The Geology of the Southwestern Part of Lake Elizabeth Quadrangle Between San Francisquito and Bouquet Canyons.

by

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THESIS

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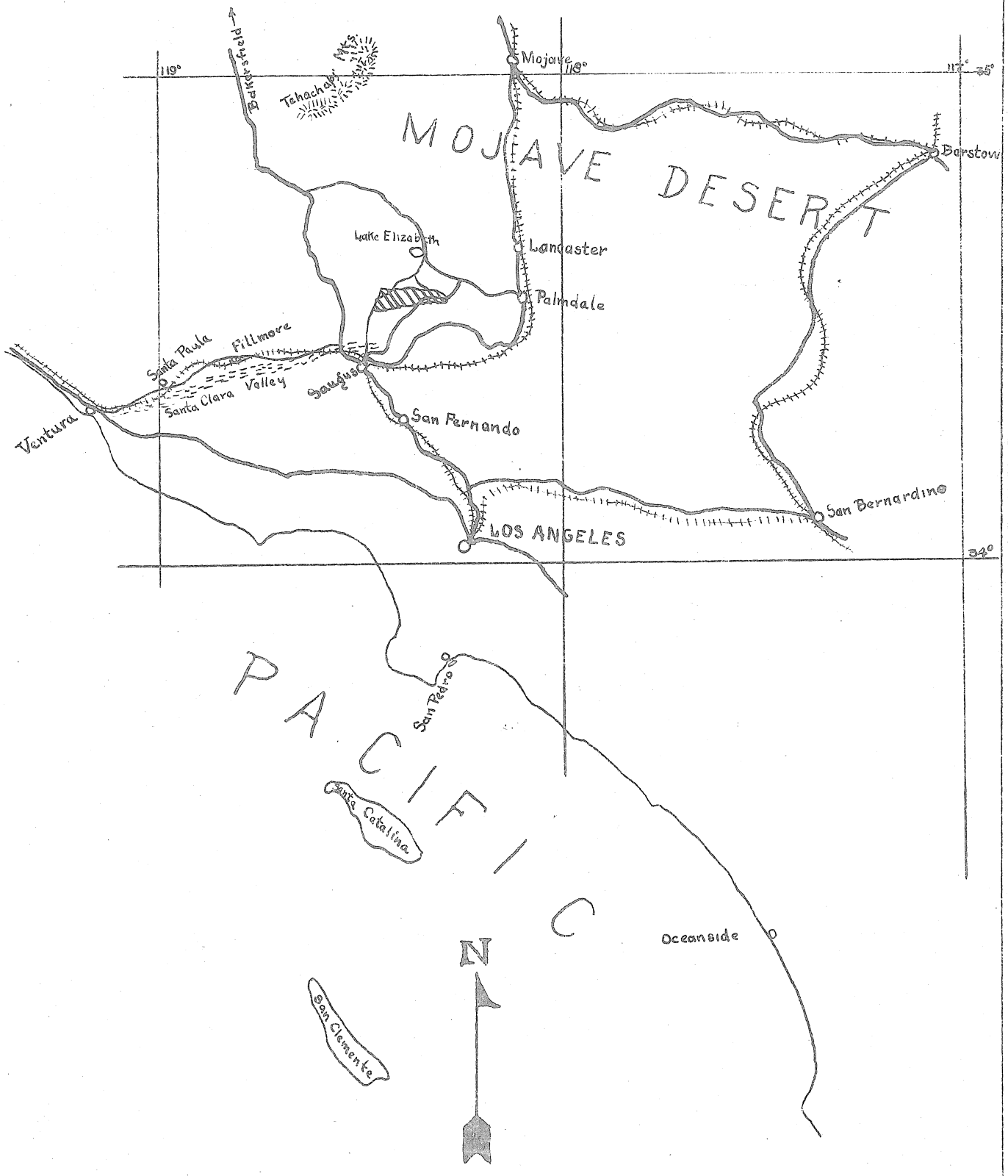
INTRODUCTION.

The San Andreas Rift forms one of the largest and most continuous structural features in the world and as a fault system, has few equals in magnitude of displacements, complexity of movement or size of area affected. The structural relation resulting from the continued movement upon it and auxiliary fault systems is typical of Coast Range structure. Each contribution to the understanding of the structural features in the vicinity of the San Andreas Rift aids in the ultimate understanding of the major feature.

It was with the desire of becoming acquainted with some of the features evidenced by major faulting systems as well as the solution of the geology of an area in Coast Range structure that this problem was undertaken.

Dr. Kew in U.S.G.S. Bulletin 753 has published on the San Fernando and Tujunga quadrangles lying south of Lake Elizabeth quadrangle. Mr. Clements, of the California Institute of Technology, is at the present time engaged in working out the relations in the Tejon quadrangle on the west. Dr. Noble is making an extensive survey of the Rift itself for the Seismological Department of the Carnegie Institute and has mapped as far north along the Rift as Palmdale in Lake Elizabeth quadrangle.



MAP SHOWING LOCATION OF AREA

SCALE approximately 21 miles to 1 inch

SUMMARY

This area is composed of three different kinds of rocks: (a) a metamorphic sedimentary series of pre-Jurassic age forming the basement complex to the south; (b) an intrusionive mass of Jurassic(?) age to the north; and (c) a wedge-shaped mass of Tertiary sediments [9000± feet of Martinez(?) (Eocene) sandstones with some shale and 1500± feet of Sespe (Oligocene?) sandstones and shales] dipping steeply southward at an average angle of 60-80°. The Tertiary formations are separated from the basement complex by a low angled normal fault, the San Francisquito fault, and from the crystalline mass to the north by an overthrust. The trend of all structural features is in a general east-west direction approximately conformable to the trend of the San Andreas Rift four miles to the north.

GEOGRAPHY.

The area to be discussed in this report lies about fifty miles north and east of the city of Los Angeles. It is in the form of a triangle with its base along the western edge of Lake Elizabeth quadrangle in San Francisquito Canyon and its apex at the junction of Bouquet and Spunky Canyons. The total area included amounts to twenty-five to thirty square miles.

The Los Angeles-Mojave highway comes within ten miles of the area and from there good dirt roads, either directly by way of San Francisquito Canyon, or roundabout through Bouquet and Spunky Canyons go to the area. Saugus is the closest town lying on the Los Angeles-Mojave highway while Palmdale is the closest one upon the desert side.

Aside from the workmen at the municipal power houses in San Francisquito Canyon and for a few scattered homes in upper Bouquet Canyon, the area is without population.

Lake Elizabeth quadrangle lies between the parallels $34^{0}30'$ and 35^{0} north and longitudes 118° and $118^{0}30'$ west. It comprises some hundreds of square miles of desert and mountainous topography with the San Andreas Rift cutting diagonally across its southern half. The original topography was on the scale of two miles to the inch but this was run up for detailed mapping to two inches to the mile.

CLIMATE AND VEGETATION

The climate might be regarded as bordering on the arid type since the area is adjacent to the Mojave Desert proper. The average rainfall thirteen miles to the southwest at Saugus is around 17 inches. Most of the streams are intermittent in this vicinity. The water is generally very hard and often contains a great deal of iron.

The temperature averages about 62^{0} F. the year around but may go well over 100^{0} F. in the summer months.

A dense growth of chaparral makes the going heavy once one is off of the roads or trails. Few trees are to be found and those are restricted to the canyons.

TOPOGRAPHY.

The maximum elevation within the area is 4500 feet and the lowest point about 1300 feet. The average relief, however, is only about 1500 feet.

Two main streams deliver the run-off from this area into the Santa Clara River to the south and thence to the ocean. San Francisquito Creek drains all the western and central portions of the area being fed by short tributaries. At one time the run-off was stored in the San Francis reservoir in that canyon but after the breaking of the dam at that site, the waters resumed their old path into the Santa Clara River. The San Francisquito as well as Bouquet Canyon valleys are incised, meandering stream-channels cutting indifferently across the strike of the rocks uninfluenced by variations of hardness. Clearly, they both are antecedent streams. In its lower stretches, The San Francisquito Creek encounters a fault and for a distance forms a fault-line valley.

Soo Canyon is a subsequent stream channel as well as a fault line valley which joins San Francisquito Canyon.

Clearwater Creek drains into San Francisquito Canyon in the northern part of the area from both east and west. The valley is partly subsequent where the drainage has taken ad-

advantage of softer shale members to widen its path, and partly resultant from faulting where movement has accentuated the zone of weakness.

Bouquet Canyon drains the extreme eastern portion into the Santa Clara River and is an antecedent river channel as is San Francisquito Canyon.

The stream valleys are nearly all narrow with the major tributaries having numerous falls. Most of the tributaries have eaten but a short distance back from their trunk stream.

GEOLOGICAL AGE

The complex shows the remnants of an old and extensive erosion surface on its upper reaches. The stream channels are narrow and the drainage pattern simple, so that the age of erosion cycle portrayed in this area is young maturity, (with the understanding that middle maturity evidences the maximum of relief).

DESCRIPTIVE GEOLOGY

The structural relations encountered might be summed up in a statement that this area represents a wedge of steeply dipping tertiary sediments lying between metamorphic and crystalline areas with strong normal and over-thrust relations existing between them.

STRATIGRAPHY

General Features

The rocks within this area fall conveniently into three natural provinces. The basement complex (pre-Jurassic) lies to the south as a series of old metamorphosed sediments. The Tertiary rocks lie within and are composed of the Martinez(?) (lower Eocene) and the Sespe (Oligocene?) formations. To the north is a granite mass (Jurassic?) which was probably intruded in the basement complex as a batholith but which now stands with faulting relations to it.

JURASSIC(?) AND PRE JURASSIC(?) SYSTEMS.

Basement Complex.

The oldest formation exposed in this area is a series of old metamorphosed sedimentaries lying to the south and extending from there far to the east. A satisfactory age determination of this series has never been made and since only a recognition of the relative age of the complex was necessary in this report, no detailed work was done on it. Upon similarities with other igneous intrusions of that period, the batholithic mass now appearing to the north has been considered to be of Jurassic or early Cretaceous age in conformity with the igneous activity in the Sierra Nevada and adjacent regions during that time.[1] This would establish the age of the

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

complex as pre-Jurassic. Further work in this region might give more definite relations. This series is definitely bedded and shows clear structural relations so that establishment as pre-Cambrian would depend on one's willingness to believe that formations of this age in Coast Range provinces could show such clear relations after having been subjected to the dynamic stresses known to have been at work here.

Before the intrusion of the batholith, the complex suffered regional metamorphism and then folding. The planes of schistosity are generally conformable to the bedding planes. The axes of the folds trend in a general east-west direction.

LITHOLOGY

The complex is a rather homogeneous series of micaceous schists with some quartzite layers and some paragneisses. The individual mica laminae are separated by quartzose zones. This probably indicates that the original sediment was an arenaceous series apparently deposited some distance from its source.

The intrusions within the complex evidently were not all of the same period. Smaller isolated patches, generally of basic rocks, appear within the complex and have been extremely metamorphosed. Some of these intrusions are almost schistose in structure instead of having a gneissic texture.

The southern limit of the basement complex in Bouquet Canyon is at the contact between it and the Mint Canyon (upper Miocene) formation. Here the Mint Canyon formation dips steeply to the south having a fault contact with the basement complex. A 50 to 100 foot layer of white crystalline rock occurs between the two formations and this occurrence has been regarded by many in Southern California regions as indicative of faulting relations.

GRANITE ROCKS (JURASSIC?)

To the north of the Tertiary sediments lies a large area of igneous rocks which are supposed to have been intruded as a batholith into the basement complex during Jurassic time in conformity with the igneous activity of that period in the Sierra Nevadas. They now exist in fault relation with the basement. This crystalline mass consists mainly of a granitic series variously intruded and with segregational phenomena. Mineralization has accompanied the intrusions of some of the dikes. These rocks have been metamorphosed to a degree developing gneissic texture but not evidencing the extreme metamorphism common in the intrusions, probably of an early period, within the complex itself. Possibly the batholith was intruded during the later stages of metamorphism to which the complex was subjected and only suffered, itself, the subsequent dynamic stresses.

LITHOLOGY

The granite is a typical one, being composed of orthoclase and albite, quartz and hornblende with some magnetite and biotite. The felspars do not show a definite crystalline boundary although the albite shows good cleavage with indications of the degree of metamorphism which the rock has undergone.

The andesitic dikes in the upper part of Nouguet Canyon have been mineralized and carry gold with some silver. The plagioclase are phenocrysts of andesine and labradorite; quartz, hornblende and some biotite occur. A copper ore in west Clearwater Canyon is associated with a monzonite. More basic rocks appear in the area mostly as dolerites.

THE TERTIARY SYSTEM

Eocene

Martinez(?) Formation

The relations of the Tertiary formations present a most perplexing problem and one which cannot be definitely solved on the basis of information available in this size area.

The Tertiary system is divided into two formations, the Martinez(?) (lower Eocine) and Sespi (Oligocene?). The Martinez(?) lies to the north as a tremendous series of massive sandstones and thin bedded shales aggregating to a visible thickness of nearly 9000 feet of sediments dipping

steeply southward. Through evidences of the occasional appearance of cross-bedding in the massive sandstone along with complementary evidence of gradation in coarseness of sediments, it must be concluded that the base of this series lies to the north.

The contact of the Martinez(?) with the igneous mass to the north is not clearly expressed on the surface. The strike of the sediments approximate that of the contact; their dip is steeply southward and conformable in a general way with the line of contact. On first appearance the contact seems to be depositional and Clearwater Canyon to be nothing other than a subsequent stream valley.

Some disturbing factors were not explained by the assumption of a depositional contact; (1) the appearance of the zone of white crystalline rock about 75 to 100 feet thick interposed between formations along the line of contact and traceable as a white band across the country. The phenomenon has been discussed already in its appearance at the Mint Canyon-Basement Complex contact in Bouquet Canyon (pp8) where it was stated that it has been used by many as a rough criterion for indication of faulting betwenn areas of sedimentary and igneous rocks; (2) A series of shales about 75 feet thick in the lower part of the formation are traceable across the country but appear to end abruptly at the contact quite contrary to the general notion of the sediments conforming roughly to the outline of the surface upon which they are deposited; (3) the fact that a theory of a deposition contact

did not explain the presence of occasional dip of sediments toward the contact plane; (4) a thin section of the white zone along the contact eliminated three explanations for the origin: (a) it could be either a weathered zone peculiar to that type of rock; (b) it could be a dike rock following the contact plane as a zone of weakness; or, (c) the zone might be one affected by metamorphic action alone.

The thin section showed the rock to be a granite with large proportions of felspar, some quartz and very little magnetite or hornblende. No single vestige of altered products of weathering appears so that explanation can be eliminated. The thin section shows the rock to be somewhat metamorphosed but not more intensively than the core rock throughout the igneous province. Hence, metamorphic action could not have caused this phenomenon. With most of the crystals being euhedral, the rock could hardly be a dike rock.

The extreme amount of brecciation within euhedral crystals is astonishing. A certain amount can be expected in a metamorphic region but the position of extinction within the boundaries of a crystal wandered in a curved path over each fragment of the crystal showing that the particles have suffered movement with relation to one another, probably through brecciating forces.

The contact is indicated to be a fault contact with a dip of 66°S and a strike of N80°W, in which the tertiary

PLATE I

West in Clearwater Canyon. Clearwater fault between granite on the right and Martinez(?) sandstones on the left. Los Angeles Municipal Power house #1 in the foreground.

sediments to the south have been thrust over the crystalline mass to the north.

In the northeastern part of the area along Bee Canyon the Martinez(?) is in fault contact with the basement complex through the continuation of the San Francisquito fault.

THE MARTINEZ(?)-SESPE CONTACT

A structural problem arises in the relation between the Sespe formation and the alleged Martinez(?). The solution of this problem had an important bearing on the age of the Martinez(?) sandstone since this sandstone series is entirely free of fossil material.

The Sespe to the south has an almost constant dip of 40° to 50° north at the contact. The Martinez(?) to the north may be broken near the contact, but up to the immediate vicinity, displays an unvarying dip of approximately 70° south. The contact plane dips beneath the Martinez(?) at an angle varying from 40° to 70° north. At first sight it appears that the sandstones series to the north is younger than the Sespe (Oligocene?) formation but areal mapping shows that nearly 9000 feet of this northern formation dips southward beneath the Sespe formation and could be younger only by means of faulting.

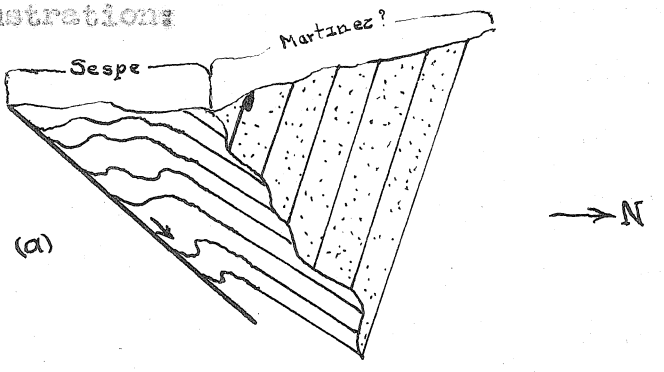
The base of the Sespe was determined to be to the north through reason of finding in the base of a sandstone stratum lying immediately to the south of shale inclusions from that earlier shale member.

PLATE II

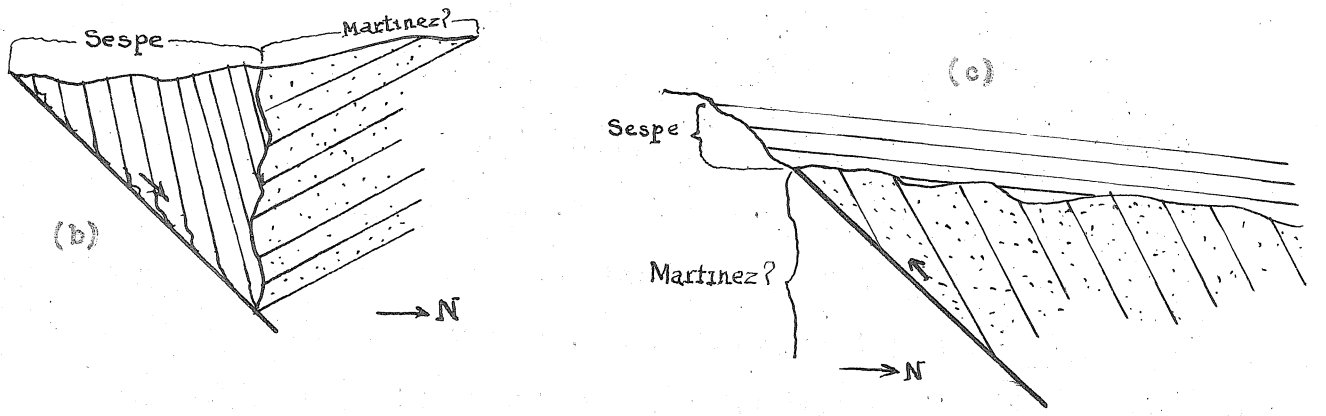
Dip of the Sespe toward the Sespe-Martinez(?) contact plane. San Francisquito Canyon.

In Bee Canyon the Martinez(?) sometimes shows anticlinal folds along the Martinez(?)-basement complex contact on the San Francisquito fault. This would tend to indicate that the last movement of the Martinez(?) with respect to the complex has been upward. At one locality a ravine shows the typical disposition of the two formations along the contact plane. Here a zone about one foot thick, of altered Sespe clay and a pencil of typical fault gouge outlines the contact. The amount of gouge can hardly be taken as indicative of extensive movements between formations as cannot the amount of brecciation. Some of the Sespe shales along the contact show slickensiding but although the contact is frequently crossed by deep canyons, no trace of a fault of any magnitude is apparent.

The best information at hand would indicate the contact to be depositional with possibly some minor adjustment between formations and with a sequence of events as shown in the following illustrations:



(a) Present disposition of the Sespe and Martinez (?) formations.



(b) represents an intermediate stage while (c) represents the disposition of the formations at the time the Sespe was deposited.

This stratigraphical relation indicates that the sandstone series to the north is the oldest formation and it has been assigned, dubiously, to the Martinez(?) (lower Eocene) formation.

LITHOLOGY

The Martinez(?) formation consists of massive bedded sandstones which greatly preponderate over the interbedded shale members. The sandstone is a medium grained arkosic sandstone with angular grains of quartz and felspar and some mica, cemented by a siliceous cement containing a little iron oxide. It has a varying color on a fresh surface from a dark grey to a yellow-brown but always presents a reddish-brown weathered surface. Some of the layers have a siliceous and calcareous cement. Lenses and thin strata of conglomerates with pebbles up to two inches in diameter appear in parts of the section.

The base of the Martinez(?) along Clearwater Canyon has a shale series of a thickness varying from 75 to approximately 1000 feet, lying between sandstone strata. The shale is arenaceous, finely laminated and has a greenish-brown appearance on weathered surface. In the eastern part of Clearwater Canyon the shale occupies a broad area and has a red color. It includes here many concentric concretions stained with iron oxides. Some of the shale series have a high content of carbonaceous material and form almost lignites.

AGE DETERMINATION

It is surprising to find a section of such thickness as is included in this formation without discovering any fossils. Some reed and plant bud remains were found in the calcareous sandstone stratum. Various occurrences of worm borings are to be noted. The origin is thus probably marine, the deposition being carried on in tidal flats or shallow waters and at such a rapid rate that conditions were unfavorable for life.

The presence of Martinez twenty miles to the south[1] as the closest Eocene formation coupled with the general lithological similarities[2] were made the bases of the choice of assigning this series to that formation. The series compare quite favorably to the Tejon[1] (upper Eocene) which is found

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1. Cit. opp. pp6
2. Lawson, A. C. San Francisco Folio, U.S.G.S. Folio 193, 1914

exposed at San Cayetano Mountain 30 miles westward.[1-2]

The degree of induration, the thickness of the formation and the lack of fossil remains argue individually against a unanimous choice. Many characteristics are favorable for assigning the formation to the Chico (upper Cretaceous) formation.[3]

SESPE(Oligocene)?

The Sespe formation in this area consists of an alternate series of fine-grained sandstones and black shales. The sandstone layers vary between 6 inches and two feet thick; the shale strata are usually less. The typical red aspect of the generalized Sespe formation appears on a weathered surface. The series in this area forms the base of the Sespe further to the south and is conformable to it. A gradual increment of conglomeritic particles is apparent so that 4 miles southward the Sespe formation is entirely a conglomerate. It has a thickness in this area of 1500± feet. The Sespe-Martinez(?) contact is depositional; the Sespe-Basement complex contact is the San Francisquito fault. This formation is generally badly folded and contorted and has a topographical expression in low-lying hills.

LITHOLOGY

The base of the Sespe as seen in this area differs radically from the massive exposures further to the south where the formation is mainly a conglomerate. The sandstone

1. Eldridge, G. H. and Arnold, R., The Santa Clara Valley, Puente Hills and Los Angeles Oil Districts, California U.S.G.S. Bul. 309, 1907.
2. Pack, R. W. The Sunset-Midway Oil Field California Part I, U.S.G.S. P.P.116, 1920
3. English, W. A. The Northwest part of Kern County, U.S.G.S. Bul. 721

PLATE III

Sespe sandstones and shales in San Francisquito Canyon showing contortion of series near the San Francisquito fault.

is very fine grained consisting of small, rounded particles mainly of quartz and felspar cemented with a calcic and iron cement. The color on a fresh surface is a greyish black and the color of the weathered rock is red. Strata have an average thickness of 2 or 3 feet.

The shale is somewhat arenaceous with a great deal of iron oxide. It is very finely laminated; purple to black, and generally exists in thin layers of but a few inches thickness intercolated between the sandstone strata.

A gradual increment in conglomeratic particles within the strata is to be traced southward.

AGE CORRELATION

The age of the Sespe (Oligocene?) formation has always been a matter of more or less speculation. In all of the numerous occurrences along the Pacific Coast it is never found with satisfactory faunal evidence for age determination. The Sespe in this area forms the basal portion of, and is conformable with, known Sespe 4 miles to the south. It has been correlated in this region on its characteristic color and lithological appearance as well as on its stratigraphical position.

Without any fauna to characterize it, the Sespe formation cannot be assigned a definite origin. Its red color throughout suggests deposition in an arid climate. The fineness of grain of the basal shales and sandstones imply deposition in protected playas. As more and more soil in this source region was stripped away, the coarser would become the detrital material and this agrees with conditions in the field.

QUATERNARY SYSTEM

Valley Alluvium

The rate of down cutting of the streams within this area has resulted in the formation of narrow canyons without any great amount of valley fill. However, at the junction of Bouquet and Spunky Canyons in the eastern part of the area, erosion has been much faster than the streams could carry the detrital material away. As a result, a broad basin a half mile wide and about the same in length has been formed. The alluvium does not represent more than a few tens of feet thickness, but it has formed a fertile soil.

GEOLOGICAL STRUCTURE

The division into three provinces: (a) a basement complex to the south; (b) an intrusive area to the north; and, (c) a central portion of steeply dipping Tertiary sediments emphasizes the importance of the structural relations of the isolated Tertiary sediments.

The basement complex has been metamorphosed with the development of planes of shistosity parallel to the bedding and later was folded into folds tending approximately east-west. The intrusive mass to the north has suffered some metamorphism since its formation.

The two Tertiary formations form a series of sediments dipping steeply toward the south. They have a depositional contact between themselves while the Clearwater fault separates the Martinez(?) from the intrusive mass to the north, and the San Francisquito fault appears between the basement complex

and the Tertiary formations to the south.

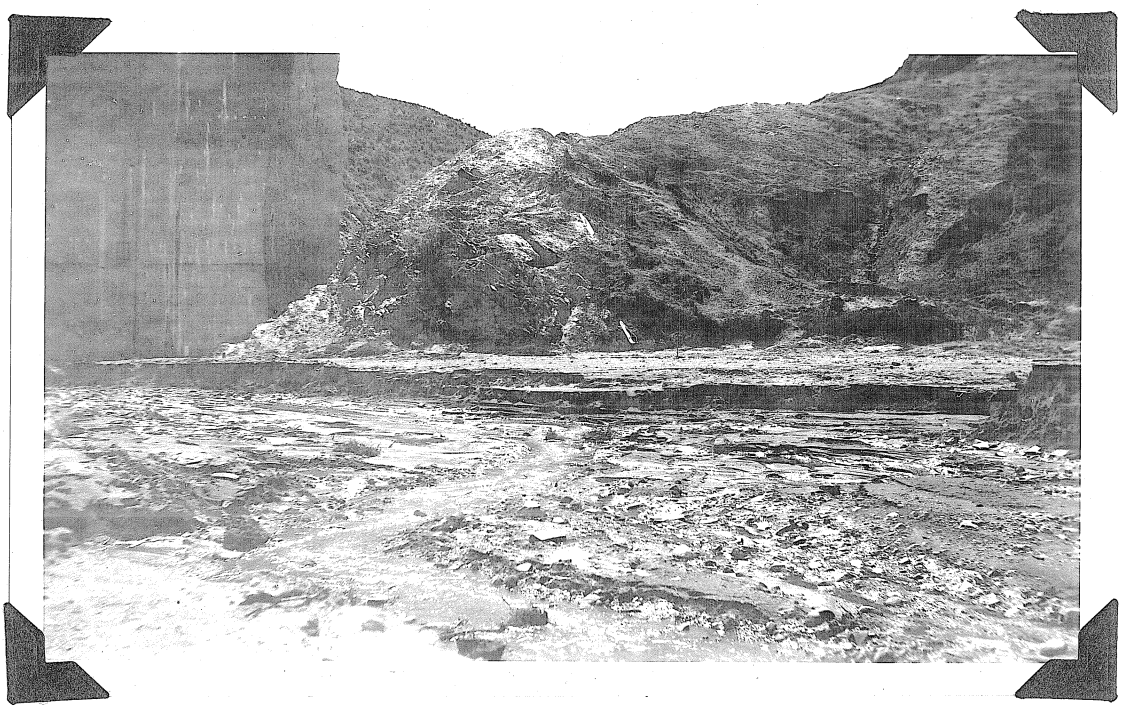
FAULTS

The San Francisquito fault was displayed in an unusual manner when the St. Francis Dam broke. A detailed section across the fault zone was displayed. The basement complex to the south of the fault has been badly shattered for a distance of 30 feet from the fault. The fault plane itself contains from one-half to four feet of gouge. The Sespe formation to the north has been shattered and the included boulders sheared for an indeterminate distance from the fault plane. The dip of the San Francisquito fault is 59°W, strike N 61°E. It is a normal fault with the basement complex to the south rising.

In order to have the Tertiary strata dipping steeply toward the south, the net vertical displacement must have been approximately 5900± feet. The horizontal extension that would occur along the normal fault of this throw is probably taken up in this area by over-thrusting along the Clearwater fault. The absence of Tertiary formations later than the Sespe (Oligocene?) formation and the narrowness of the canyon prevents the determination of the period of the latest movement. No topographical evidence of recent activity is to be found and the San Francisquito fault is probably a dead one.

The occurrence of steeply dipping Tertiary sediments with strong normal faulting and over-thrusting existing be-

PLATE IV



Looking southward in the strike of the San Francisquito fault showing relations between the Sespe (conglomerates) on the right and basement complex on the left.

tween them and areas of old metamorphic or crystalline rocks has been reported[1] as a common characteristic in the vicinity of the San Andreas Rift. The trend of these areas conform approximately to that of the Rift.

THE CLEARWATER FAULT

The contact between the Martinez(?) formation and the intrusive mass to the north is an overthrust fault. This fault has a strike N 80 W, dip 66°S. It is evidenced on the surface by a white zone of brecciated material about a hundred feet wide. The Martinez(?) formation on the south sometimes dips into the fault plane.

The amount of overthrusting of the Martinez(?) on the intrusive has resulted in a vertical rise of about 2100 ± feet. The overthrusting along this fault has taken up the horizontal extension which would otherwise have resulted from the normal faulting along the San Francisquito fault. No age determinations for the period of latest movement could be made.

SUMMARY OF HISTORICAL GEOLOGY

Not enough work has been done in the basement complex to generalize upon conditions of its deposition but the uniformity of the series and the presence of quartzites and paragneisses would argue for marine deposition near a land mass.

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1. Noble, L. F. The San Andreas Rift and Some Other Active Faults in the Desert Region of Southwestern California; Seismological Society of America, Bul Vol 17, #1, pp 25-39 March, 1927.

Submergence was continuous during the deposition of the Martinez(?) formation. Conditions must have been such that accumulation went on nearly as rapid as submergence so that shallow water deposits were always being formed. The source of material was relatively close at hand since the rate of deposition was so rapid as to be unfavorable for marine life. With but a comparatively small thickness of shales present, the uniformity of the series indicates that conditions of deposition were constant over a long period of time and that the position of the shore-line did not vary a great deal. That land was relatively close at hand is indicated by the presence of fossil reeds and plant buds.

The uplift of the Martinez(?) formation following deposition marked a general trend toward emergence, a condition which seems to have prevailed in this area up to now. The vertical movement along the fault planes must have been considerable since the Sespe (Oligocene?) formation has a large angular discordance with the underlying Martinez(?).

Deposition did not reoccur until (Oligocene?) times when the Sespe formation was deposited under arid conditions in playas and large basins. The coarseness of the final conglomeritic phase of the upper Sespe suggests that it was deposited as a fanglomerate.

The periods of movement along the faults in this region cannot be stated. The latest uplift was in such a late

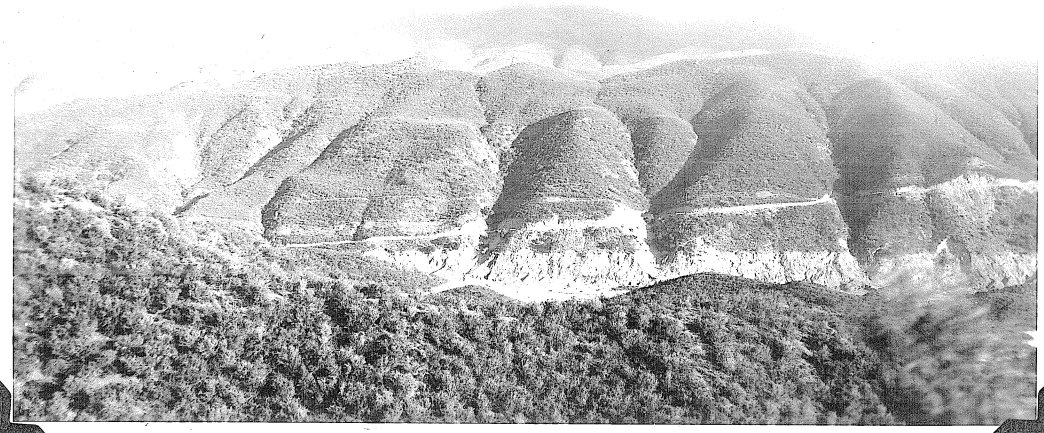
Tertiary period that the valleys are sharp and narrow and have not yet reached base-level.

PHYSIOGRAPHIC DEVELOPMENT

The present topographical features in this area are the result of a long period of erosion and faulting activity. The major stream channels are antecedent from some former land surface and now appear as incised meandering streams cutting indifferently across the strike. The subsequent stream channels such as Clearwater Canyon and Bee Canyon are relatively recent developments. Clearwater Canyon follows a shale member in the Martinez(?) and has not widened its channel much outside of this confine. Bee Canyon has developed as a fault line valley following the zone of weakness between the Martinez(?) and the basement complex. San Francisquito Canyon becomes a fault-line fmr valley where the stream encounters the San Francisquito fault.

The skyline along the basement complex is a markedly straight-line feature and this old surface, some 1600 feet above the level of the present San Francisquito valley marks an old erosion surface. The San Francisquito creek in its downward cutting has formed terrace-like surfaces due to variation in hardness of the strata in the basement complex. The flatness of the land surface on the complex side and the fact that San Francisquito and Bouquet creeks are incised meandering streams indicates that this represents a stage in late maturity in

PLATE V



Eastward from the Sespe-Martinez(?) contact in San Francisquito Canyon. Old land surface upon the basement complex in the distance with terrace like features formed in the down-cutting of the San Francisquito creek in the folded complex. Sespe formation in the foreground.

the physiographic cycle before the uplifts which caused the present trenching of the stream channels took place.

ECONOMIC RESOURCES

The economic resources within this area are not of great value. Recent activities have been started in both Bouquet and San Francisquito Canyons for removing roofing slate. The excavations follow the planes of schistosity, horizontally and slabs up to 10 feet long are removed.

The Grey Eagle Mine has been operating along two andesitic dikes at the head of Bouquet Canyon within the intrusive mass. The dike rocks dip steeply to the north. The deposit is an epigenetic, epithermal(?) deposit/both vein and disseminated, with mineralization richest in the northern dike rock and less so in the southern and sparingly in the foot-walls. The minerals are gold, silver, chalcopyrite, galena, and fine grained quartz. The 100 foot level has been reached. Mine estimates give a mean value for the ore of $20 per ton. Erosion of the upper levels of these two dikes have given rise to the placer gold appearing in small quantities in Bouquet Canyon.

A small mining claim of the Clearwater Copper Mining Company has been located in west Clearwater Canyon. The work is hardly beyond the prospecting stage. The copper is disseminated in basic rocks intruded with the crystalline area and is associated with pyrite and chalcopyrite.

The California Graphite Company of Los Angeles had a graphite claim located at the junction of Bear and San Francisquito Canyon in the crystalline series there[1]. The resources were described in 1914 as being promising and extensive and operations were carried on at two levels. However, for some reason or other, activities have ceased.

The Los Angeles Power House No.1 of San Francisquito Canyon stands at the junction of west Clearwater and San Francisquito Canyons. Power is generated for Los Angeles consumption through three penstock units from the Los Angeles Aqueduct.

The alluvium flats at the intersection of Bouquet and Spunky Canyons are occupied by small fruit ranches whose trees are as yet quite small.

Most of the area is rugged and heavily covered by chaparral and consequently, quite useless for any economic purposes.

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1. Eastin, E.S. Graphite; Mineral Resources of the United States, U.S.G.S. Part 2, Non-Metals, 1914

PLATE VI

Looking southward from granite in upper San Francisquito Canyon. Basement complex in the distance.

PLATE VII

Looking southwest in San Francisquito Canyon. The Sespe formation lies in the center, the basement complex on the left and the Martinez(?) on the right.

PLATE VIII

At junction of Bee and San Francisquito Canyons. Looking northward up Bee Canyon. Complex on the right, Sespe in the immediate center and Martinez(?) sandstones on the left.

PLATE IX

Looking northeast in San Francisquito Canyon. Igneous rocks in the distance, basement complex on the right and Sespe formation on the left.

PLATE X

West Clearwater Canyon. Slumping of the shales within the Martinez(?) formation.