THE GEOLOGY OF A PORTION OF THE HUMPHREYS QUADRANGLE,, CALIFORNIA

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A B S T R A C T

Included in the tract studied are four sedimentary formations and the recent alluvium. These formations are in the order of their deposition: the Mint Canyon, the Modelo, the Saugus, and the old alluvium or terrace deposits. The Mint Canyon and the Saugus formations are both of terrestrial origin; the Modelo is of marine. The area is of especial interest because each of the beds rests unconformably on the next under it, and because the boundary of the basin of deposition is included in its extent. This evidences itself with the thinning of the Modelo and the overlapping of the Saugus onto the Mint Canyon. There has also been deformation and minor faulting, especially in the northern portion.

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I N T R O D U C T I O N

Location and Size of Area

The region considered in this report is a tract of about five square miles situated in the central portion of the Humphreys Quadrangle in Southern California. The area lies between the Plum Canyon Road and the Bouquet Canyon Road extending from their juncture northward to the Vasques Canyon Road. The whole region lies about ten miles north-east of the town of Saugus, which is about thirty miles from Los Angeles on U.S. Highway 6, the Mint Canyon Highway. From Pasadena the area is reached by traveling along Foothill Boulevard westward to its junction with the Mint Canyon Highway just north of the city of San Fernando. The Mint Canyon Highway is then followed to its junction with the Bouquet Canyon Road just north of the town of Saugus. Approximately four miles up the Bouquet Canyon Road the Plum Canyon Road branches to the eastward. This marks the southern and eastern boundaries of the area.

Purpose and Method of Study

This problem was undertaken as a requisite to attaining the degree of Bachelor of Science from the California Institute of Technology. The purpose being to give to the student the opportunity of undertaking a piece of original and independent research and at the same time to give him the benefit

of expert advice in the places of the greatest difficulty. The method of study has been to run a Brunton Compass traverse over the entire area mapping the formations and the structures on a photographically enlarged section of the U.S. C.S. topographic sheet. Data was entered on the map as rapidly as it was collected and any interesting facts were also entered in a field notebook kept for that purpose. The field work was done in the academic year 1938-1939.

PHYSICAL CONDITIONS

RELIEF AND ELEVATIONS

The general region is in the hills which lie between the San Gabriel Mountains and the Sierra Pelona Ridge. The entire region is marked by downcutting streams and youthful topography. The relief of this particular area varies from moderate in the southern portion to extreme in the northern portion where a 300 foot cliff and badlands have developed. The maximum elevation of the area is 2318 feet at the triangulation marker in the east-central part and the minimum elevation is about 1353 feet in Bouquet Canyon in the extreme southwest.

TOPOGRAPHY

The topography is the result of the uplift of an old, mature land surface and its dissection. The old land surface

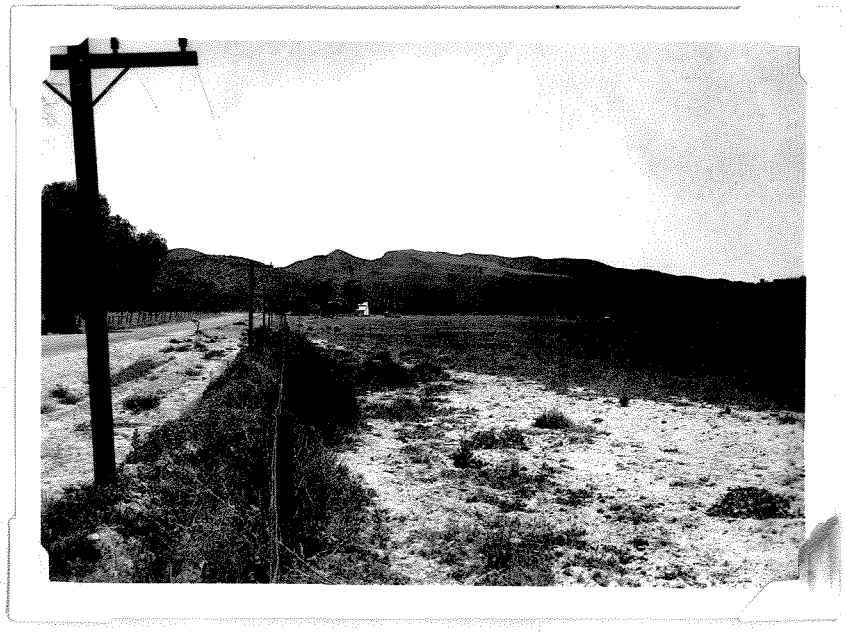

Plate I Old land surface in Plum Canyon

is present in several places in the territory. In the northern part it is present, though strepped, as a large flat-topped, internally drained portion on the divide between Mint and Bouquet Canyons. It also accurs as the gently sloping hillsides of remarkably even dip which are a feature of the southwestern corner of the area.

In the northern and central parts of the region the topography is typically badland. This is formed by the erosion of the poorly lithefied Mint Canyon formation. The topography is featured by cliffs and deep gullies which are as steep as

Plate II Badland topography with an ash bed forming a ridge

the angle of repose of the rocks in which they are cut. In this region there are several ash beds which control topography to a marked degree. These ash beds stand out as ridge forming members which stretch for about a mile across the northern

part of the area. Other resistant beds also tend to form ridges, but the ash are the most prominent.

The streams are mostly in a youthful stage with steep 'V' shaped canyons. In the soft Mint Canyon formation the streams cut downward very rapidly and then reach grade giving them a concentration of grade near their heads. Plum Creek in its upper reaches has a concave profile due to the old land surface on which it originates and which it follows for a distance.

DRAINAGE

The northern part of the area drains westward into Bouquet Canyon which in this place has a southwest drainage. The extreme northeastern tip of the area drains into Mint Canyon. The southern portion of the area drains into Plum Creek which originates on the plateau to the north and soon cuts itself a course first south, then west to join Bouquet Canyon. The westward running portion of Plum Canyon and Bouquet Canyon are wide canyons filled with alluvial material as is common in semi-arid regions. The streams, intermittant in type, become raging torrents in the rainy season, and soon pick up a full load of detritus in their steepest parts. On reaching the graded section the stream drops much of this material giving rise to an alluvial deposit in its valley which is alternately cut and filled as the stream swings across it. For the time being both Plum and Bouquet Canyons are

being cut more than they are being filled.

Both Bouquet and Mint Canyons empty into the Santa Clara River, which pursues a westerly course to the Pacific Ocean.

VEGETATION AND CULTURE

The vegetation of the area is typical of semi-arid regions. It is so called chaparral with the characteristic assemblage of sages, cacti, yucca, manzanita, greasewood, buckwheat, bunchgrass, scrub oak, etc. which is so common on Southern California hillsides.

Throughout the area there are scattered houses, often absented, which are as a rule connected with small farms. The farms occupy stream bottoms and the old alluvium, and are therefore very limited in extent. The floors of Bouquet and Plum Canyons, the old alluvium, and the ampitheater in the north are the chief agricultural regions. Cattle and horses are allowed to range over much of the area; pigs are farmed in one valley in the south. There are some scattered homes which are independent of any farming activity, and also independent of topography. Because of the prevalent ill-feeling toward trespassers, it is advisable to see as many of the large land holders as possible before trespassing.

EXPOSURES

The exposures in much of the area are very poor, owing to the softness of the rock and to the vegetation. In the

badlands the exposures are excellent, but are almost inaccessible. Throughout the area dips and strikes are very hard to obtain, as a rule, because of the coarsely sorted nature of the beds.

STRATIGRAPHY AND PETROLOGY

MINT CANYON

The lowest member in the series represented in the area studied is the Mint Canyon. This formation, named by Kew, is very well exposed in the northern part of the area. This exposure is in direct proximity to the type locality in Mint

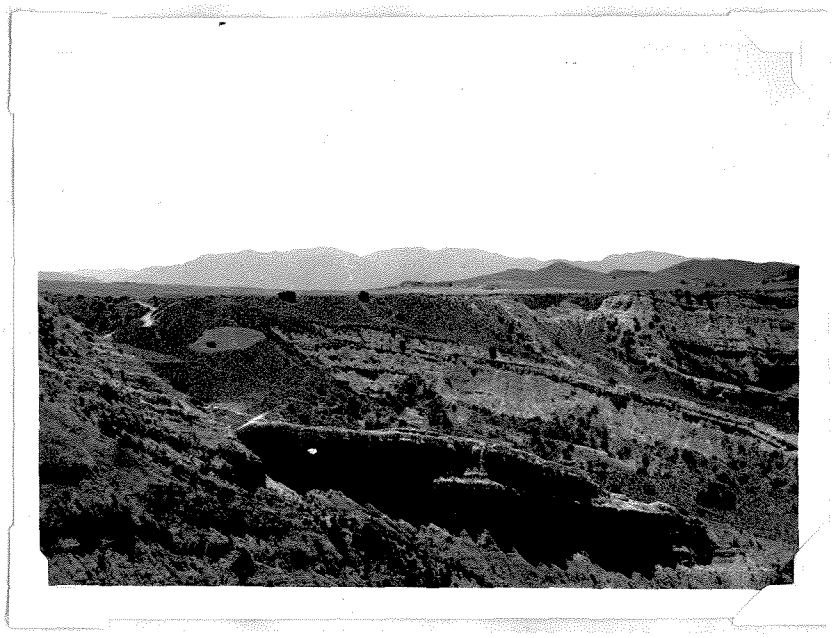

Plate III Mint Canyon formation and the flat at the head of Plum Canyon

Canyon. The age has been determined as Upper Miocene from the vertebrate fossils found in the area by Maxson. Stirton wishes to place the formation in the Pliocene, but the stratigraphy in relation to the overlying, generally accepted upper-Miocene Modelo as well as the fossil record formation precludes that possibility. Numerous horizons carry vertebrate fossil

remains. All the fossils in the area, however, have been fragmentary as they have, as a rule, been transported. Fragmentary horse teeth and the proximal phalange of a camel, Alticamellus species (Upper Miocene), were found by the author at the locality listed on the map as Fl. Numerous fresh water gastropods, Paludestrina imitator Pillsbury, are present in this formation, but they are of no importance in dating the formation.

The Mint Canyon formation is made up of interbedded sandstones, shales, ash, and conglomerates. The beds are discontinuous and subject to lateral change. Two zones of beds may be distinguished in this area. The lower zone made up of sandstones and shales for the most part, with some conglomerate, is slightly colored. The coloring is predominately brown with some reds and yellows. These slightly colored beds lie below the lower ash beds in the northern part of the area. Above these there is a zone of beds which are predominately white in color. Interbedded with the sediments are eight easily distinguishable ash beds. The lower six ash beds are made up of crystalline ash; the upper two are almost purely nitric. The crystalline ash beds occur as three sets of two each. Each ash bed of a pair is separated from the other by from 25 to 75 feet of sandstones and conglomerates. The pairs are separated from each other by several hundred feet of varied sediments. The ash beds are all lensing out to the eastward.

The individual beds become very lenticular and some show a gradual change to sandstone.

Plate IV A cliff in Bouquet Canyon showing the lensing out of an ash bed

The sandstones of the Mint Canyon are very arkosic with feldspar predominating over quartz in some cases. The range in grain size from siltstones to conglomerates with a medium coarse grained average. Some of the beds are very micaceous and all carry some mica. Some of the sandstones, especially those in the lower zone have many concretions. The cementing medium in the concretion of the lower zones seems to be iron oxide, and where concretions occur in the higher zone it seems to be gypsum. As a rule the sandstones in the Mint Canyon are very poorly lithified and generally show little cementation. The compaction in the sandstones is moderate and

is almost the sole lithifying force.

The shales in the Mint Canyon are generally coarse grained, of about mudstone composition. These shales are not compact and are very easily eroded. On exposure they tend to become clayey mud which cracks and completely hides the original structure. In a very few places there are fine grained compact shales, but these are quite rare. As a rule the shale is subordinate in importance to sandstone and conglomerate in this formation.

The conglomerate beds contain rocks of all varieties, present in boulders of all sizes. Perhaps the commonest fragmental rocks in the Mint Canyon are lava boulders seldom more than eight to twelve inches in their longest dimension. Fragments of anorthosite, granite, gneiss, schist, conglomerate, sandstone, shale, and quartz are also common. Some of the conglomerates are concretionary, containing almost perfectly round, flat sandstone concretions.

The formation as a whole contains some gypsum and no lime with the exception of rather extensive caliche deposits seemingly parallel to the old land surface.

MODELO FORMATION

The Modelo formation of Upper Miocene Age overlies unconformably the Mint Canyon in the southern part of the area. This formation is named for its type locality in Modelo Canyon where it is an extensive shale and sandstone series several

thousand feet thick. In the type locality there is no fossil record so the Modelo has been dated by its strategraphic relations with formations of known age. It is a marine formation and is the only one in this region. Because of this fact the finding of marine fossils definitely places an unknown outcrop in the Modelo. The occurrence in the area under study attains a maximum thickness of 200 feet in the southwestern part of the area and thins out gradually to the southwest, eventually disappearing entirely.

The basal member of the Modelo is a well cemented, lava bearing conglomerate member which varies in thickness and constitution as it extends northward. The maximum thickness of this conglomerate member is about 25 feet in the cliff in the western area. As the bed thins, it undergoes a change in composition, becoming more sandy, less well lithified and very like the Mint Canyon. Above this basal member are a series of fine grained sandstones; scaly, finely bedded shales; and coarse sandstones which complete the thickness of the formation in this area. These beds are truncated under the Saugus which laps over the Modelo onto the Mint Canyon to the northeast.

The rock composition of the Modelo is almost identical with that of the Mint Canyon and it is only by the use of color changes and a few other criteria that they may be distinguished. The Mint Canyon is a predominately white formation and the lower members of the Modelo are brown thus giving a means of differentiation. Higher in the Modelo section the

sediments become a lighter brown and white (a yellow-white as opposed to the grey-white of the Mint Canyon). The Modelo is arkosic, predominately coarse grained sandstones with some sandy shales and the basal conglomerate. It may be distinguished in scattered outcrops by shell fragments, particles of carbonized wood, gypsum encased pebbles, and the existence of any lime, other than caliche. As a rule the Modelo is quite well lithified and is much more resistant toerosion than the Mint Canyon.

A pecten of indistinguishable species was found at the spot marked F2 on the map anda large collection of marine fossils was collected in Plum Canyon at the spot marked F3. The existence of Modelo at F4 was proven by the finding of a piece of limestone in the arkose that may represent a relict algal reef or thick, fractured shell (specimen P.C. 12). The fossils have not yet been classified though they contain specimens of two types of Gastropods, worm borings and a mollusk of unknown superfamily (P.C. suite).

SAUGUS

The Saugus formation is the name given by Kew to extensive land and marine laid deposits of upper Pliocene and lower Pleistocene time. These deposits are exposed very well in Soledad Canyon near the town of Saugus. In this areathe Saugus is limited to about 200 feet of coarsely sorted gravels and sands which are slightly lithified. They occur along the crest of

the central ridge and under the alluvium on the southern slopes of this area. The basal member of the Saugus on the exposed cliff face is a bed of coarsely sorted conglomerate of

Plate V Cliff in Bouquet Canyon exposing the Saugus-Mint Canyon unconformity

a brown color. This overlies directly a bed in the Mint Canyon which is red, colored partly by wash and partly by its own inherent coloring matter. The beds which succeed this are interbedded sands and gravels all generally colored brown. The rock fragments making up this formation are generally the same as those in the Mint Canyon. This would indicate that the formation represents a reworking of the Mint Canyon or a continued supply of detritus from the same sources. Because the fragments are generally smaller and more decomposed, it is probably reworked material.

OLD ALLUVIUM

This material is the detritus of the Saugus and Mint Canyon formations in the earlier erosional cycle. It is present on the broad sloping hillsides north of Plum Canyon and on the top of the raised closed basin on the eastern boundary of the area. It is present in other places in the area but the

Plate VI The old land surface on the flats at the head of Plum Canyon

occurences are either too small or too uncertain to map. On the table land the alluvium was deposited on the beveled edges of the Mint Canyon and then most of it was stripped off leaving only the bottom layers and a well developed zone of caliche just below the surface. Through some deformation attendent on the uplift of the area this was made into a small perched basin which occupies the divide between Bouquet and Mint Canyons.

In the southern portion of the area I have mapped agood deal of old alluvium. There is a question as to whether this is actually alluvium or merely dip slopes of Saugus. Because of the smooth nature of the general topography, because the stream cuts showed no evidences of lithification, andbecause it obscures all the structure which is traceable to its boundaries I have mapped this as alluvium. In channel cuts along Plum Canyon the cross bedded, lenticular nature of the gravels seems to authenticate this. The boundaries between Saugus and alluvium are very difficult to place exactly, so I have placed them as accurately as I could and dotted the contacts.

RECENT ALLUVIUM

In all the larger stream beds there is deposited alluvium arising from the present erosional cycle. This alluvium is composed predominately of light colored sands and gravels with some silt and almost no clay. Much of this is being utilized for truck gardening and general farming.

GEOLOGIC STRUCTURE

REGIONAL STRUCTURE

This area lies in the east-west trending portion of the California Coast Ranges and is, as a consequence controlled by the San Andreas Rift which passes about twenty miles to the north. To the south of the area is the San Gabriel Fault and south of it the Sierra Madre Fault which raised the San Gabriel Mountains. Some geologists have likened the San Gabriel Mountains to a fault prism pressed up between the San Andreas and the Sierra Madre Faults. If this is the case the same compressive forces also deformed the entire region. This also would explain the faulting in the area. Whatever the cause, there was a definite compressive force operative in ageneral north-south direction to deform the area. Perhaps the most important structure in the region is the thinning out of the beds as they continue northward with the ultimate disappearance of first the Modelo andthen the Saugus. This was brought about partially by the original basin of deposition and partly by erosional periods between the deposition of the various formations. There was a large basin of deposition which received detritus throughout the Miocene and Pliocene. This basin was terminated on its northern side either in, or close to the area under discussion. A sequence of depositional and erosional cycles with slight deformation in between then sufficed to give the thinned structure which may be considered original.

FOLDING

There has been quite extensive folding in the area with one major structure dominating the deformation. This structure is on limb of an anticline or syncline which runs in a north easterly direction and dips slightly to the west. Superimposed on this feature are several minor folds which are of slight importance.

FAULTING

There has been much faulting in the area, especially in the northern portion but it is of comparatively small importance and displacement.

Plate VII Displacement of an ash bed on a minor fault

Because most of these faults are included entirely in the Mint Canyon formation it is necessary to map small units of that formation in order to find them all and place them accurately. Since that exactitude is beyond the scope of this paper there have been many of the smaller faults missed in the field mappings. In some places there are very complex minor faulting problems which are further complicated by the nature of the outcrops which often are two dimensional, being exposed only on a precipitous cliff and in poorly lithified material.

The displacement on these faults is of a small magnitude, with the largest not being over 100 feet horizontal displacement. The type of fault varies from strike slip to hinge and one place a syncline just broke under the strain to give a fault of little or no displacement.

GEOLOGIC HISTORY

The geologic history of the area begins in the Upper Miocene, at which time the Mint Canyon formation, a series of typical lacustrian deposits were being formed. The lake waters were inhabited by small gastropods, Paludestrina imitator Pillsbury, and bryozoa which were included in the sands and muds in which they lived. The calm depositional sequence was broken by periods of recurrent, explosive volcanic activity which deposited extensive ash beds over the lake bottom. The deposition was rapid enough to produce beds of pure ash. Between the periods of explosive activity deposition continued as before. Camels (Alticamellus), horses, (Merychippus, Protohippus), and other land animals were occasionally washed into the lake and were incorporated in the sediments. This period of deposition was ended by the elevation, tilting, and deformation of the newly formed beds which exposed them to erosion.

Later in the Miocene the entire region again subsided and the sea encroached on the land. In the marine basin thus formed, there then occured extensive sedimentation, the Modelo formation. Most of the Modelo sediments in the area were deposited in the shallow waters near shore. The sea level fluctuated, however, and part of the sediments were laid down under deeper water conditions. Molluscs (Pectens, Lucenacea, etc.), gastropods, and worms lived on the muddy bottom at one stage in this period, but changing conditions made them disappear.

In post Miocene time the entire region underwent uplift, deformation (folding and faulting) and tilting, followed by an erosional period. This erosional period beveled both the Modelo and the Mint Canyon to a practically plane surface. Following this erosional cycle, the land once again subsided and the region became a depositional basin again.

In the very late Pliocene and early Pleistocene deposition of the Saugus formation occured in this terrestrial basin. The sediments thus formed lapped over the Modelo onto the bevelled Mint Canyon. These sediments were derived almost entirely from the earlier beds which it overlies.

Following this early Pleistocene sedimentation, there was a period of slight deformation and uplift which once again brought the region up to be eroded. The uplifted territory was eroded to the stage of late maturity and alluvium covered much of the country when once again uplift occured. This uplift, accompanied by tilting, lifted the old land surface up as much as 500 feet above Bouquet Canyon.

In the present erosional cycle, the canyons are eating their way back into the uplifted rocks and are again filling their floors with alluvium.

CROSS SECTION SHOWING EXTINCTION THE MODELO

MINT CANYON

MODELO

SAUGUS

OLD ALLUVIUM

Scale ?
location ?