GEOLOGY

OF THE SOUTHERN PART OF THE RED MOUNTAIN QUADRANGLE,

CALIFORNIA

submitted

as a partial fulfillment

for

the degree of

B.S.

by

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May 31, 1938

And the earth was without
form, and void . . .

Gen. I,2.

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SUMMARY

An area of about twenty square miles in the southern half of the Red Mountain Quadrangle, Los Angeles County, California, was mapped geologically in the spring of 1938. The area lies within the Transverse Ranges Province of California, and comprises the following rocks: a pre-Cambrian mica schist (Pelona schist) , continental sediments of Oligocene (?) (Sespe formation) and lower-upper Miocene (Mint Canyon formation) age, and marine sediments of upper Miocene age (Modelo). The Sespe is overthrust over the Pelona schist and the Mint Canyon. The Mint Canyon lies with a depositional contact upon the Pelona schist and is overlain unconformably by the Modelo which overlaps it to the west.

The area has undergone several periods of rejuvenation during Quaternary times, the uplift not being accompanied by tilting. Remnants of the old land surface and stream terraces at various levels indicate that before uplift the area was in late maturity of the physiographic cycle; now it is in a youthfull stage of development.

The main structural features are the Sespe overthrust, folds trending northeast-southwest, and a well developed flow cleavage and shear joint system in the schist. Forces of a static nature have affected the area at one time, as shown by the flow cleavage in the schist, but the most recent, dominent force acting in the area is considered to be compressive, non-rotational, inclined below the horozontal, and acting in a southwest direction. Its attitude is approximately N10°E.

INTRODUCTION

LOCATION AND EXTENT

The area investigated and herein described is situated in the northwestern part of Los Angeles County and in the southwestern part of the San Gabriel Mountains. It comprises the southern half of the Red Mountain Quadrangle, having as its eastern and western limits, 118°30′ and 118°36′ west longitiude and as its northern and southern limits, latititudes 34°33′ and 34°30′ respectively. The area mapped contains about

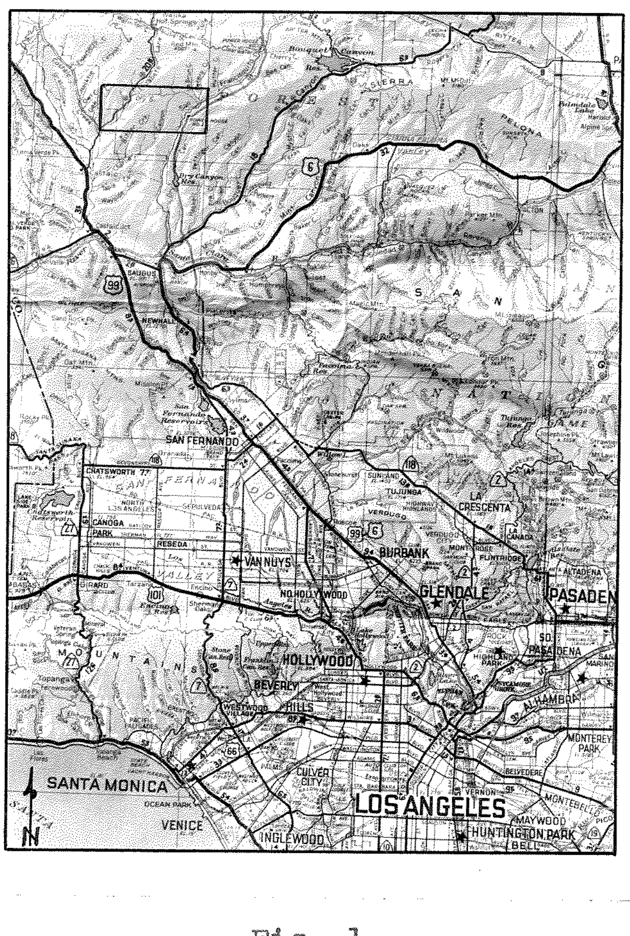


Fig. 1

Location and extent of area

twenty square miles. It is about forty-five miles north-west of Los Angeles and about nine miles north of Saugus. The area lies within the reserves of the Angeles National Forest.

The area is easily reached by automobile, for there are excellent paved roads from all outlying districts which lead to Saugus. The main highway from Los Angeles to Saugus is U.S. 99, but there are others equally good. In addition a branch of the Southern Pacific railroad passes through Saugus. The only unpaved road to be encountered is a good, gravel road in San Francisquito Canyon.

PURPOSE OF INVESTIGATION

The purpose of this investigation was to fulfill partial requirements of the California Institute of Technology leading to the degree of Bachelor of Science. To this end field work was carried out during the spring of 1938 during the author's senior year at the Institute.

METHOD OF INVESTIGATION

The aerial geology was placed upon a U.S. Geological Survey topographic map surveyed in 1931 and having a scale of one to twenty-four thousand. Fairchild aerial photographs were also used in mapping. Locations of points and dips and strikes were determined by a Brunton compass.

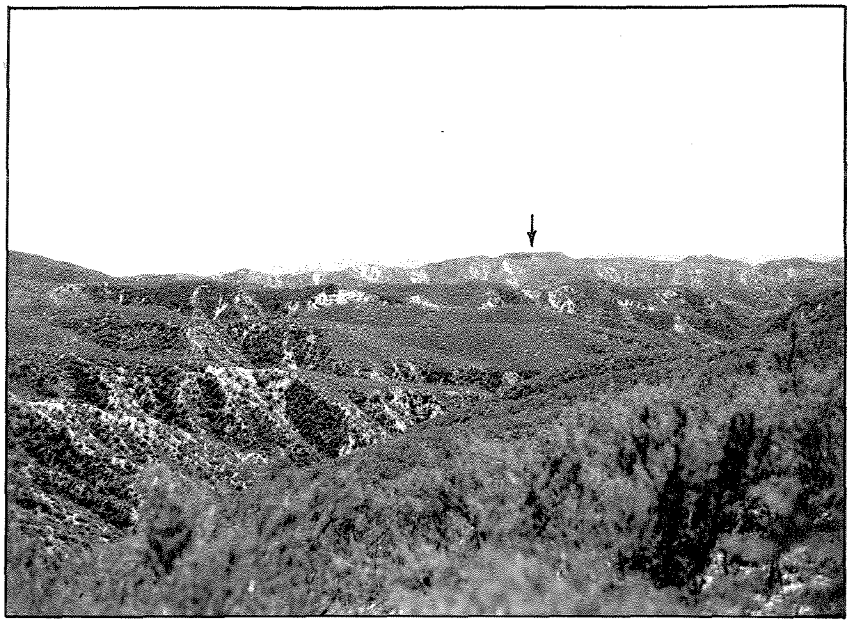
PREVIOUS INVESTIGATIONS

There has been very little geological work of a thorough nature done in this region. The earliest work was that of J.D. Witney[1] who made a reconnoisance survey of the San Gabriel Range and the vicinity around Los Angeles in 1865.

1) See bibliography

O.H. Hershey[2] in his studies of the Quaternary geology of the state of California made a geological reconnaissance sketch map of part of Southern California which includes the San Gabriel area north of Saugus. But his maping here was of such a sketchy nature and so little was known of the geology around the Saugus area and so its correlation with known geology of other regions that its usefulness is very limited. It is interesting to note that Hershey first recognized the prominence of stream terraces in this region. He distinguished four such stream terraces on the sides of the Sants Clara River east of Saugus and corrlated the highest, the one designated as the 400-foot terrace, with the highest marine terrace on the coast. Hershey[3] also investigated the Pelona schist which makes up the Sierra Pelona Ridge northeast of Saugus. He described it as being mostly a true mica shist containing strips of coarsely crystalline actinolite and quartzites which have retained enough of their original character to show their detrital origin. He correlated the Pelona schist with the Abrams mica schist of the Klamath region and believed it to be the oldest rock exposed in the state. After a later investigation[4] Hershey correlated the Pelona schist with the Abrams schist and with the Rand schist in the Rand Mountains, Kern County, which he called a continuation of the Pelona schist. These schists were assigned to the upper Archean epoch. The latest report on this area and the only one that covers the complete geology of the region in a satisfactory way is the paper by Clements.[5]

PLATE I



A. Looking East at a remnant of an old stream terrace Haskall Canyon runs diagonally across picture.

B. Mature summit areas of the Modelo formation. This is a part of the old land surface being dissected by the Pleistocene (?) to recent rejuvenation of the region.

Physical Conditions

RELIEF AND ELEVATIONS

The San Gabriel Mountains as here exposed are a belt of rugged ridges roughly parallel and running in a general northeast-southwest direction. The ridges slope generally southward, finally disappearing under the alluvium of the Santa Clara Valley. Their summits in the southern part of the quadrangle are flat or gently sloping and are remnants of old stream terraces that once covered a large part of this region.* Topography is not controlled to any great extent by the underlying formations. The valleys are generally straight, steep-sided, and in a youthful stage of development, much in contrast to the mature aspect of the higher portions of the ridges. It must be emphasized that the anomolous relationships between the drainage pattern and the land forms are due to rejuvenation of an area in late maturity.

The ridges rise to an average height of about 2,000 feet at the northern end of the area and slope down to about 1,600 feet at their southern end. The highest point in the area is 2,475 feet, located at the eastern extremity of the Pelona schist highlands. The lowest point is situated at the southern end of Elizabeth Lake Canyon and is 1,225 feet in elevation. San Francisquito and Elizabeth Lake are the two main canyons in the area, and of the two Elizabeth Lake Canyon is the larger. It is about 200 feet wide at the northern end of the area and about 1,800 feet wide at the southern end.

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* See PLATE I

San Francisquito Canyon does not show such a widening of its stream channel; it widens its channel from about 600 feet at the northern end to 1,400 feet at the southern end of the area. The two streams are roughly parallel at their southern ends.

DRAINAGE

The drainage in the area is generally southward. The drainage of all the smaller streams unites with that of either the Elizabeth, San Francisquito, or Bouquet Canyons and flows southward to the Santa Clara river which in turn flows westward 44 miles to the Pacific Ocean. The striking thing about the drainage pattern is the parallelism of the subsequent streams. San Francisquito, and Elizabeth Lake streams, like all the others in the region are intermittent, the lower part of their stream courses being dry during most of the year. San Francisquito stream as shown by the presence of a wind gap associated with the northern part of its course, lying outside the ares, and by its relation to the structure of the area is a subsequent stream. The stream occupying Elizabeth Lake Canyon is also probably subsequent. Elizabeth Lake and San Francisquito streams are the only ones which flow on an alluvium bed continuously throught the area, but from the width of the canyons and the nature of the streams this alluvial covering is not thought to be very thick. All the other streams in the area are rapidly degrading their courses. San Francisquito stream is peculiar in two respects.

Its valley walls where it passes through the fault contact between the Pelona schist and the Seape conglomerates are asymmetric. This is due in part to the differential hardness of the two formations and in part to the difference in structure between the two rick bodies. Also the part of San Francisquito Canyon lying south of the former Saint Francis Dam shows the effects of sudden overloading of a stream. Huge blocks of concrete have been carried downstream from their former position, the stream course has been abnormally widened, the lower canyon walls have been swept clean of their mantle exposing bedrock, patches of alluvium have been deposited on slopes high above the present level of the vally floor, and small natural lakes have been formed where there was abnormal scouring action while mounds of alluvium have been deposited in the middle of the stream canyon where local slowing down of the flood waters caused them to deposit their load.

CLIMATE AND VEGETATION

The area is of the typically semiarid type. The government recording station at Newhall, ten miles to the south has recorded over a thirty-eight year period a mean annual rainfall of 17.54 inches. This comes mainly during the months of December through April.

The vegetation of the area is composed of mainly chaparal growth, consisting in part of greasewood, buckthorn, white sage, black sage, yucca, and sumac. Live oaks and cottonwoods grow in some of the canyons.

EXPOSURES

As a general rule exposures are very good throught the area. This is especially true in San Francisquito Canyon where the flood waters from the broken Saint Francis Dam have scoured the sides of the canyon clean of alluviun and have laid bare the fault contact between the Sespe and the Pelona schist and Mint Canyon formations. Only on the gently sloping summits of the ridges where there is an extensive covering of alluviun are outcrops wanting.

CULTURE

The hand of man is not much in evidence in this region. Cattle ranches are scattered throught the larger valleys and cattle feed is grown on the lower alluvial surfaces. The population of the area is sparce. There is an elementary grade school and a small colony of Los Angeles Metropolitan water districts workers situated in San Francisquito Canyon. San Francisquito power house number two is directly across the canyon from this settlement.

GEOMORPHOLOGY

The unusual topographic expression of the area and the amomolous relations existing between present stream development and the land forms of the area they drain deserve special mention. Study of the flat tops of ridges and of the highlands area to the east of the quadrangle, together with the old stream patterns still present on these surfaces show that they represent remnants of an old land surface in rather late maturity of the physiographic cycle.* Stream terraces are scattered at various places and levels over the area, still retaining their original horozontal position, and by their elevations and distribution show not only that they once covered a large part if not the whole part of the southern half of the area, but also that the area underwent at least two periods of rejuvenation. Before rejuvenation the streams were agrading and were flowing southward in wide valleys with gentle slopes. The stream divides were not high and were in the nature of smooth, rounded, low-lying ridges. The streams were more or less parallel and of the subsequent type. As soon as the region experienced uplift the streams immediately began to degrade. Those who drained the largest areas and whose watershed was the greatest had the most advantage in downcutting and soon were entrenched far below their former level. The smaller streams experienced little change for their cutting power was limited. Soon, however,

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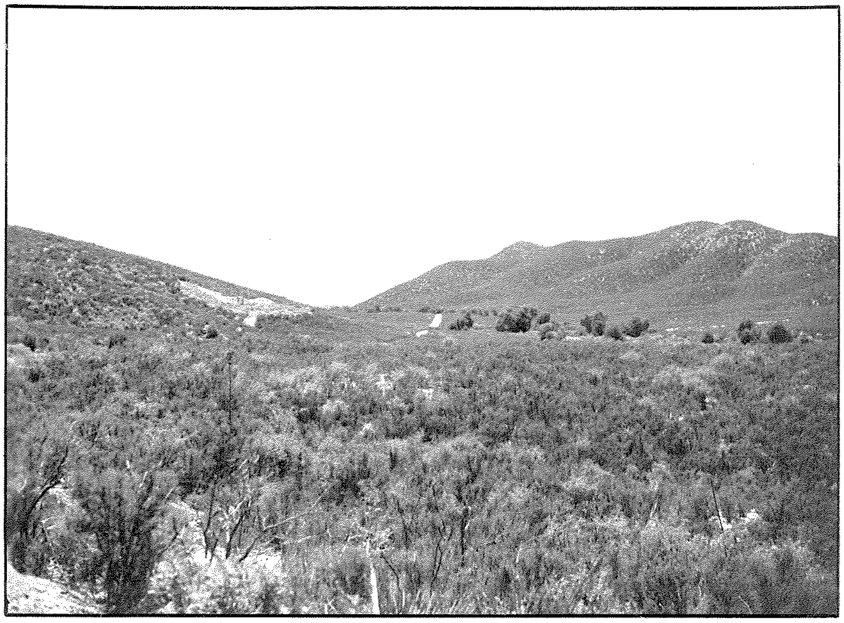
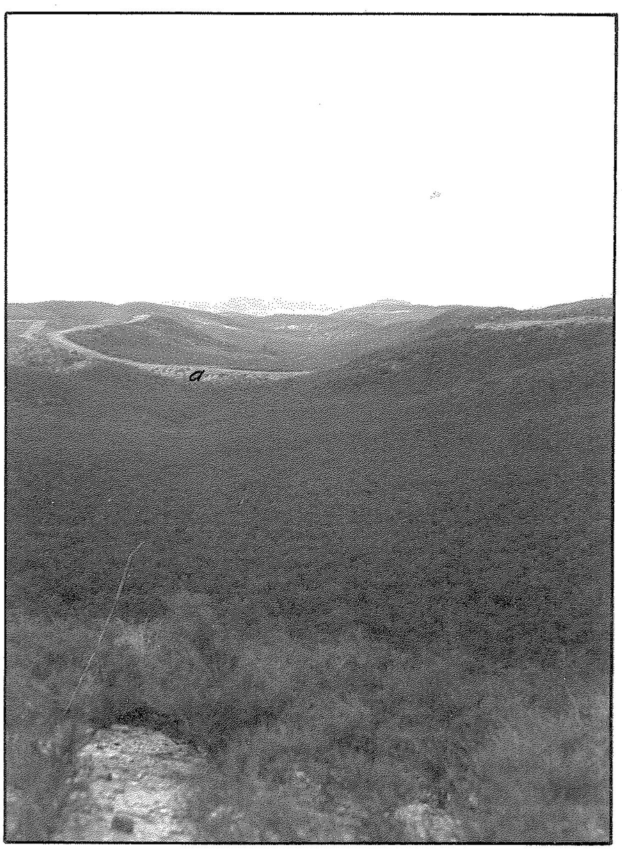
* See PLATES I, II



A. Looking south at a mature stream valley on the schist highlands to the east of San Francisquito Canyon. This canyon is parallel to and 600 feet above San Francisquito Canyon.



B. Looking at a mature stream valley occupying summit of ridge just west of San Francisquito. At a, a subsequent stream working headward from San Francisquito Canyon at the left has captured the drainage from the upper part of this old stream valley.

subsequent streams working headward and right angles to the large entrenched streams captured many of the old streams, producing small wind gaps and leaving the old mature valleys abandoned.* The present erosional cycle is in a period of youth and has not had time to dissect the gently sloping highlands. The stream terraces on the eastern part of the area stand at an elevation of about 2,100 feet, while the large terrace on the western side is at an elevation of 1,500 feet.** A study of the eastern wall of San Francisquito Canyon at its lower end leads to the probability that there were at least three distince upliftings of the area.*** However since terraces occur in many other places in this region and a satisfactory determination of the mumber of uplifts would require a study of them all, this information is outside the scope of the present report. It is important to recognize the fact that were several rejuvenations of the region.

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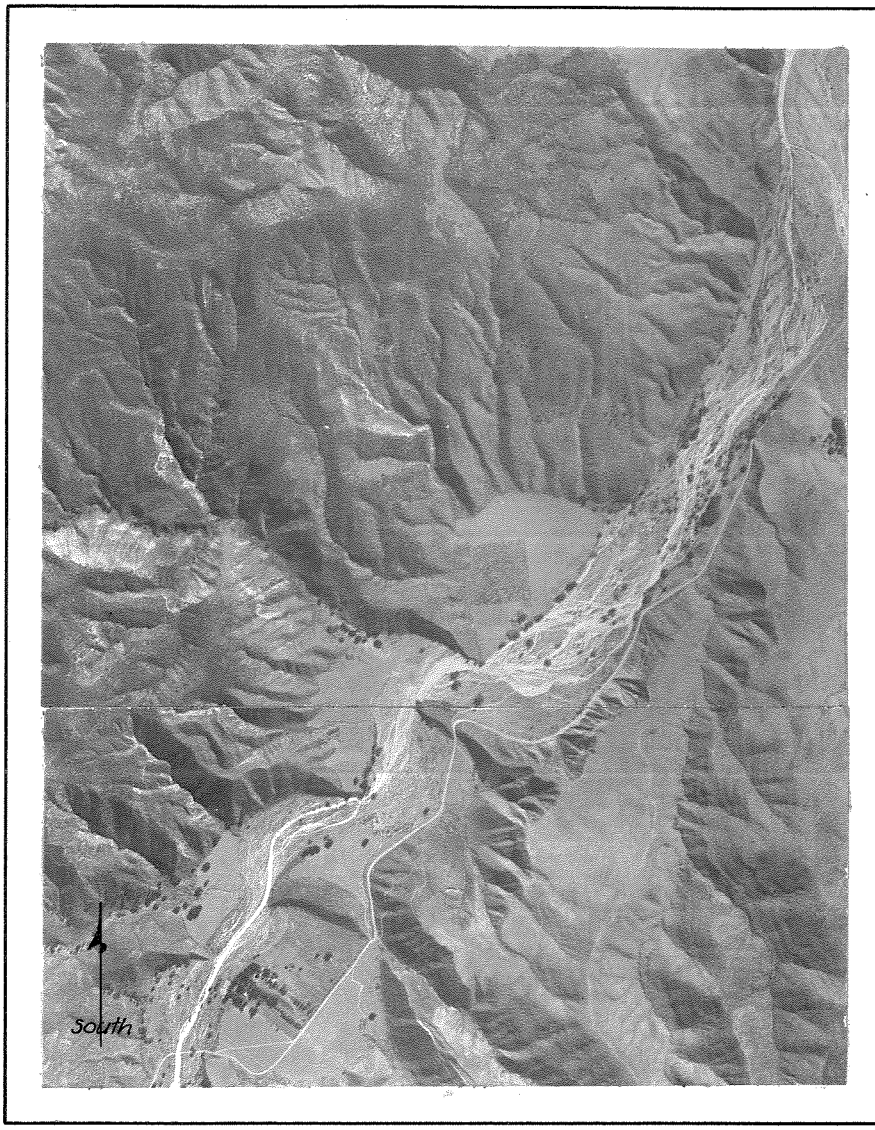
* See PLATE III
** See PLATE IV
*** See PLATE V

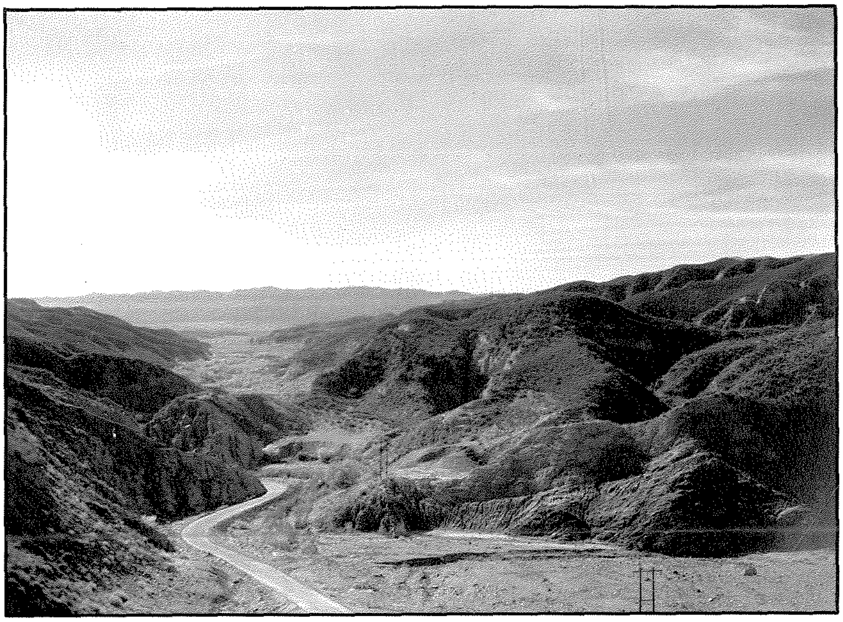
PLATE III

Drainage pattern of the southeastern half of the Red Mountain Quadrangle. Streams accurately drawn, 100 foot contours generalized. The parallelism of the major streams is very apparent. The stream occupying Drinkwater Flat was once a branch of the Dry Canyon stream, flowing along the dotted line ABC. But it has been captured by the subsequent stream, D, working headward from San Francisquito Canyon. The capture took place at A. The saddle, B, therefore, is a wind gap. AB is a potential obsequent stream.

PLATE IV



A. Vertical airplane photograph of lower part of Elizabeth Lake Canyon just north of Castaic Creek. An old stream terrace is on the west of the Creek still excellently preserved.



A. View looking down San Francisquito Canyon. Santa Clara Valley in the distance. Mint Canyon sediments showing badlands type of erosion are shown in the center foreground lying on the Pelona schist. Profile of east canyon wall in distance suggests at least three periods of rejuvenation of San Francisquito.

STRATIGRAPHY AND PETROLOGY

GENERAL FEATURES

The rocks of this area are of two main types: metamorphosed basement complex; sedimentary series. The basement compex is a schistose rock outcropping in a curved region in the middle of the area east of San Francisquito Canyon. It is considered in this report to be pre-Cambrian. The sedimentary series occupies the main part of the area, and ranges in age from Oligocene (?) through upper Miocene. Quaternary terrace deposits occur in a few places in the area and recent alluvium is present in some of the stream courses. The sedimentary rocks comprise the Sespe formation (Oligocene?), Mint Canyon formation (upper-middle Miocene), the Modelo formation (upper Miocene), and river terraces and valley alluvium (Pleistocene to recent). Mention should be made here of three little patches of highly silicified extrusive volcanics which occur as a capping on the Mint Canyon formation on the ridge between San Francisquito and Charlie Canyons. It is very difficult, if not impossible to find an explanation for these because they do not correlate with any of the geology that has been mapped in this region. The sedimentary rocks exhibit a great lithologic diversity, sandstones, conglomerates, shales, and limestones being present.

METAMORPHIC ROCKS

PELONA SCHIST

Distribution and topographic expression. The Pelona schist occupies the middle part of the area lying east of San Francisquito Canyon. A few scattered patches of schist occur on the west side of the canyon, however, and they show that the stream occupying San Francisquito Canyon, when it was rejuvenated, was superposed on a somewhat unconformable layer.

The topographic expressions fo the schist areas present some striking features. The schist highlands to the east of San Francisquito Canyon represent remnants of a region in late maturity of the physioghaphic cycle. The maxium relief is generally under 300 feet, the stream valleys are wide and have gently sloping sides, and the hills have wide bases and smoothly rounded tops. The east face of San Francisquito Canyon in the vicinity of the old dam site shows gentle but definite changes in slope which in some places have formed sloping benches. Previous investigators have assigned various causes to explain this. Nickell[8] assigned the cause to the differential erosion of hard and soft layers in the schist. Clements[7] called attention to the landsliding on the slopes, some of which has happened in recent years. The present suthor has carefully examined this face of the canyon and found many irregular areas of gouge and breccia located at the inflection points of the spurs running down this face, indicative of faulting. This would explain the variation in height of the present gently sloping portions of the canyon wall. But an examination of the height of the principal sloping terrace platform shows it to be the same as the principal terrace in the Mint Canyon in the southern part of the area. There can be little doubt that they are related and represent periods of arrested downcutting of the San Francisquito stream. Landsliding has modified the canyon wall to some extent but the principal cause for the shelves is rejuvenation of the stream.

Lithology. The schist exposed in this area is a typical mica schist. Its color varies from light grey to dark bluish-grey to brownish-blue to dark blue-black. Weathering gives it a yellow stain. The Pelona schist exposed in southern California occupies an area of over 130 squares miles and contains in addition to a mica schist facies, greenstone schist, amphibole schist, quartzite, and limestone. However the schist in the area under investigation contains only the mica schist facies and no quartzites or limestone. Quartz veins are numerous, nevertheless, and characteristically swell up and then pinch out .The degree of metamorphismis constant through the formation. Simpson[9], in his report on the geology and mineral deposits of the Elizabeth Lake Quadrangle states that the presence of sode-rich plagioclase, epidote, zoisite, muscovite, actinolite, and chlorite indicate metamorphism of the mesozone, or zone of moderately high temperature. Thin sections of the schist exposed east of San

Framcosquito Canyon show the main mineral to be quartz, with successively smaller amounts of orthoclase and muscovite. Some biotite is also present. The quartz grains show an interlocking relationship characteristic of recrystallization, but they show rather violent wavey extinction and a cataclastic texture which suggests that after undergoing recrystallization as a consequence of an original thorough-going metamorphism, they were subjected to a second period of metamorphism not so intense as the first. Parallel orientation of the minerals is well developed, and the quartz bands are separated by abundant whisps of muscovite. The schist in the area is generally rather fresh except on the surface areas of the mature highlands and at the Mint Canyon contact.

<u>Structure.</u> The schist possesses a definite bedding, a flow cleavage parallel to the bedding, and an excellently developed set of master joints.* The sttitude of these joint sets as measured at various places in the schist is given in Table I.

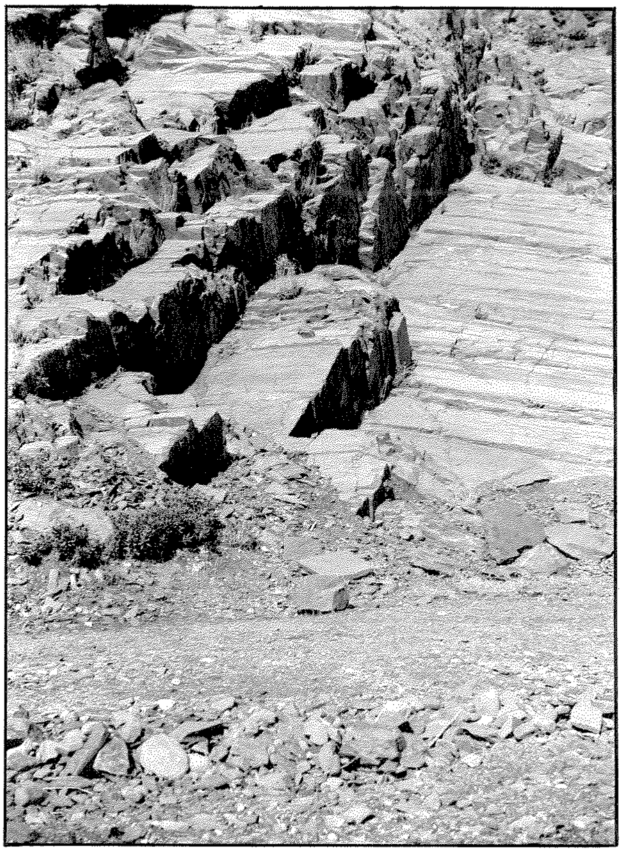
Table I.

Attitude of Joint Sets in the Pelona Schist

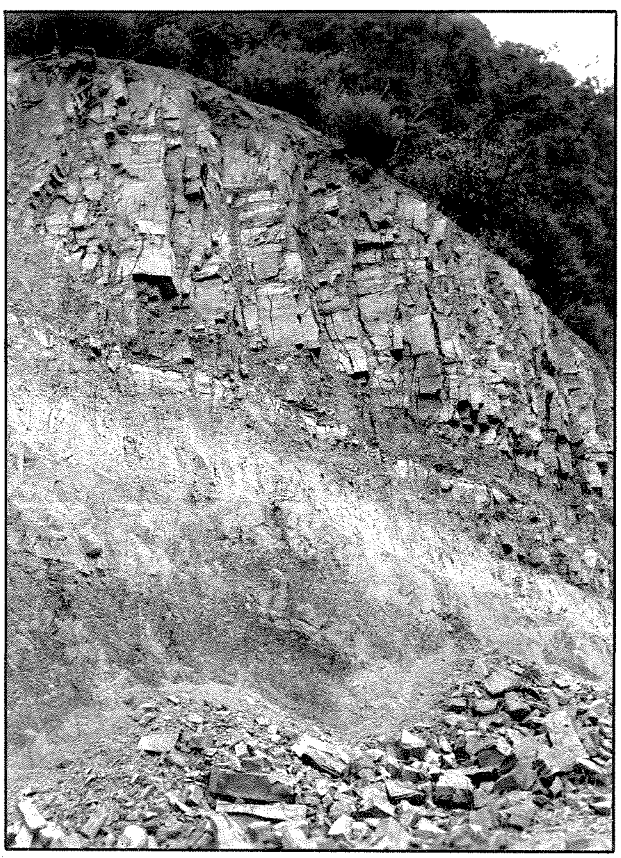
N52W 71NE	N37W 55SW	N4E 80NW
N37E 45SE	N45E 87SE	N77E 28SE
N25E 51NW*		N86W 53NE*

* Dip and strike at locality where jointing was measured

* SeePLATE VI



A. Jointing in the Pelona schist exposed in San Francisquito Canyon. Bedding planes are also well shown.



B. Jointing in hard silisified bed of Sespe, located at its northern extremity in the area.

The joints show smooth and evenly developed surfaces characteristic of the shear type of jointing. The attitude of the schist is variable over its whole extent, but the strike is generally about north fifty to sixty degrees east and the dips from sixty to eighty degrees and not uncommon. No definite axes of folding could be traced in the schist. Near the southeastern boarder of the schist tygmatic folding occurs.

Age and correlation. There has been much debate as to the age of the Pelona achist. Hershey[3], who gave it its name, first correlated it with the Abrams mice schist of Archean age in the Klamath region, believing these rocks to be the oldest exposed in the state. Later[4], he correlated the Pelona schist with both the Abrams schist and the Rand schist which he believed to be a continuation of the Pelona series. He called these rocks youngest Archean in age. Simpson[9] states that the Pelona schist is similar in lithology and structure to the Rand schist and he correlates the two using this evidence and the fact that lower Paleozoic ricks close to this region (within 100 miles) have not been metamorphosed or have been only locally metamorphosed by igneous intrusions to give the Pelona schist a pre-Cambrian age and metamorphism.

Origin. R.T.Hill[10] mentions that Tolman has considered the schist at the dam site to be a metamorphosed granite and believes that this explanation might hold for a large part of the schist, although he mentions that the presence of limestone lenses and areas of graphitic schist suggest a sedimentary origin for at least part of the schist. Later investigations[5,9], however, have shown fairly definitely that a large part of the schist, if not all of it , had a detreital origin, and therefore it represents a metasediment.

<u>Conclusions.</u> The Pelona schist in the area investigated is considered to be an original sedementary series of rocks laid fown and also metamorphosed in pre-Cambrian times. Its mineralogical composition suggests that the original sediment was an arkosic sandstone.

OLIGOCENE (?) SERIES

SESPE

Distribution and topographic expression. A series of rocks considered Oligocene in age and called the Sespe formation occupies the upper mortheastern part of the area. Its topographic expression is very similar to that of other formations except that resistant conglomerate beds form conspicuous outcrops on the hillsides. Sespe topography is also characterized by knobs of resistant conglomerate occuring on the summits of ridges and sometimes forming steep cliffs.*

Lithology. The Sespe beds as exposed in this area consist of conglomerates, sandstones and shales, with the conglomerates predomination at the southern end of the formation and grading into finer sediments northward. Their greatest thickness in the area is about 1,700 feet. A deep brownish red is the typical color of the formation although a bed of green sandstone occurs at the southwest extent of the formation and just below this lies a whitish silicified bed of sandstone showing well developed jointing.** The conglomerates are characteristically thick-bedden. The sandstone and shales are thin-bedded, however.

The conglomerates are made up mainly of sub-angular to angular fragments of a gabbtoic rock, a coarse-grained

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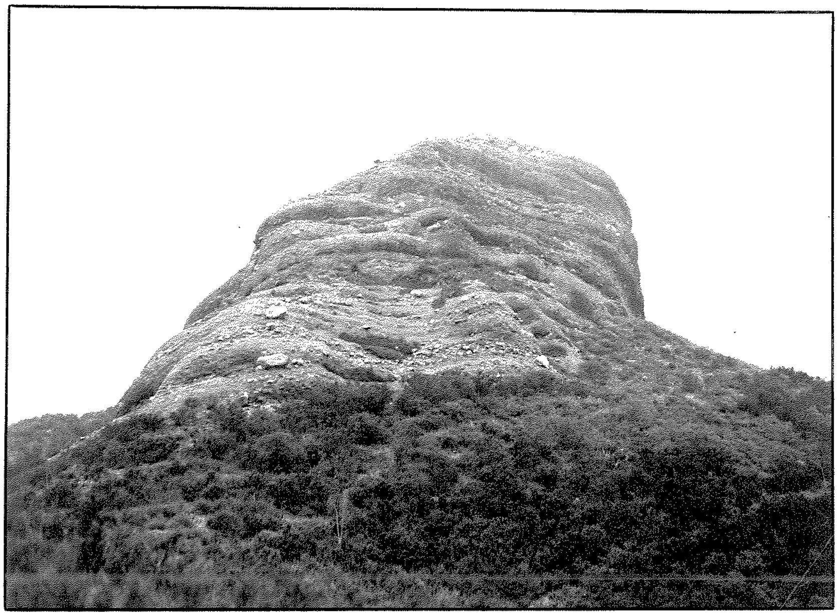
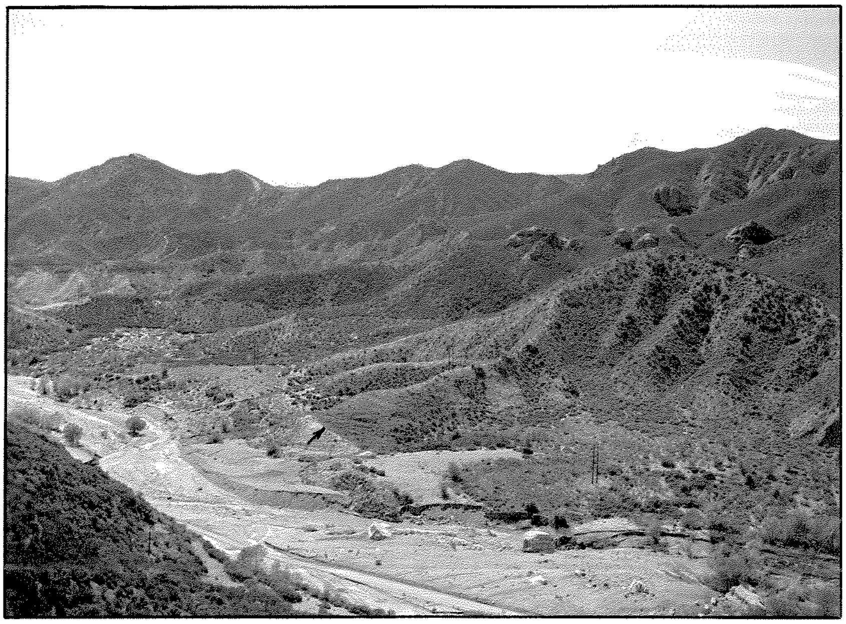
*See PLATES VII, VIII
** See PLATE VI

PLATE VII



A. Resistant knob of Sespe conglomerate on ridge between San Francisquito and Charlie Canyons. Thick bedding, poor sorting, and sub-angular nature of the sphaeroclasts is well shown.

PLATE VIII



A. View southwest looking down San Francisquito Canyon. Sespe overthrust excellently shown. Dark beds above arrow are Sespe, light beds below are Mint Canyon. Small block of schist underlies Sespe when the fault runs into the alluvium. The topographic expression of the Sespe ridge to the right of the picture is characteristic.

granitic rock containing abundant and large phenocrysts of feldspar, and quartzite. There is no sorting of any kind, no arrangement of anguclasts, and there are no stratafication planes. The anguclasts range in size from small pebbles to boulders several feet in diameter. The conglomerates are very well cemented, the main binder being calcite.

The sandstones of this formation are generally fine grained and thin bedded. A thin section of a typical sandstone shows it to be composed of angular to sub-angular particles of quartz and feldspar in the approximate ratio of five to six. There is no banding of the grains. The cement consists of a mixture of calcite and clay derived from the decomposition of the feldspar. Iron oxide is also present giving the sandstone its reddish-brown color. This rock made one of the foundation rests for the Saint Francis Dam, and the failure of the dam is directly traceable to the use of this rock as a foundation for a dam because from its very nature it is dissolved and softened by constant wetting."

The shales are soft, thin-bedded and contain abundant gypsum. A few small calcareous concretions were found scattered irregularly in the shale. The shale makes up only a small portion of the Sespe in this area.

<u>Environment of sedimentation.</u> The Sesps in this area represents conntinental sediments. From above mentioned

lithologic characters it is evident that the source for the sediments was to the south as shown by the arkosic nature of the sandstone and of the freshness of the feldspar in the conglomerate anguclasts. Abundant schist frafments in the formation show that the Pelona schist was exposed to erosion during Oligocene times. There is some difference of opinion as to this however. R.D. Reed[12] believes that moist conditions prevailed during the deposition of the Sespe and supports this view by showing occurences of arkosic sandstones in formations known to have been deposited in humid epochs.[14] The Sespe is here considered to have been laid down in an alluvial fan area at the south grading into playa conditions to the north. The land area supplying the large blocks of rock found in the southern part of the formation.

Relation to underlying rocks. The Sespe formation is thrust faulted over the Pelona schist and the Mint Canyon formations, the reverse nature of the fault being beautifully exhibited in San Francisquito Canyon where the flood wa ters from the Saint Francis Dam have swept clean the contact.* The fault has a reverse dip about fourty-five degrees, as observed in San Francisquito and Charlie Canyons. Its overthrust nature is indicated by the low reverse fault plane and by an isolated outlier of Sespe lying on the Mint Canyon in the northern central part of the area.

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* See PLATE VIII

Age and correltation. The age of the Sespe in the area is very uncertain due to the lack of fossil evidence. It is correlated on lithology and stratigraphic position. Elsewhere Sespe is known from vertebrate remains to range from upper Eocene through Oligocene.

PRE-MIOCENE

SAN FRANCISQUITO BRECCIA

Short mention is here made of a few very small patches of breccia which were found in the schist and which either have not been noticed before or have been entirely disregarded. The breccia consists entirely of angular material derived from the schist. The anguclasts range in size from a fraction of an inch up to nearly a foot in diameter. The schist fragments are jointed, showing the Pelona schist was jointed before this formation was laid down. The breccia is well cemented and very well compacted. The matrix which consists of small schist fragments of about the size of gravel particles does not make up much of the rock. The whole rock mass is exactly the same color as the schist. A few actinalite schist particles containing metacrysts of feldspar or cyanite occur in the breccia patches.

MIOCENE SERIES

MINT CANYON (LOWER-UPPER MIOCENE)

Distrubution and topographic expression. The Mint Canyon formation outcrops in a diagonal band running northwesterly across the area and thinning out in this direction. Its topographic expression changes greatly from the bottom of the formation to the top. The lower formation is characterized by badlands erosional features while the upper possesses smooth surfaces and steep cliffs.

Lithology. The Mint Canyon in the area can be divided into two rather definite lithologic units, a lower and an upper. The lower unit begins with a well-developed basal comglomerate consisting mainly of sub-angular rocks poorly assorted and cemented, and ranging in size from pebbles to rocks one foot in diameter. Its thickness varies through the area from almost nothing to over 100 feet. Near the schoolhouse in San Francisquito Canyon there is a limestone lens in the lower Mint Canyon which is about twenty feet above the contact with the Pelona schist. A thin section of this rock showed it to be made up equally of limestone and clay. The color of the lower Mint Canyon formation varies giving an effect like the Painted Desert. Reds, greys, blue-greys, and cream colores predominate. Sandstones and conglomerates make up the formation. They are poorly compacted, porous, and poorly cmented with calcite. Poorly developed torrential cross lamination is present in some of the coarse sandstones. The lower Mint Canyon is characterized by a hererogeneous lithology. Near its western boundary there occurs areas of of granitic blocks deposited with so little cementing material that the effect is that of a small granitic intrusion. The original shape of the constituent blocks has been lost through weathering. In other places the exclusive deposition of schist fragments has formed schist conglomerate pockets which are very conspicuous. The sandstones vary in coarseness rapidly both vertically and horozontally. Locally a few calcareous concretions are present. On the ridge between San Francisquito Canyon occur three small, isolated patches of a rock capping the Mint Canyon much altered by silicification and opalization. Dr. Campbell of the institute, who examined thin sections of this rock, is of the opinion that they represent an intensive study of these rocks so no definite conclusions can be drawn from their occurence. Further study of thse small remnants would undoubtedly be worth while.

The upper Mint Canyon is strikingly different from the lower with which it is comformable. It is a light brown color ove its whole extent. Its lithology is also constant,* consisting of irregularly intersperse coarse sandstones and conglomerates. The conglomerates show no sorting, sandstones are sub-rounded, and they occur as irregular lenses in the sandstone layers. They are separated from the sandstone by very indistinct bedding planes indicative or comtemporaneous deposition and erosion conditions existing on floodplains. The conglomerates consists mainly of quartize and well cemented sandstone sphaeroclasts ranging in size from pebbles

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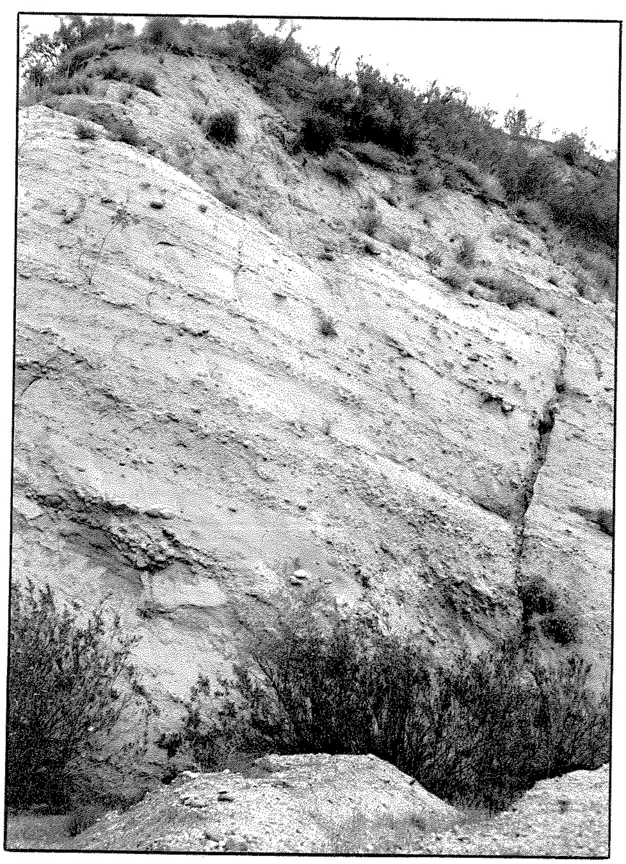
* See PLATE IX

up to one foot in diameter. The upper Mint Canyon formation shows a wide variation in the amount of cementing action by calcite. Some sandstone layers are little better compacted and hardened than some beach sands. At other places, however, both conglomerates and sandstones are well cemented. The characteristic features of the upper Mint Canyon are its massive bedding and regularity of lithology both vertically and horozontally.

Environment of sedimentation. The Mint Canyon formation in contrast to the Sespe is composed of arenaceous sandstones, indicative of a different realm of environment, although it too represents a land laid formation as attested by its lithologic character and the presence of vertebrate found in it. The variation in color of the lower member suggests a strong variation in climate while the upper member suggests constant climatic conditions. Torrential crosslamination and the irregular lensing of the conglomerates in the sandstones is indicative of floodplain conditions. The sea could not have been very far to the south at this time and the Mint Canyon was probably laid down in a broad floodplain running into the sea, for Clements[7] who has done mapping of the southern part of the Tejon Quadrangle found that the basal conglomerate of the Mint Canyon graded westward into the littoral zone of marine sedimentation. Climatic conditions were probably semi-arid but they certainly were more moist than when the Sespe was laid down. Abundance of schist in sediments shows that the Pelona schist was exposed to erosion during the deposition of the Mint Canyon.

PLATE IX

A. Lower Mint Canyon beds exposed on west side of San Francisquito Creek. The badlands type of erosion shows up well in these soft gravelly beds. Pelona schist to right of dotted line.



B. Characteristic appearance of upper Mint Canyon beds. Massive bedding and lenticular layers of conglomerate indicative of contemporaneous erosion and deposition.

Relation to underlying rocks. The Mint Canyon overlies the Pelona schist with a depositional contact , a well developed basal conglomerate being present.

Age and correlation. The presence of a vertebrate fauna in the Mint Canyon formation which is characteristic of upper-middle Miocene or lower-upper Miocene and the stratigraphic relationship of the Mint Canyon to other formations, such as the Modelo, which overlies it, whose age is definitely determinable by invertebrate fossils, fairly definitely places the age of the Mint Canyon as lower-upper Miocene in age. Maxon* believes that the lower Mint Canyon probably represents middle Miocene times.

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* Communicated

MODELO (UPPER MIOCENE)

Distribution and topographic expression. The Modelo formation takes up the whole western half of the area. Its topographic expression is characterized by generally smooth slopes. Landsliding is not infrequent in the shales and mudstones, and after heavy rains small local mudflows are formed.

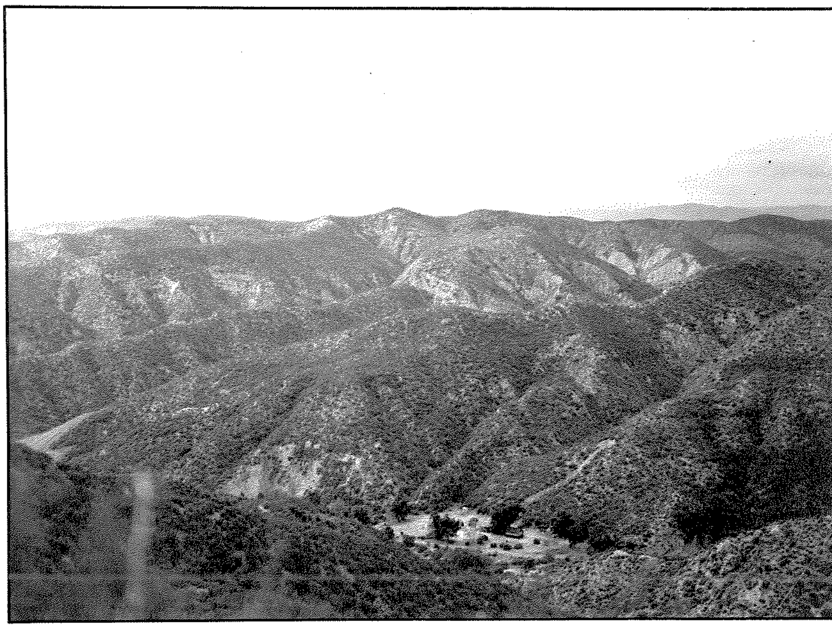
Lithology. At the base of the Modelo occurs a pebble conglomerate showing very little sorting and no stratification. It is poorlu cemented. The thickness of this basal conglomerate is variable; it ranges in thickness from about ten feet to around one hundred feet. The pebbles that compose it are chiefly rather well rounded and cemented sandstones which seem to have some mainly from the Mint Canyon, and this is a strong argument in favor of the contested view that the Mint Canyon and Modelo formations are unconformable. The remainder of the formation is mainly made up of punky, friable shales and mudstones, highly gypsiferous, and having a vairable though predominently thin bedding. Here and there conglomerates occur which sometimes are quite thick, but they make up a negligable fraction of the whole formation. They are probable in the nature of lenses in the shale. No silicified or organic shales were encountered, and the formation as a whole is quite porous and poorly cemented. The Modelo formation is buff colored and its thickness in the area is about 5,000 feet.

Relation to underlying rocks. It is the view ofthe author that the Modelo unconformably overlies the Mint Canyon. This is shown by the nature of the basal conglomerate discussed above, the uneven and irregular surface of contact between the Modelo and the Mint Canyon, and by the comparison of the outcrop of a prominent bed in the Modelo and the Modelo-Mint Canyon contact on the spurs of a steep valley wall where they both occur near to one another, but not parallel to one another. Strong evidence for an unconformity is also furnished by the overlapping relationships between the Modelo and the Mint Canyon. The Modelo overlaps the Mint Canyon to the west as shown by the map and by Clements[7] who found that to the west where the Mint Canyon pinches out, its place is taken by marine Modelo.

Environment of sedimentation. During upper Miocene times the seas occupied the southwestern part of the area, the strand line running diagonally across the area. The land mass stood to the northeast. The basal conglomerate was deposited in the littoral realm of sedimentation while the shales, which make up the main portion of the formation, were deposited in the seaward side of the neritic realm of sedimentation.

Age and correlation. No diagnostic fossils have been found in the Modelo in this region but from the lithologic correlation and stratigraphic position of the formation its age is fairly definitely fixed as being upper Miocene. A scanty fossil assemblage has been found by Kew[13] south of the eastern portion of the author's area which indicates upper Miocene age.

A. Old landslide in Modelo shale beds exposed on west side of lower San Francisquito Creek.



A. Looking southwest across Charlie Canyon just below San Francisquito trail. Anticline in Modelo beds.

STRUCTURAL GEOLOGY

REGIONAL

The structural geology of the western part of the San Gabriels is very complicated. The San Andreas, master fault of California, bounds the northern part of the San Gabriels, the Sierra Madre fault the southern part. Both these faults, however, are not simple, single great fractures of the earth's crust. Each represents a complex fault system with differential movement on various faults of the system at different times, giving rise to complex structural relationships. R.T. Hill[10] has shown that the faults of the San Andreas system can be grouped into three systems on the basis of their attitudes — those parallel to the San Andreas, those running in an east-west direction, and those in a northeast-southwest direction. Folding is abundant to the north of the Santa Clara Valley, the axes trending generally east-west in the vicinity of Piru Creek and northeast-southwest in the San Francisquito Canyon region. The axes of folding are highly irregular as to direction, and no definite pattern of folding is present.

LOCAL

Faulting. One large fault, an overthrust, occurs in the area. A few small fractures occur, but on the whole the area is quite free from faulting, a rather strange fact considering the San Andreas is only fifteen miles to the north. The Sespe overthrust has a dip of about forty-five degrees generally northward and is quite free from associated faulting.

Folding. Several folds were mapped in the area, the largest of which is the anticline between Charlie and Bitter Creeks. Due to the heterogeneous rock assemblage axes of folding are not pervasive, and the folds generally are not very symmetrical. The folding appears to be of the concentric type, and is rather gentle in the southern part of the area, the dips not being over twenty degrees. A prominent anticline in the Sespe was mapped whose flanks dipped off at angles of sixty to seventy degrees. The folding is not well developed enough and exposed over a sufficiently long area to make a determination of whether they plunged or not. The axes of folding are all nearly parallel to each other.

Jointing. The jointing in the schist has been mentioned. Only the time of jointing and its structural implications will be discussed here. Boulders of Pelona schist occuring in the basal conblomerate of the Mint Canyon are jointed showing that the time of jointing in the schist was at least pre-Mint Canyon. Further, the schist anguclasts which make up the old breccia exposed in a few places on the Pelona schist are alsojointed so that the age of jointing is pre-San Francisquito breccia. In the northwestern part of the Sespe formation there is a hard brittle silicified bed* exhibiting a well developed joint system whose attitudes are N35°E89°NW and N54°W60°SW. These attitudes correspond closely

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*See PLATE VI

with those of the jointing in the Pelona schist* and indicate that forces producing the jointing have acted in approximately the same direction from the San Francisquito breccia to Sespe times.

<u>Interpretation of structure.</u> In assigning ans orientating forces to explain the structure of the area four things must be bourne in mine. First, and most important, is that the San Andreas to the north is the dominent structural feature of the region. Forces must be assigned which will be in harmony with forces necessary to produce this great strike-slip fault. The Sespe overthrust, folding, and the joint system are the other three structural features to be accounted for. Vickery[15] has advanced evidence based on associated folding to show that the thrust forces were exerted at an approximate angle of N40E and were horozontal. Assuming such a force acted in this area it would explain the Sespe overthrust which has moved in a southwest direction over the area. The joint should be vertical and have strikes of N5W and N85E. Some of the jointing in the schist comes very close to this.** However it is not vertical. The axes of folding present in the area could have been formed by such an assigned force. The inclined position of the joint planes could be explained as a result of folding of the schist after vertical joints were formed in it. The

*See Table I, p 18
** See Table I, p 18

uniformity of the altitudes of the jointing in the Pelona schist throught the area studied in contrast to the strong variation in the attitude of the bedding in the schist argues against this view however. Thus the conclusion to be drawn is that the forces must not have been horozontal but inclined at some angle to the horozontal. Their direction of application was about southwest and their direction was about N10E.

HISTORICAL GEOLOGY

Only those events affecting the area investigation will be mentioned.

Pro-Cambrian.

1. The sediments now making up the Pelona schist were deposited, tilted, metamorphosed.
2. Perhaps one more period of metamorphism of the Pelona schist.

Jurassic.

3. Quartz veins associated with the emplacement of a granite stock to the north intruded into Pelona schist. Erosion

Pre-Miocene.

4. San Francisquito breccia deposited, thoroughly compacted and cemented. Then greatly eroded.

Miocene.

5. Mint Canyon deposited, area tilted and folded, Mint Canyon eroded. Some volcnaic activity(?)
6. Sea encroached upon Mint Canyon from the southwest.
7. Modelo deposited in a neritic environment, area folded, the axes of folding not changing. Erosion

Close of Miocene.

8. Sespe thrust over Mint Canyon then eroded back.

Pleistocene.

9. Region underwent uplift of several hundred feet without tilting. Further periods of uplift without followed. Streams were entrenched in their courses and the present drainage pattern developed.

ECONOMIC CONSIDERATIONS

The area contains nothing of much economic value. Flagstones of schist are quarried in San Francisquito Canyon. The quartz veins in the schist carry a poor gold content. No oil has been discovered in the Modelo

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EXPLANATION

SEDIMENTARY ROCKS

Qal

Alluvium
(stream deposits)

UNCONFORMITY

Qt

Terrace deposits
(unconsolidated sands, gravels, and conglomerates)

UNCONFORMITY

Tm

Modelo formation
(buff marine sandstones and gypsiferous shales, few conglomerate lenses)

UNCONFORMITY

Tmc

Mint Canyon formation
(non-marine variegated sandstones and conglomerates in lower member, buff massive sandstones with irregular lenses of conglomerates in upper member)

Ts

Sespe formation
(red non-marine coarse conglomerates and sandstones, the conglomerates composed of fragments of granitic and metamorphic rocks)

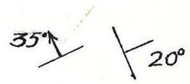
?

San Francisquito breccia
(grey compact mass of unsorted schist fragments firmly cemented)

METAMORPHIC ROCKS

Ps

Pelona schist
(quartz-mica schist with associated ribboned quartz veins)



Strike and dip,
headed arrow accurate,
unheaded arrow approximate

Axis of anticline

Axis of syncline

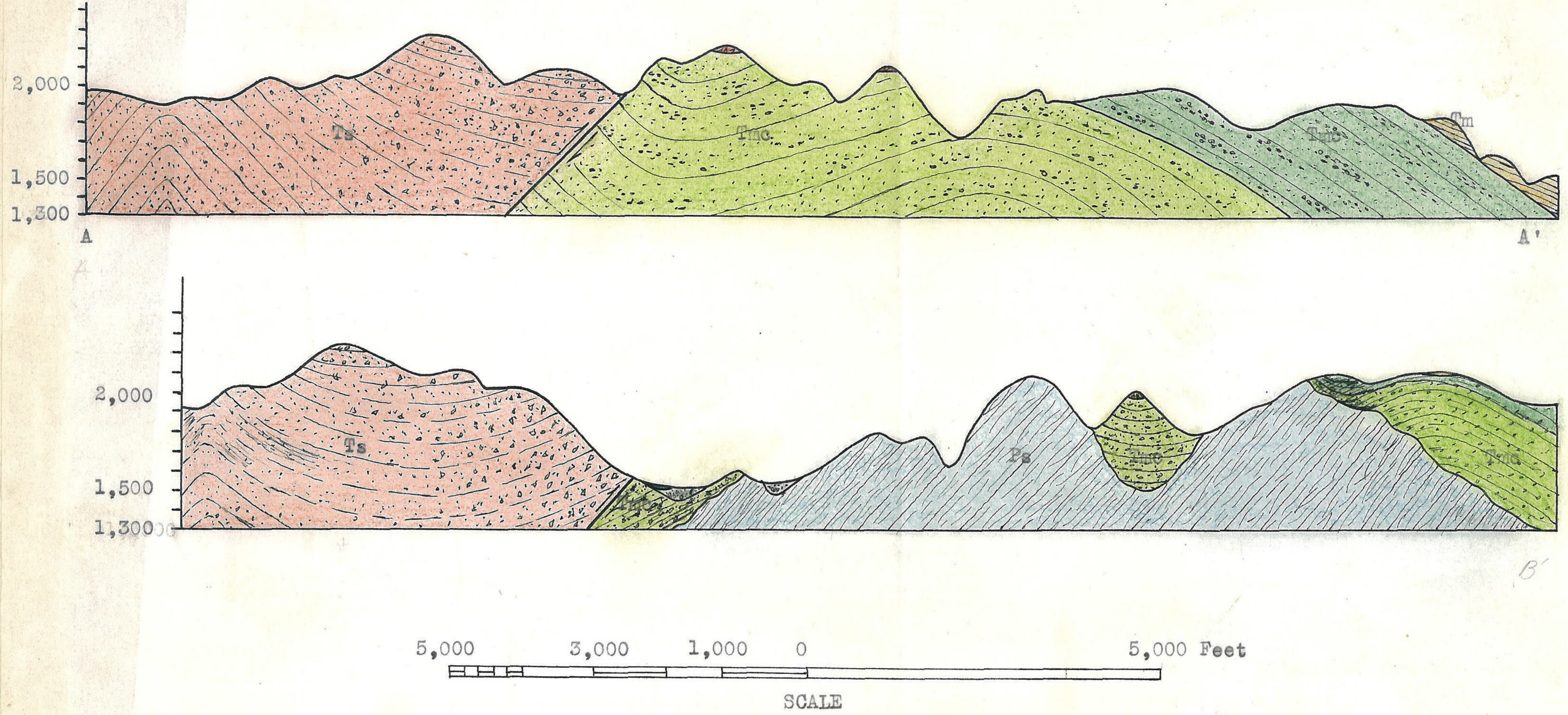
⊕

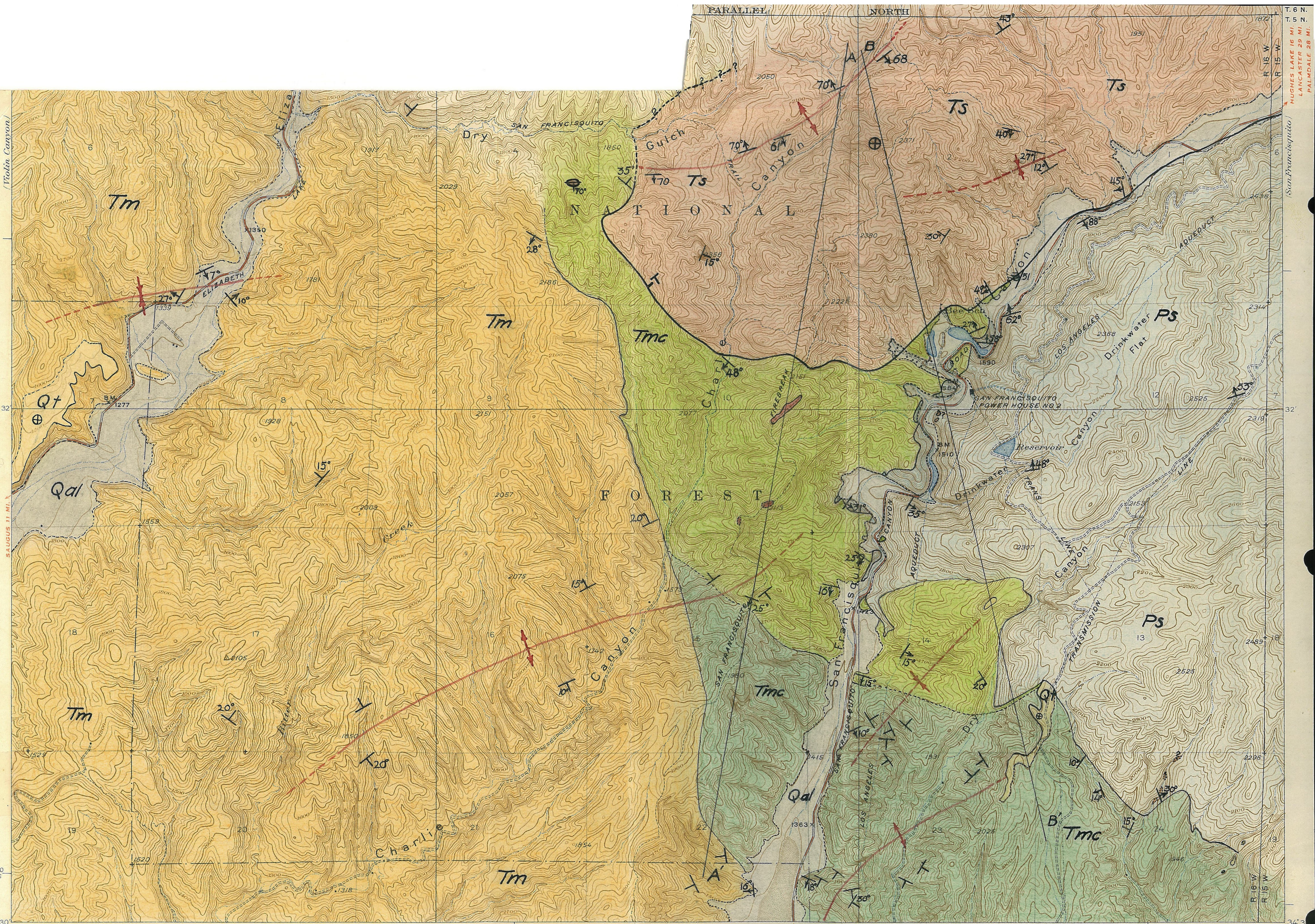
Horozontal bedding

Overthrust side of thrust fault

Boundaries between formations

STRUCTURE SECTION





Topography by C.W.H.Nessler
Control by U.S.Geological Survey
Surveyed in 1931

TRUE NORTH
MAGNETIC NORTH
16°
APPROXIMATE MEAN DECLINATION 1931

Scale 1/24000

1 ½ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Contour interval 25 feet
Datum is mean sea level

Land lines pertaining to T. 6 N. Rs. 15 and 16 W., are omitted because land plats and topography cannot be reconciled.

Polyconic projection. North American datum
5000 yard grid based upon U.S. zone system, G

HARD IMPERVIOUSLY SURFACED ROADS
OTHER MAIN TRAVELED ROADS
INFORMATION FURNISHED BY LOS ANGELES COUNTY, 1934

RED MOUNTAIN, CALIF.