THE GEOLOGY OF THE QUAIL LAKE REGION,

THESIS

by

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PURPOSE OF INVESTIGATION

At the suggestion of Dr. Buwalda of the Institute Staff , the mapping and investigation of this hitherto little known section of the Mojave Desert was undertaken. It had been known for some time that there were marine beds lying in the extreme western corner of the desert, their age relation however ,had been but tentativly determined and their areal extent and structural relations were unknown. U.S.Geol. Survey Water Supply Paper 278 by Harry R. Johnson is the only paper known to the writer which deals with this area.

In the present study ,an effort is made to map the areal geology as carefully as possible ih the short time available and to determine the age and structural relations of the marine formation.

ACKNOWLEDGMENTS

Acknowledgments are due to Dr. Buwalda of the Institute for his kindly supervision, to Dr. W.P.Woodring for his paleontological determinations,and to Mr. McKenzie of the Tejon Ranchos ,Mr. Sandberg,and other ranchers of the vicinity for their courtesies.

GEOGRAPHY

Quail Lake is located at the head of Antelope Valley in the extreme western corner of the Mojave Desert. It is a shallow sag pond in the San Andreas Rift lying at the western extremity of the North American Great Basin Province. It lies some eighty miles northwest of the city of Los Angeles. The Los Angeles - Bakersfield highway ,commonly known as the Ridge Route passes through its vicinity.

The area mapped extends eastward from a north -south line drawn three miles west of Quail to a similar line drawn six miles to the east of Quail. The mountainous ridge marks approximately the southern boundary while the Los Angeles - Kern county line was taken as the northern limit.

CLIMATE ,VEGETATION AND RAINFALL

The climate is slightly modified from the arid Great Basin type. Johnson gives the average annual rainfall at Mojave ,some thirty miles to the east,as 4.78 inches. Manzana ,twelve miles east ,is given as 7.44 inches. Judging from the vegetation,the rainfall at Quail is practically the same of slightly greater than that at Manzana. Due to elevation,the higher portions receive somewhat more . The temperature in summer not uncommonly rises above 100°F. and ice and snow in the winter are not unusual. Snow often lies upon the higher ground for several weeks at a time . In the valley it remains for short periods only.

A large part of the country is covered with grass and other seasonal growth. The northern slopes of the higher

portions west of Quail and the northern slopes of Libre Mountain are more of less thickly covered with scrub oak, manzanita, occasional junipers and other semi-arid shrubs.

TOPOGRAPHY

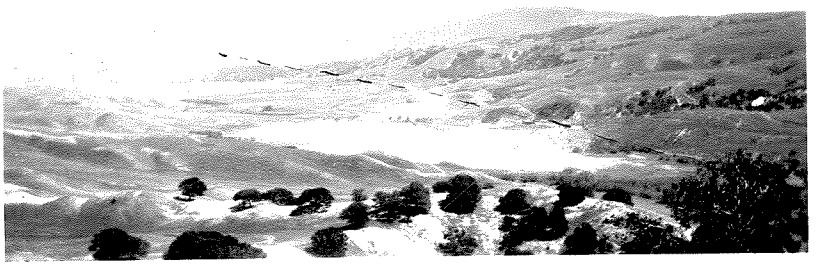
The most persistent and striking topographic feature is a large valley which completely traverses the area in a direction N 75°W . Along the south side of this valley is a mountainous ridge rising from one thousand to sixteen hundred feet ,and extending eastward from the vicinity of Quail. Along the north side of the valley is a ridge which drops from mountainous porportions at German to a height of two hundred feet at Quail. From this point it continues eastward along the valley with a relief of one hundred feet of less . This ridge is broken at Libre Creek and again two and a half miles to the east by streams which enter the valley from the desert. The ridge is best pictured as the edge of a broad block which has been slightly uplifted and tilted northwestward toward the desert. This block has then been deeply dissected by streams into parallel ridges and valleys which run out into Antelope Valley . From Libre Creek eastward the erosion has not been so uniform and the topography is somewhat rougher than that between Libre and Cottonwood creeks.

In the northwest portion of the area between the western boundary and Cottonwood Creek ,the valleys have a southeast trend toward the creek. They are steep sided and widely spaced with smooth undissected intervals between. They are comparitivly recent cuts into an old subdued surface , the whole of which has a slope in practically the same direction as the stream valleys.

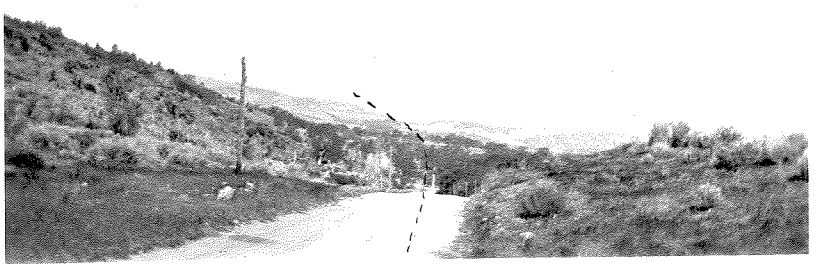
DRAINAGE

Quail Lake is a fault depression lying slightly northwest ~~of the center~~ of the center of the area. It receives the drainage of three or four square miles of immediately surrounding surface. West of this the drainage which enters the Rift Valley escapes southward to Piru Creek . The drainage from the block lying north of the Rift is carried out into Antelope Valley where it soon disappears. The surface water entering the Valley east of Quail is also carried out into the desert.

PLATE I



Trace of San Andreas Rift , Quail Lake in the middle distance , Libre Mountain in the distance.



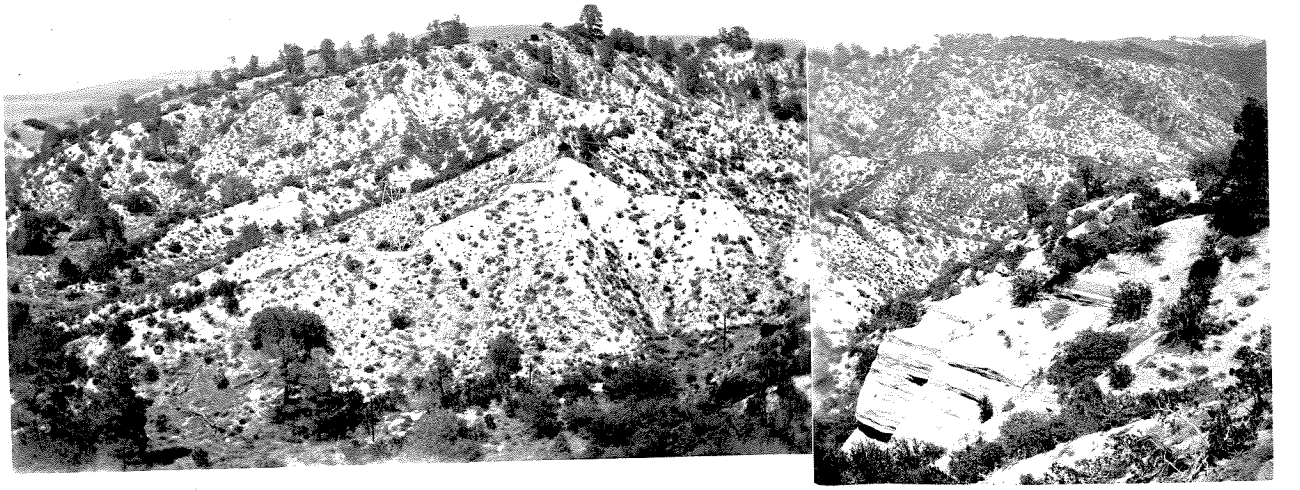
Trace of the San Andreas Rift, from eastern end of area.

PHYSIOGRAPHY

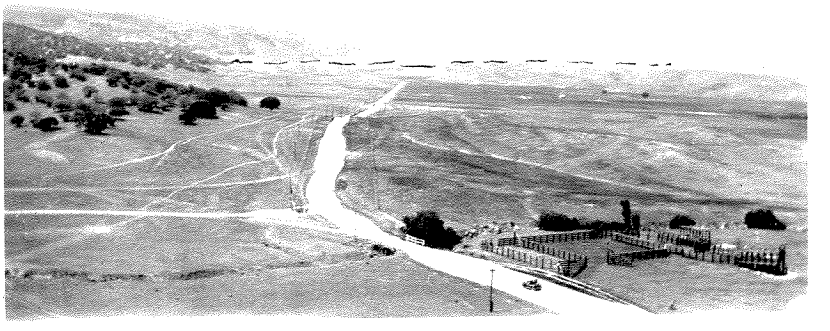
The remarkable ,straight ,persistent valley which traverses the region ,is the physiographic expression of the largest major fault in California ,the San Andreas Rift. In this vicinity it does not differ greatly from the description given by Noble who has mapped it from Palmdale to the Imperial Valley. (Seism Soc Am,B ,Mar.'27) The width of the Rift Valley is at times greater than half a mile . It is a feature which physiographically is independent of the surrounding topography. There may be a high scarp on either side of on neither . Again it may penetrate deeply into the mountains . Along Libre Mountain it lies at the foot of a sharp break in slope but there is one small ridge extending out across the fault which is marked only by two notches cut into it . West of Quail the scarp changes rather abruptly from the southern to the northern side of the Rift. Here again it may be seen cutting as a notch across a ridge running out from the mountain. There is no defined evidence of either horizontal or vertical movement at this place. Other typical featubes of the Rift are long parallel slice ridges and sag ponds.

The large mountainous ridge which follows the south side of the Rift is naturally divided into two sections. The highest and most easterly one is known as Libre Mountain.

PLATE II



South side of mountain south of Quail ,showing how present erosion is cutting into the old surface which lies on top.



Valley of Libre Creek striking into the rift.

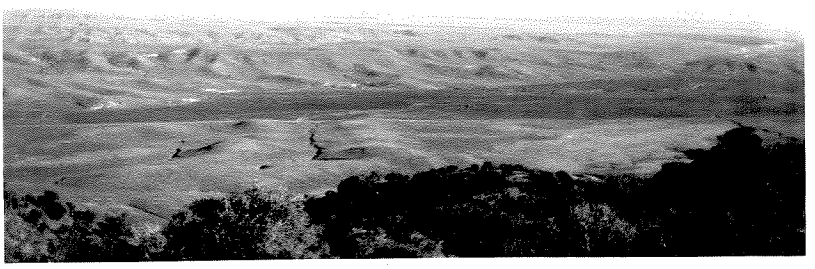
It is a rugged mass of the older rocks constituting the basement complex . The even crest of the mountain and the gentle slopes which mark the upper ends of the spurs ending in the Rift Valley suggest that in a previous erosion cycle the mountain had reached a somewhat subdued form which due to recent uplift has been deeply incised and almost completely destroyed by the latest erosional activity.

The western portion of the ridge presents a marked contrast to the other . As far west as Quail exposures were found which indicated that the core is of granite. This is however seldom exposed for, instead of thinly covered or barren precipitous slopes as on Libre Mountain ,there is a mantle of residual or detrital soil which in part comes from the granite and in part from the soft Tertiary formations which overlies it in places. This soil mantle gives an appearance of a very rounded old age surface which is entirely out of place in its present position. The ominous position of the old surface is indicated by the drainage channels which have begun to cut deeply into it. The rejuvination of this mountain may well have been a slightly less vigorous expression of the same action which caused the more complete dissection of Libre Mountain.

As indicated earlier ,the area lying to the north of the Rift Valley has the appearance of a broad block which has recently been slightly uplifted and gently tilted away from the Rift. The elevation ,relief and the attitude of the beds indicates that the uplift to the northwest of Quail has been much greater than elsewhere along that side.

PLATE III

Looking northward down Cottonwood Creek, showing old erosion surface to the sides and the Techachapi in the distance.



View from west of Libre Ranch, looking across parallel ridges toward the Techachapi.

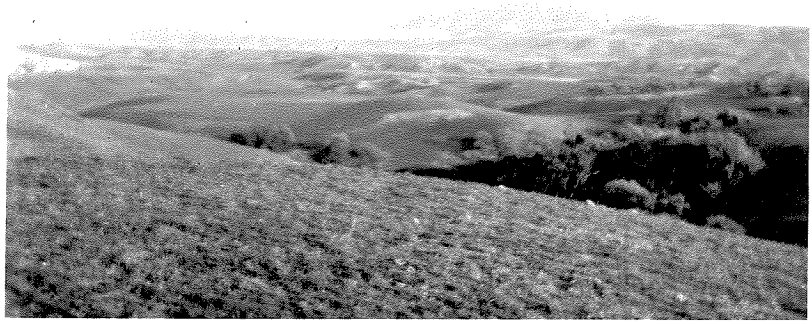
That it has been uplift rather than removal of material from the weakened zone along the Rift ,serving to give the relative elevation ,is substantiated by the erosional activity on the back slope of the block.

From Libre Creek southeastward the history is somewhat obscured by the complexity of the structure but in broader outline it seems to be practically the same as for the rest of the block except that there is lack of any indication of a subcycle of erosion such as is clearly defined to the northwest of the creek.

This subcycle was a pause in the process which has been operating to uplift and bevel off the Tertiary marine formation. This interval was long enough to create a very subdued topography in the most elevated portions of the block. Due possibly to a reversal of the movement of a change in the amount of rainfall,the area which lay below the low residual hills was aggraded with a sandy loam which in some instances may be more than fifty feet in thickness. These greater thicknesses are exposed close to the present ravines which cut into the old surface. In one instance a ravine shows a thick section of the aggraded material,the bottom of which has not been exposed. A short distance back of this exposure,the surface is one which has been beveled across the Tertiary formation . This would indicate that there had been a relief developed before the interruption which was greater than that at present.

PLATE IV

Mountain south of Quail , showing old rounded form.

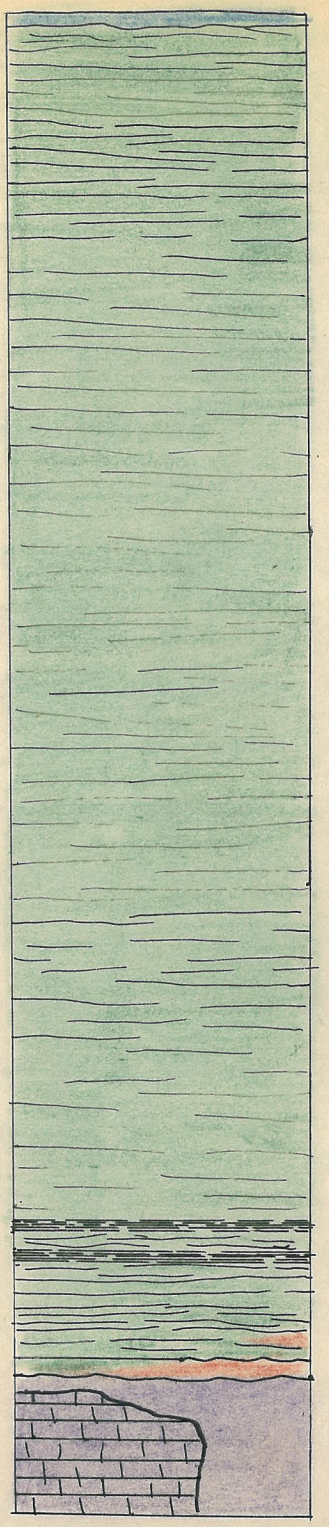


Libre Mountain in the distance , from the northwest.

As had been mentioned before the drainage of the northern block from Cottonwood Creek eastward is parallel and follows the slope of the old land surface regardless of the underlying materials through which it cuts. This should pretty clearly indicate consequent development .

West of Cottonwood Creek ,the drainage has to some extent been influenced by the underlying structure to form valleys which are parallel to the bedding. This however is not the determining cause of the direction of flow ,for, the streams have the same direction across the granite above the sedimentary contact. Since the stream courses follow the slope of the land and the attitude of the strata indicate uplift to the west it is evident that the drainage toward Cottonwood Creek is due to consequent development.

STRATIGRAPHIC COLUMN



Pleistocene alluvium 50'

Miocene marine 7000'

Shale 200'

Miocene lavas and pyroclastics 100'

Paleozoic limestone intruded by Jurassic granite.

STRATIGRAPHY

The formations exposed in the area range in age from Paleozoic (?) to Recent . At the base of the section is the Basement complex. It consists of Paleozoic (?) limestone intruded by a Jurassic (?) granitic batholith.This is overlain by a Miocene formation which has at its base a volcanic accumulation. Lying across the beveled edges of the Miocene there is a loose sandy loam deposit which is probably Pleistocene or later.

Basement complex

Paleozoic (?)

The oldest known rocks in the area are found in Oso canyon. They are for the most part highly metamorphosed limestones or marbles with a very small amount of quartzite. They lie upon a granitic mass which is probably batholithic in size . These rocks are referred to the Paleozoic largely because similar rocks in the Tachachapi and San Gabriel mountains have been considered to belong to that system.

Jurassic (?)

Granite.....This is a very acid rock. A thin section taken from close to the basement contact in Oso canyon showed quartz and orthoclase in large quantities and a smaller amount of microcline. The only ferro-magnesian mineral detected was biotite.The texture is holocrystalline equigranular,medium grained. The granites of Libre Mountain appear to be somewhat less acid when examined in hand specimens.

Pegmatite.....There is a large exposure of this rock across the first ridge north of Oso canyon at the basement contact. A thin section shows coarse orthoclase and quartz in graphic intergrowth. Smaller crystals of microcline and oligoclase are present in minor amounts.

Miocene

At the base of the Tertiary rocks on the north side o of the Rift Valley there was considerable volcanic activity. This was followed by the deposition of several thousand feet of sandstones and a small amount of shale and silt.

West of Quail the volcanic material in some places lies between the basement complex and the sandstones. In other places not far distant the sandstones may be found lying directly upon the granite. The volcanic rock is a vesicular basalt which is probably not over one hundred feet if thickness. The vesicular nature and the relation to the other formations points to a flow which was either very irregular in distribution or else was deeply eroded before the basal sediments were deposited. There is some suggestion of a small flow of basalt interbedded in the sandstone.

East of Libre Ranch the volcanic materials were not differentiated. They consisted of a large accumulation of tuffs and flows of rather basic nature. West of Libre Ranch the lavas were separated from the tuffs which were then mapped with the sandstones. These lavas are very variable in composition and hand specimens appear to range from a glassy rhyolite to a dense spherulitic basalt. The tuffs are typical accumulations of ash, pumice and other fragmental material firmly cemented together.

The color of the outcrops is typically a brownish red and gray-green. West of Libre Ranch the lavas and tuffs are in a small syncline above some sedimentaries.

A fifty foot section of the south synclinal limb is exposed three quarters of a mile northwest of the Libre Ranch house on the north side of the road. It consists of a series of interbedded cherts, sandstones, and fine conglomerate .The bedding is thin and very definite . The weathered surfaces are tawny to yellowish in color. Where these members emerge to form the north limb of the syncline they are overlying sandstones and conglomeratic beds which are very similar to those found in the Miocene. Since the lavas, tuffs and sediments appear to be conformable,it is believed that the volcanic activity was contemporaneous with the deposition of the Miocene.

The remainder of the Tertiary on the north side of the Rift consists of a thick series of appearantly conformable sandstones with a small amount of shaly material interbedded not far from the base. The beds extend northeastward beyond the area to an unknown distance. The total thickness of the formation is at least seven thousand feet and is probably greater. The sandstone in exposures between the basement contact west of Quail to the hill near the intersection of the Cottonwood Creek road and the main highway are moderately to heavily bedded and are very hard. The mineral grains are coarse ,sharply angular quartz and feldspar. The outcrops are bold and weather to grayish yellow and buff. In this series of sandstones are two dark shale beds which on weathering break into small lenticular fragments.

Also there are a few beds of rather loose silty material containing crystals of gypsum. From Quail northward the bedding is very thick and somewhat uneven. Cross bedding is evident in some exposures. The materials are very coarse and sharp. The outcrops are usually light in color.

The lowermost beds in Oso canyon are highly fossiliferous and are very coarse and thick . The fragments are quartz, feldspar , pebbles and also grains of calcite. The cementing material is largely calcium carbonate. These beds weather to a dirty white color . At station six which lies three quarters of a mile northwest of Oso canyon and over a mile west of Cottonwood Creek , there are beds very similar to the basal members in Oso canyon except that they are less calciferous. The fossils are appearantly similar although occupying a much higher stratigraphic level. The forms identified from the two localities were: Pecten crassicardo and Ostrea titan. These are regarded as typically Upper Miocene forms. Arnold however in 'Paleontology of the Coalinga District' records Pecten crassicardo from the Vacqueros to the Jacalitos and Ostrea titan from the Vacqueros to the Santa Margarita. For the lack of more definite evidence the formation is simply assigned to the Miocene. A Conus sp.? was also found . It is a large tropical appearing thing which resembles the living, Gulf of Lower California form, Conus fergusoni.

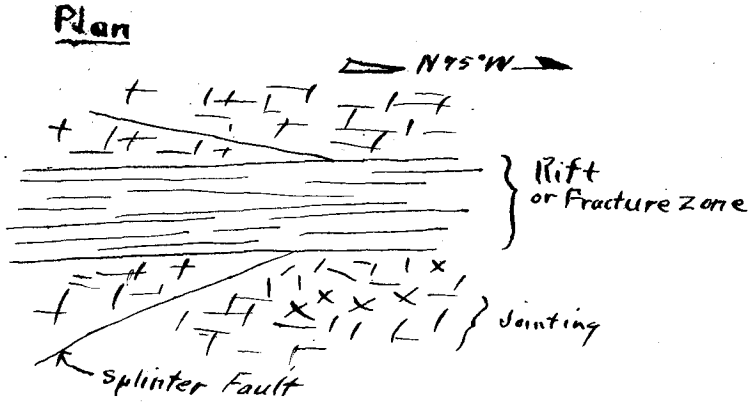
The sediments south of the Rift are somewhat similar to those on the north ,but there are some characteristic differences . No evidences of fossils were found on the south side . There are no examples of induration on the south which are comparable to those on the north. The ratio of fine to coarse material is judged to be greatest in the southern beds. The formations are alike in that they fragments are coarse and arkosic and the bedding is poor and irregular for the most part.

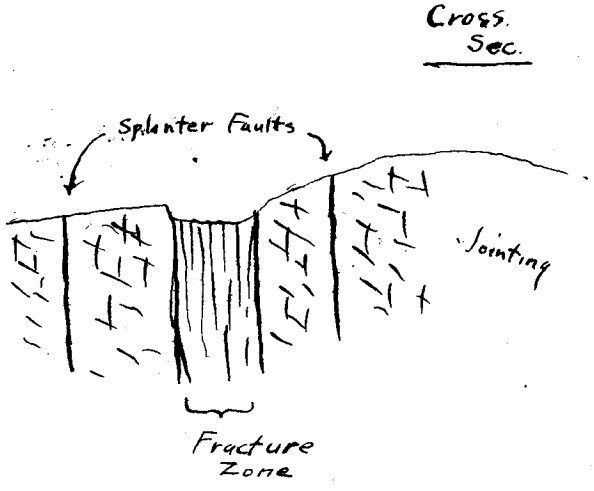
Pleistocene (?)

The alluvium which forms part of the old erosion surface on the bleak north of the Rift is evidently considerably older than the present alluvium and is considered to be Pleistocene. It ranges from a loam to a gravel and is somewhat redder in color and coarser in texture than the Recent alluvium.

STRUCTURE

The dominant structural feature of the region is probably the faulting . The San Andreas Rift ,the physiography of which has been previously discussed is by far the most significant fault in the area. Greatly shattered material in the Rift Valley coupled with long narrow slice ridges indicates that the Rift is in reality a broken mass lying between blocks which are relatively little shattered. While there is intensive jointing in the formations which lie to either side of the valley,this is inconsiderable compared to that which has taken place in the Rift . Branching off from the master fault there are smaller fractures which might be called splinter faults. The diagrams will perhaps show the relations most clearly.





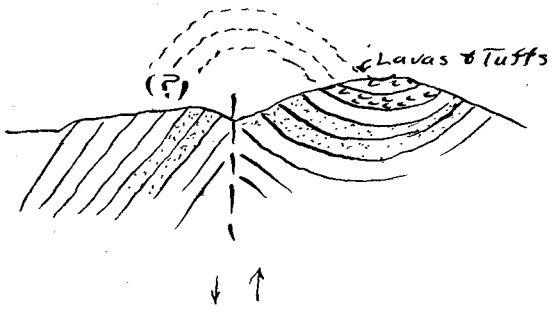
Along the north side of Libre Mountain and its companion to the west there are faceted spurs which would indicate vertical movements of from two to four hundred feet . The spurs are very discontinous and the appearant breaks in level vary in magnitude along the supposed fault planes,making very detailed work necessary to secure more than a rough estimate of the amount of displacement. During the field work no definite evidence of horizontal movement was detected. Due to the difficulties in the identification and correlation of the Tertiary formations which lie on both sides of the Rift west of Quail,it is impossible to establish the relative movements of the two blocks.

Where the sedimentary-basement complex contact approaches Oso canyon from the south there is some evidence which points to faulting . This evidence consists of springs ,jointing ,and a small amount of slickensiding and contortion of sediments which lie in the line joining the other features . This line has been dotted in as a fault . In some places it is very close to the basement complex -sedimentary contact. However it is not the contact for in Oso canyon and again west of Quail the relations are found to be clearly depositional. Definite evidence of movement in a particular direction are lacking. It may be that there was a zone of weakness here which acted as a hinge line as the block to the westward turned upward,giving the sediments to the west the existing difference in attitude from those to the east.

The Garlock fault which lies four miles to the west is roughly parallel to this zone of weakness and is believed to mark the opposite end of the block . It is the first known active fault to be encountered in that direction. There may exist however some intervening fault unknown to the author.

The fault shown along Líbre Creek is somewhat doubtful . It was located on the basis of the straight valley striking into the Rift and the very sharp minor folding and jointing at a point midway between the Líbre Ranch road and the head of the valley.

The fault shown to the south of the one just mentioned is indicated by an abrupt change from a persistent north dip to one steeply to the south. These southward dips are on the north limb of a syncline with tuffs and lavas in its trough. If the point of change in dip which has been mapped as a fault was the axis of an anticline ,one would naturally expect to find repitition of the lavas to the northward . This however is not the case . A conflicting bit of evidence is that the beds which are very close to the supposed fracture are somewhat similar on both sides.



The fault splitting off to the west from the Rift north of Libre Mountain is predicated on the basis of notched spurs and the discovery of a gouge zone in a roadcutin one of the notches.

As stated before ,faulting is the major structural feature . However there is some minor folding especially along the San Andreas Rift . The syncline south of Libre Creek has been mentioned . Along Libre Creek there has been a great deal of minor folding and contortion which seems to die out quickly away from the fracture zone. The main block of the sediments which lie north of Quail seem to form a fairly uniform monocline dipping away from the rift. To the west of Quail the monocline has been altered by forces which may be related to faulting.

HISTORY NORTH OF THE RIFT

The present study of the region shows a rather poor record of a great interval of time.

The first event recorded is the deposition of the Paleozoic (?) limestones. They may indicate either deposition in deep water or accumulation in a quiet marginal sea.

Second .....The intrusion and possible uplift of the limestone by a granitic mass . This probably occurred in the general epoch of Jurassic intrusive disturbances .

Third .....Erosion which removed much of the limestone and in places cut deeply into the granite before Miocene time.

Fourth.....Movements which formed a basin in Miocene time to receive materials derived from the granite and limestone after their respective movement upward. The coarse angular nature of the fragments ,the presence of calcite grains and the thick uneven bedding suggests that the accumulation is a near shore deposit supplied by a region of very high relief.

Fifth .....Since Miocene time this formation has been uplifted and tilted northward away from the Rift and beveled off by erosion. The present physiography indicates that this process is still in operation and shows the marks of a subcycle of erosion which was inaugerated in the Pleistocene .

MOJAVE DESERT

The new data gathered in the preparation of this report may serve to throw more light upon the history of the Mojave Desert.

The existence here in the Miocene of a low-lying marine basin might be taken to suggest that the reduction or formation of a basin in what is now Antelope Valley had begun at least as far back as the middle of that period. The faunal similarity between this region and the San Joaquin Valley indicates a connection of the water bodies. The evidence of the sediments having been derived from the present Techachapi region suggests that the sea must have swung around and entered the basin from the south .

The present physiography would tend to indicate that the subsequent uplift of the Miocene above the level of the Desert has not been rapid enough to gain much over the rate of erosion.

SUMMARY

The region consists of two distinct provinces separated by a large valley which marks the San Andreas Rift.

On the north side of the Rift is a Tertiary marine formation which is probably Upper Miocene in age. The Miocene rocks extend some distance up the southeast face of the Techachapis and lie with a depositional unconformity over a Paleozoic(?) limestone and a Jurassic (?) granite which has been intruded into the limestone. Close to the contact the strike is parallel to the mountains while about thirty five degrees is the maximum dip away from them. Within a short distance of the contact however the attitude changes sharply and the remainder of the formation has a strike roughly parallel to the Rift and a steep dip northeastward away from it. The topography has been produced by the incomplete dissection of an old erosion surface ,rejuvinated probably since the Pleistocene.

On the south side of the Rift there is a poorly consolidated irregularly bedded formation which is probably Tertiary ,overlying a granitic basement. Because of difficulty in identification ,it was impossible to determine the relations to the formations across the Rift.