay Shale. To the east of the first bridge in Gaviota Canyon a stream cut cliff offers a very good exposure of this formation.(See fig) A grayish black shale which weathers to a dull brownish gray forms the major portion of the section. In places it contains a high percentage of crystalline gypsum. Intercalated with the shale are numerous hard limy layers, and in some instances cherty layers which are a foot or so thick. A few very fine,poorly indurated,light gray sandstone beds are intercalated with the shale.The weathered outcrops of the shale have a rather nodular appearance and the bedding is indistinct making it difficult to obtain reliable attitudes. Extensive slumping in the Clay Shale and the Monterey above it has taken place thus covering up the underlying beds and masking the structure.

The Lower Clay Shale is a definite lithologic unit between the Monterey,which is composed almost entirely of material of organic origin and the Vaqueros which is of a coarse detritual

material that was deposited under shallow water conditions. The Temblor in the Coalinga district as described by Anderson is very similar in lithology. Its stratigraphic position is that of the Temblor in San Joaquin Valley. It has been reported that beds containing Temblor fossils some distance east of the area can be traced westward into what has been called the Lower Clay Shale. No molluskan fossils were found and only a few foraminifera belonging to the genus Siphogenerina in the area covered by this report. The lower Clay Shale has been tenatively refered to the Temblor.

MONTEREY.

Flanking the range on the south is some 1300 feet of Monterey Shale. How far the strata extend out into the Santa Barbara Channel is not known. The beds dip steeply to the south at angles between 40 and 80 degrees. This series of shales which is almost wholly of organic origin overlies conformably the Lower Clay Shale which has been called Temblor.

The lower part of the section is composed of a series of thin bedded, hard, brittle, siliceous shales varying in thickness from a quarter of an inch to one inch. Layers of chert, some of which are a foot thick, are found in the lower part of the section. Lenticular yellow concretions of hard flinty and limy material are included in the shale and range in diameter from a few inches up to two feet or more. They occur thruout the section and at irregular intervals displacing the shale, in some cases forming a bed. The series of high knolls along the coast are formed by the harder material which is found in the lower part of the section.

The upper part of the Monterey is made up of white or light chocolate colored diatomaceous shale and considered as a whole is very soft and light in weight. The extremely fine grained shale gives rise to a very fine laminae. However, where the material is very soft the bedding planes are almost indistinguishable. Only where weathering has removed the less resistant material and left projecting laminae is it possible to see the bedding in the very soft chalk like material. Very few beds of detrital material are found in Monterey. A three foot bed of a medium grained sandstone outcrops on

the west side of the first large canyon, west of Agua Caliente Canyon. A ½ of a mile west of Agua Calienta and a short distance above the road a conglomerate phase is found . There is 40-50 feet of a coarse sandstone, 50% of which is formed by very angular flinty fragments that were derived from the Monterey, quartz with some feldspar and a few pebbles of aphantic rocks constitute the remainder. The material is all poorly sorted and fragments up to 6" in diameter are common. This bed lenses out to the east and is only a few feet thick where it outcrops along the beach west of the oil well in Sacate Canyon. The sandstone and conglomerate are black due to the high bitumen content. These beds are evidently a reservoir for the oil which formed in the siliceous shales of the Monterey.

A half a mile above the old adobe shack in the northwest branch of Gaviota Canyon is the first large canyon coming in from the west. A sandstone bed about a foot thick occurs in the Monterey. This bed contains many shall fragments and foraminfera. Below it is a bed approximately three feet thick which might be called an interformational breccia. The material is all angular and conposed entirely of flinty fragments derived from the Monterey. Above the sandstone is the soft diatomaceous part of the section. A strong odor of bitumen is evident when the rock is freshly broken or rubbed. The synclinal structure of this part of the area produces a large area of outcrop. It is estimated that the Monterey is 800 feet thick in this part of thearea.

The physical character of the diatomaceous shale, its thin bedding, brittle nature, and porosity allow it to slump and almost flow when staiding on steep slopes. Pits dug while prospecting for marketable grade of diatomaceous earth offered a few places for obtaining reliable attitudes.

In the part of the Santa Ynez Range considered in this report the deformation of the Monterey has not been as acute as in some parts of the range. Only one small sharp fold was seen and this was in Brea Canyon which is some four miles to the east of Agua Caliente Creek. The Reversal of dip takes place in about 300'. The beds are nearly isoclinal but show little breaking which gives some idea of the incompetency of the Monterey shale.

PLEISTOCENE TERRACES.

Along the portion of the coast covered by this area the ocean cut terraces are not well developed. A few miles to the west,however, the terrace becomes nearly a mile wide.Only one distinct terrace surface which is about 50' above the present sea level can be distinguished. The surface bevels the Monterey shale which dips steeply to the south. The terrace surface is fairly even and is slightly inclined toward the ocean.

The material of the terrace deposits is usually sand and conglomerate,for the most part the former. The sand is medium to coarse grained and contains a few water worn pebbles. Normally it is soft and grayish but in many places compact, being stained reddish yellow and hardened with iron oxide or filled with iron oxide concretions. In some places the angular fragments of the Monterey form the major portion of the material and almost necessitates the use of the word breccia in describing the deposits. A black clayey soil is developed on the terraces.

The canyons and valleys in this area are filled with alluvium, in some cases it is 50 feet thick .This material was evidently laid down when the streams were adjusted to the level of the ocean at the time the terraces along the coast were being formed.

Deposition of the terrace material was carried on in shallow water and much of the material was derived on the spot from the wearing away of the shore line of the Monterey.

These deposits give undeniable evidence of a great uplift of the coast during Pleistocene time. It seems most probable that the terraced surface resulted from marine planation along gradually rising shore lines and that the formation covering them represents beach and shoew deposits. Probably the rise of the land was too rapid to allow much off shore extension of the deposition.

STRUCTURE.

The general structure of the Santa Ynez Range taken as a whole is anticlinal. This is best seen near San Marcos Pass as noted by Fairbanks. Arnold in speaking of the Santa Ynez Range says," It is dominated by a great southward dipping monocline that forms a high ridge alone the coast,north of which the strata are gently folded along curving lines that reflect two different structural trends. The folds expose Tejon, Vaqueros and underlying Franscian beneath the Monterey toward the west end of the range are in places abrupt and complex. The anticline of the Santa Rosa Hills has the appearance of crossing the Santa Ynez Valley and continuing to the southeast." Along the north side of the range east of Nojohui Creek the monoclinal nature of the range is apparent.(See fig)5&6 To the west of Gaviota Canyon the range is anticlinal in nature.

FAULTING.

One of the major structural features of this area is the fault which has a S50W trend and crosses the southern portion of the area. It crosses the highway about a half mile north of the narrows in Gaviota Canyon continuing in a sputhwest direction but rapidly decreasing in throw. Mr Clark has mapped the adjoining area on the west, has shown this fault as doubtful. The displacement decreases rapidly and has not been sufficient to offset any recognizable horizons,but the rapid change in dips and strikes along the projected direction of the fault indicates that it continues some distance to the west prehaps

even to the coast. In the vicinity of Gaviota Canyon the upper Gaviota has been dropped down against the Lower Gaviota, the dips of the former, although south are only about 10-15 degrees while the later are bewteen 40 and 50 degrees. To the north east along the fault the Upper Gaviota beds strike N-S with east dips thus striking directly into the Eocene Undifferentiated which strikes nearly E*W and dips to the south. Although the formations in contact are lithologically similar the attitudes they have leave little doubt as to their relations. When viewed froma distance the abrupt ending of the sandstone reefs,which are cut off by the fault, is a very striking feature.The fault plane can not be seen at any place,however, the trace of it is nearly straight indicating that the fault plane is approximately vertical. The south block has moved up with respect to the north one. The movement has a large horizontal component as shown by the displacement of the Vaqueros, in the first large canyon to the West of Agua Caliente Canyon. In the South block having moved west with respects to the north block.Apparently this fault continues to the east of this area and changes to an E*W direction joining the fault that runs along the north face of the range. For some distance east of this area Vaqueros is found dipping into the old rocks which form the face of the range.[1] Bailey Willis in his paper,"A Study of the Santa Barbara Earthquake of June 25,1925" Includes a fault map of the region. The fault discussed is evidently the westward extension of his Santa Ynez Fault North.

1) Bull. of Seismological Society of America 1925/

In the region of Gaviota Canyon the fault makes an angle of approximately 45 degrees with the axis of the range. It would seem that this fault is the result of the same forces that caused the bowing of the axis of the range to the east, notably at Santa Ynez Peak and north of Carpinteria. If the strain ellipsoid produced by non-rotational forces is considered it would be logical to expect such a fault as above described. Such a fault would be in the plane of no distortion or in other words the plane of maxium shear.

Thru the middle portion of the area are two faults which have a general E-W direction. Of these two the most southerly one joins the northern one just to the east of Canda de Las Cruces. The southern fault runs up the canyon which is the western branch of Gaviota Canyon. The displacement has not been very great and decreases rapidly to the west. The best evidence of fault relations in the canyon branching off from the west of Gaviota Canyon is the fact that the Crassatella beds, which mark the boundary between the Upper and Lower Gaviota, are cut off and do not appear on the south side of the canyon. A shorth distance to the west the displacement is not sufficient to displace recognizable horizons and the exact extent of the fault is not known.

A little to the west of Canda de Las Cruces Upper Gaviota, Sespe, and Vaqueros are found in contact with Lower Gaviota. The beds of the younger formations strike into the contact with the Lower Gaviota and are cut off as they do not appear, except the Vaqueros, to the east of Canda de Las Cruces. The Vagueros is cut off at the point of juncture of the south

fault with the northern one. Farther to the east the Monterey is found successively in contact with Lower and then Upper Gaviota. The strike of the beds makes an angle with the contact between them. The above conditions indicate a fault contact between the formations.

The contact between the Monterey and Vaqueros west of Canada de Las Cruces is considered to be a fault contact. The Vaqueros is standing at steep angles, varying from 45 degrees to the vertical. Near B.M. 927, which is east of the area a short distance the Vaqueros dips 45 to 75 degrees to the south while the Monterey dips gently to the north. Both formations have practically the same strike. Unconformable relations might the situtation but very unusual events would have necessarily taken place in order to have produced the attitudes the beds now have. It would have involved a rotation of the Vaqueros to the south, deposition of the Monterey followed by a reversal of movement sufficient to give the Monterey a south dip. The Monterey in contact with the Vaqueros is the soft unmetamorphosed diatomaceous earth that is found in the upper part of the section in other parts of the area.

A fault is shown running nearly E and W just north of Gaviota Pass about a half a mile. The Vaqueros has been dropped down against the Eocene. At locality C50 which is on the south slope of the same hill as C49 many specimens of Turritella inezana were collected. The bed carrying the Turritellas ends abruptly against beds which

contain Eocene fossils. East of Mojohui Creek bridge, (the first one north of Gaviota Pass) the Crassatella beds can be seen dipping gently to the south and into the face of the range.

FOLDING.

The axis of the main anticline of the range has a nearly E-W direction which was the result of stresses applied or whose resultant was in a north south direction. North of the the axis of the range is a shallow syncline. The upper end of Canada de Las Cruces is in this general synclinal area. The Vaqueros is repeated but the Sespe which is found on the south flank must pinch out somewhere under the axis of the syncline as it does not appear on the north flank. The axis of this syncline can betraced to the west for three or four miles an plunges in that direction. North of this syncline is the anticline of the Santa Rosa Hills. From reconnassiance work done north of the area shown by the map accompanying this report it is believed there is a shallow syncline north of the Santa Rosa anticline which is bounded on the north by an E-W fault, and still farther to the north is another anticline and then the Santa Ynez Valley.

Along the axis of the range in some places the beds are slightly overturned. At the head of Sacate creek dips near the crest of the range on the south side of the axis may be to the north. If the same bed is followed down the flank of the range it is found to dip steeply to the south.

Abnormal dips are to be expected in the core of an anticline which is folded to such a degree as the Santa Ynez Range.

The deformation of the Santa Ynez Range resulted from many forces, the source of which it is impossible to determine The resultant of the forces at one time was compression in a N-S direction another time , or perhaps somewhat simultaneously, forces resulting in an E-W compression deformed the range. The regularity of the range suggests that the E-W compression did not become effective until the range was well formed.

It is interesting to note that the Santa Ynez Range is an E-W structure along the California coast and that this huge anticline extends to the Knot (the mountainous region around Mt. Pinos), the other ranges which join in the Knot such as the San Rafael trend to the north west. The orogenic forces producing these ranges are probably intimately connected with the forces producing the San Andres Rift.

HISTORICAL GEOLOGY.

The oldest rocks in the area covered in this report are of doubtful Cretaceous age. Arnold in his Santa Maria Bull. shows several areas of Franciscan rocks of Jurrasic age. Of them he says,"The much disturbed and metamorphosed Jurrasic sediments intruded by Serpentine form the basement complex of the whole region, but outcrops only locally." Speaking of the Cretaceous he says," In Cretaceous time a great thickness of marine sediments was laid down, but these were probably greatly disturbed before the beginning of the Tertiary. Igneous intrusions took place at different times during the Cretaceous." The unconformity found in the section and previously mentioned under the topic of Eocene Undifferentiated shows that some deformation between the Cretaceous and the beginning of the Tertiary occured. Probably only at certain places will the angular unconformity of the beds exist. Sometime in the Eocene, probably about the middle, sedimentation began and at least in part of the basin, continued to near the end of this period. Oscillation of the shore line in the later part of this period made it possible for the Sespe to become intercalated with the Eocene marine beds.

The beginning of Lower Gaviota time was ushered in by the deposition of several feet of conglomerate. Uplift had caused the return to shallow water conditions of depositions. Deformation was not of such character to cause any angular discordance of the beds with those of the Santa Rosa,

Depression of the deeper part of the basin ensued and the Upper Gaviota was deposited. The part of the basin represented by the northern part of this area was not submerged until Miocene time when the Vaqueros was deposited on the Santa Rosa. Lower Gaviota was closed with the introduction of a new fauna which contained Ficus mammilatus Gabb, Nekweis sp., Turritella variata, Venercardia nornii(Gabb) variety, and many other sp-species. No break in the marine sediments west of Agua Caliente Creek could be found but in the vicinity of Gaviota Canyon Sespe sediments are found intercalated with the Upper Gaviota. Oscillation of the coast which permitted the sea to sweep over the land and then recede brought about this situtation. Uplift of the area as a whole followed with slight deformation. Finally the area was again under the sea and the deposition of the Vaqueros in lower Miocene time took place. The apparent conformity of the Vaqueros with the Upper Gaviota (Eocene?) does not suggest a long time break , especially when it is considered that the forces of deformation which caused the formation of the Santa Ynez range were already at work. However, the fauna of the Vaqueros and the Upper Gaviota are entirely different and the lithology of the two formations indicate that they were formed under entirely different conditions. The Vaqueros is a shallow water deposit and is a pebbly conglomerate while the Upper Gaviota is chiefly sandstones and sandy shales. The break between these two formations represents all or the greater part of Oligocene time and possibly part of the Eocene. In some parts of the basina transition from the Vaqueros to the Temblor is marked

by a limestone member as seen north of the Atascadero Ranch of the Julian Rancho.Volcanic activity during the latter part of the Lower Miocene was going on in the area as shown by the acidic volcanic ash of a rhyolitic type found in the Upper part of the Vaqueros.The ejected material settled in the ocean and was interstraified with other sediments.Possible the eruptions were of submarine origin.During Temblor time deposition of fine material took place as the surrounding land became submerged and the material for the formation of coarse detrital deposits was not at hand. Only seldom did material as coarse as sand find its way to the main portion of the sea bottom. Sometimes calcareous and at others siliceous deposits during Temblor were laid down. Conditions were such that gypsum was precipitated and included with the shale. An arid climate and a nearly closed arm of the sea would be conditions favorable for this. Following Temblor the Monterey was deposited during middle Miocene time. This great thickness of material of organic origin is unique when it is considered the number and size of the organisms forming it. The siliseous test of diatoms, a one celled plant, the largest of which have only a diameter of form nearly all the material in the Monterey.Metamorphism of the lower members in the series formed a flinty brittle type of rock.

Acute deformation brought to a close the period of the Monterey deposition. Uplift and the formation of the Santa Ynez Range in somewhat its present form was the result of oregenic forces which had been more or less active for some time.(Uplift was arrested long enough for the ocean to plane

the Monterey strata off and form large terraces while the valleys were being filled with alluvium.)

During the folding and uplift of the range the sea cut into the land as the water encroached and receded forming terraces inclined toward the ocean, and beach and shallow water sediments were laid down as thin coatings over the newly planed surfaces. These deposits were probably formed as the land rose. During the periods of depression the streams built up deposits of gravel, sand and clay at different levels giving rise to extensive terraces and filled valleys. Since the formation of the terraces they have been lifted 50 feet above the level of the ocean. Faulting has accompanied the folding in the formation of the range but apparently deformation has not gone far enough to cause extensive faulting. No evidence of recent faulting such as the offsetting of terraces or stream drainage was noted. Erosion has gone on to such an extent that only scattered remnants of the pleistocene terraces are left at many places. From this brief sketch it can be seen that this region has had an interesting history and all these events have been crowded in to a rather short time geologically speaking.

CONCLUSIONS AND SUMMARY.

The Santa Ynez Range is essentially an anticlinal range having an E-W axis although east of Gaviota it is monoclinal for some distance as it is bounded by a normal fault. The structure is slightly irregular due to feature produced by E-W compression which was of secondary importance. The shear fault which crosses the range to the south of Las Cruces was in part the result of the E-W compression.

Fourteen thousand feet of sediments are exposed in this area and range in age from Cretaceous (?) to Pleistocene with the exception of the Oligocene. Pliocene do not appear in the area mapped but outcrop a short distanee to the north. Arnold refers them to the Fernando Group. The beds overlying the Cretaceous are Eocene in age and it is believed they belong in the upper part of this d division of the Tertiary. The upper most beds of the Eocene?are intercalated with the Sespe formation. Fossils found in the marine beds in between the Sespe beds but no specimens typical of known Oligocene were identified from those collected. The Sespe found in this area is called Eocene in age. Farther to the east the Sespe attains a thickness of approximately 5000 feet and in this area it is thought that the uppermost 500-600 feet may be lower Miocene in age on the basis of the vertebrate remains which it contains. Detail work covering a larger area in the general region covered in this report should

make it possible to determine the stages of the Eocene represented in this section of the range as well as gain a better understanding of the relation of the Sespe to the Upper Gaviota and Vaqueros. This area offers an excellent opportunity for the correlation of the marine and continental scales. Osciàlation of the shore line permitted the interfingering of marine and continental deposits but no rocks of undoubted Oligocene age were deposited, or if they were, they were such a distance out in the basin that uplift has not been sufficient to expose them.

The sediments which form the Santa Ynez Range were derived from an old land mass to the northeast of the area. It was composed mainly of rocks of granitic composition. A minor part of the area shedding detritus to the basin was covered by Franciscan rocks. The deepest part of the basin was to the southwest of the area now occupied by the range.

The forces forces which produced the range were in existence for a long time but the major part of the deformation took place in the Pliocene as even the Pliocene rocks stand at high angles.

Figure 1

This picture was taken looking to the west from the mouth of the first large canyon west of Gaviota Canyon. It shows the steeply dipping Monterey. A change in the strike of the beds can be seen at the point "A".

Figure 2.

This picture was taken at the mouth of Gaviota Creek. The thin bedding and platy nature of the Monterey is shown in this outcrop.

Figure 3
This view is looking north toward the Santa Ynez Range and was taken from the mouth of Gaviota Canyon. Sandstone reefs of the Upper and Lower Gaviota can be seen in the middle of the picture.

Figure 4.
This view was taken from the same position as figure 3. but is looking to the northeast. The bare, massive sandstone reefs can be seen in the distance. Gaviota Creek has cut down thru the Monterey and at the right side of the picture the old terrace surface can be seen beveling the steeply dipping Monterey.

Figure 5.

This view was taken looking east from a point about two miles from las Cruces along the Las Cruces- Lompoc road. The momoclinal nature of the range to the east of Gaviota Canyon is apparent.

Figure 6

This pictureshows the steep north side of the range and was taken looking southeastward from a point about a half a mile north of Gaviota Pass.

Figure 7

This figure shows the coarse conglomerate of the Vaqueros resting unconformably on the Eocene, This exposure is on the south side of Nojohui Creek just west of the first bridge north of Gaviota Pass.