SENIOR THESIS, MAY, 1939

THE GEOLOGY OF A PORTION OF HUMPHREY'S QUADRANGLE

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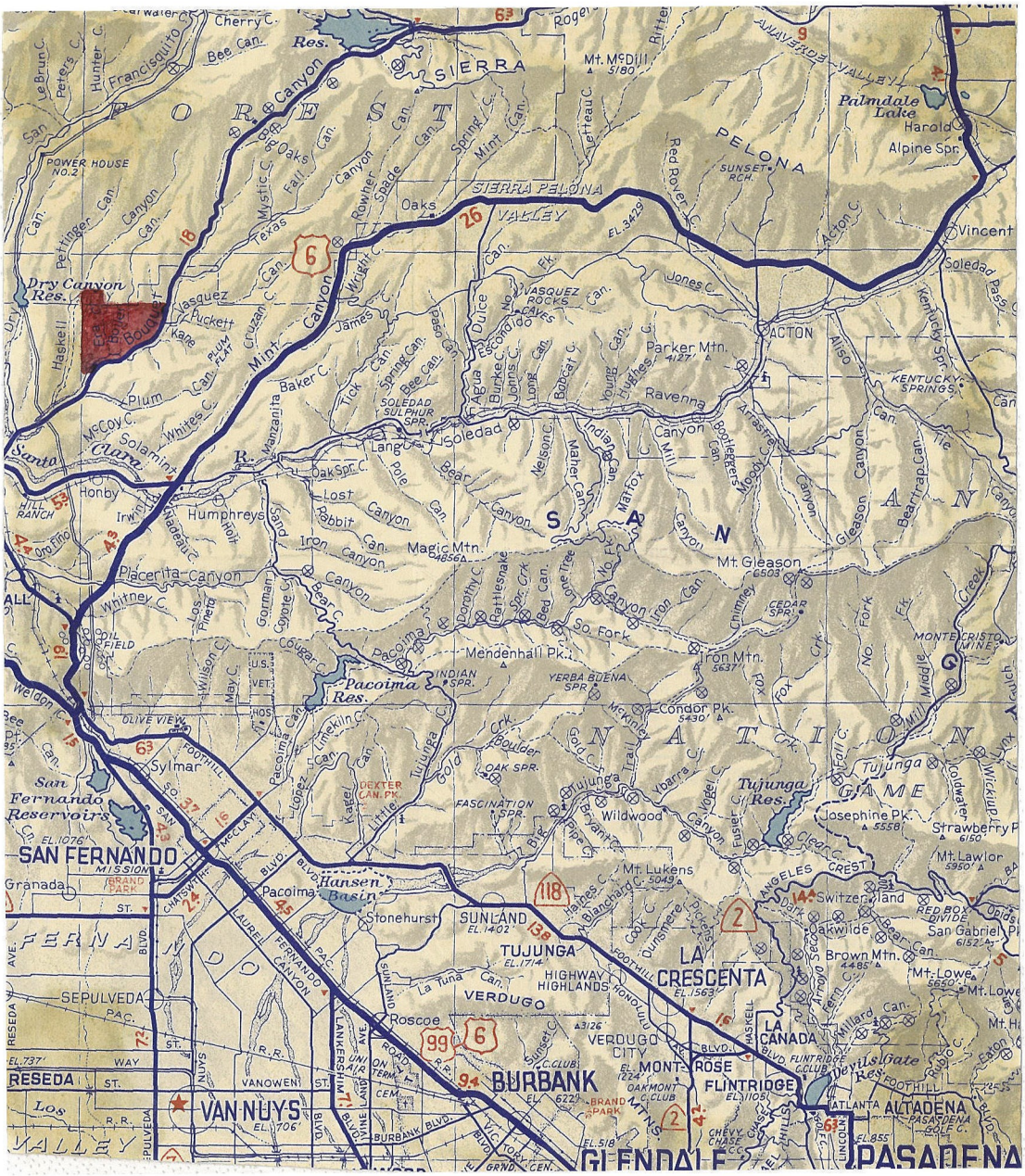
Figure 1



Map showing location of the area

ABSTRACT

Two sedimentary formations are present in this area; the Modelo formation and the Mint Canyon formation. The latter sediments make up most of the rocks in this region while the former is confined to the southwestern one-fourth of the area. An angular unconformity separates the marine Modelo (Upper Miocene) from the non-marine Mint Canyon formation (Lower-Upper Miocene). The sediments are typical of those deposited under semi-arid conditions. Conglomerates, sandstones, and clays are abundant. There has been little local faulting, but folding is developed to a high degree, especially in the sediments of the Mint Canyon. Recurrent volcanic activity has taken place in Miocene time and several ash beds are interbedded in the sediments. The only other rocks present in the area are some uplifted terrace gravels of Quaternary age and the recent valley alluvium.

INTRODUCTION

LOCATION OF AREA

The area investigated lies in the northwestern portion of the Humphreys Quadrangle. The approximate northern boundary of this area is the southern boundary of the Angeles National Forest; the area is bounded on the east and south by the Bouquet Canyon road, and on the west by the common border of the Saugus and Humphreys Quadrangles. The area is situated about fifty miles from Pasadena, near the town of Saugus. See Figure (1) for map showing location.

SIZE OF AREA

The area comprises about 3½ square miles and is roughly quadrangular in shape. It is approximately 2 miles long by 1½ miles in width.

PURPOSE OF INVESTIGATION

The area was investigated as a partial fulfillment for the degree of Bachelor of Science at the California Institute of Technology. The work was also carried on individually in order to give the student practice in working out his own field data and interpretations.

METHOD OF INVESTIGATION

The investigation was carried on with Brunton compass, hand lens, and a topographic map of Humphreys Quadrangle enlarged two times. Dips and strikes were plotted as taken in the field while fossil localities, good exposures and other places of interest were referred to a system of coordinates which cover the map of the area. Ash beds were carefully mapped in order to clarify structural relations. The most careful and complete mapping was done in the

central portion of the area. No thin sections were made but hand specimens were taken and examined carefully.

ACKNOWLEDGMENTS

I am indebted to Dr. J. H. Maxson for his helpful guidance and direction in making more clear certain structural problems in this area.

PHYSICAL CONDITIONS

RELIEF AND ELEVATIONS

Elevations in the area vary between the two extremes of 2100 feet and 1400 feet at the northern and southern boundaries of the area respectively. In general, the ridges are between 100 and 200 feet above the adjacent canyon floors.

TOPOGRAPHY

Although variations in elevation are not great, slopes are comparatively steep. Ridges are long and narrow and trend, in general, north and south. In addition to the ridges are several high mesas. The most outstanding one is situated in the northwestern part of the area and is readily visible from nearly all parts of the area. From a distance it appears as a long,high and very flat table-land. See Figure (2). Others of less outstanding appearance border the eastern boundary of the area. These terraces, or old land surfaces, are usually covered with a cap of coarse brownish red alluvium which facilitates their detection. With the exception of two long valleys running from the southern boundary through the central portion of the area, canyons are narrow, steep and V-shaped, indicating a youthful stage of development. The two valleys mentioned are about a 1000 feet wide and are being in part cultivated and used for grazing land. Bouquet Canyon, which forms the eastern border of the area, represents one of the broad older valleys that cut the old land surface.

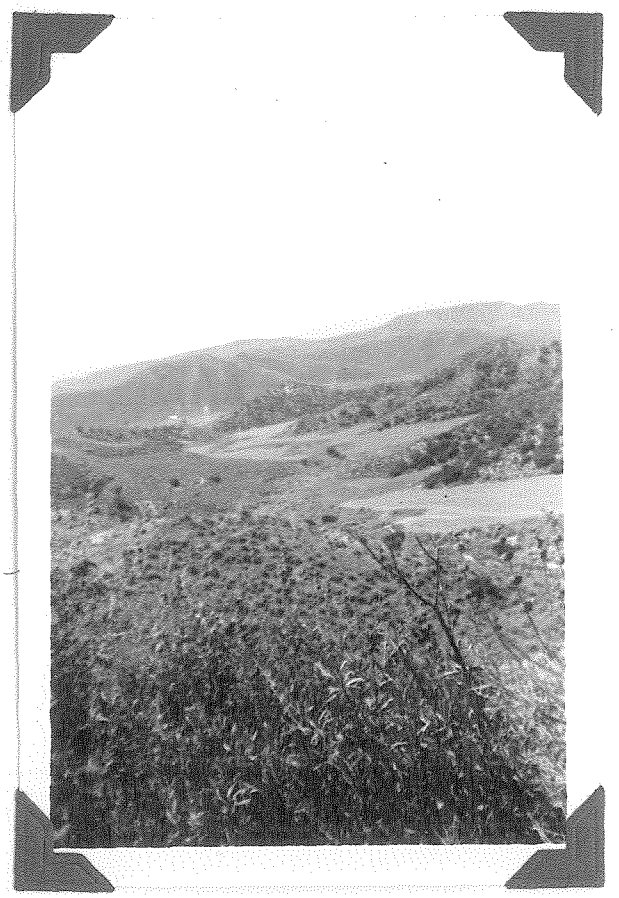
The high degree of deformation of the Mint Canyon formation, together with the lithologic character of this rock, has produced the typical badlands type of erosion which is especially noticeable in the central portion of the area. The hard resistant conglomerate

Figure 2

High mesa visible in the background.

Figure 3

Characteristic vegetation as seen in the area. This picture also illustrates a typical valley floor.



of the Modelo formation, which overlies the Mint Canyon in the southeast is responsible for the high ridge trending northwest.

In summary, the youthful stage of the area is represented by the steep slopes and V-shaped canyons in the Mint Canyon formation. Overlying portions of this are the flat terraces which are remnants of the old land surface.

DRAINAGE

Drainage in the area is towards the south and east. The small streams empty into the large Bouquet Canyon stream, which, in turn, flows southwest. The streams are dry throughout the year except during the rainy seasons. Gradients are quite steep and in several instances gullies cutting the canyon floors have depths considerably greater than their widths. Such gullies in otherwise flat valley floors would seem to indicate very recent or continuous uplift. (See Historical Geology). Most of the drainage channels in this area cut across structure, ie: stream canyons cut anticlines and synclines at nearly right angles. These streams are probably antecedent to the structure rather than superposed.

CLIMATE and VEGETATION

The vegetation is of the semi-arid type and consists of chaparral, scrub oak, sage, yucca, poison oak, cactus, and manzanita. (Figure (3). Wild flowers are prevalent in the spring months. The average rainfall of the region is approximately 20 inches a year.

EXPOSURES

Exposures are, in general, very good especially in the central portion of the area where excellent views of cross sections of anticlines and synclines are exposed in the deep antecedent stream cuts. Dips and strikes can best be obtained along the

bottoms of stream canyons; however, where the vegetation is thin attitudes may frequently be taken along the flanks and tops of ridges. Bedding in the Modelo formation is more readily determinable than in the softer sediments composing the Mint Canyon. The resistant ash beds in the latter formation furnish the best clues in the determination of its structure. (See Figure(4).

Figure 4

Outcrop of volcanic ash. Its greater resistance to erosion than the surrounding sediments may be seen here.

Figure 4a

Typical badlands type of erosion prevaland in the area.

STRATIGRAPHY AND PETROGRAPHY

GENERAL

Two formations are present in the area investigated--the Mint Canyon and the Modelo formations. The Modelo formation overlies the Mint Canyon but is separated from it by an angular unconformity. The Modelo is of marine origin and is Miocene in age; the Mint Canyon is non-marine and its age has been determined as lower-upper Miocene. Both of these formations are overlain in part by patches of Quaternary terrace gravels.

LOCAL

Mint Canyon Formation (Lower-Upper Miocene)

This formation covers the greater part (about 3/4) of the area. It is characterized by fairly steep but soft slopes frequently lacking underbrush on the flanks of ridges. In such places the badlands type of erosion stands out as light colored patches. (See Fig. 4a) Some portions of the beds in this formation (particularly the lighter ones) are swollen and cracked due to their absorption of water and consequent expansion. The more resistant ash beds stand out frequently as sharp narrow ridges.

The Mint Canyon formation represented in this area consists of various colored clays, fine to coarse sandstones, beds of volcanic ash, and a few small lenses of conglomerate. Colors produced by the weathering of these materials are distinctive: light greys, buff and reddish brown with the greys and reds predominating. The clayey sediments are quite free of hard constituents, boulders and pebbles being present only where the terrace gravels are found capping them. Stratification is well shown when viewed from a distance and can be distinguished by variations in color between beds; upon close examination colors tend to merge and the absence of good bedding planes

due to the softness and ease of erosion of the sediments make it difficult to obtain reliable attitudes. In this respect, the ash beds are valuable. Their greater resistance to erosion than the clay sands with which they are interbedded makes them excellent marker beds. (Figure (4). As an average estimation these beds are about 10 feet thick. This volcanic ash is composed almost entirely of glass. It is fine grained, hard and well consolidated but often somewhat porous. It shows a typical conchoidal fracture when split with a hammer. Wood and leaf fossils were found in portions of these beds.

Sandstones in this region make up only a comparatively small part of the rocks of the formation. The sandstones are, in general, medium grained and range from poorly consolidated types to ones that are extremely well cemented. Differences in consolidation are sometimes very local in range. Sandstone outcrops are present in which the varying degrees of cementation within the same bed was traceable by the ridges produced in the more compact material. The sandstones are well stratified and consequently are good indicators of small local irregularities in the structure. Argillaceous sandstones were found in the southern portion of the area in which resistance to deformation was so small that the folding of the sediments closely resembled that often found in highly deformed shales.

The Mint Canyon formation is non-marine in origin as evidenced by the fossil remains of horses and other vertebrate animals as well as invertebrate remains of fresh water gasteropods. Fossil localities have been marked with an X on the map.

MODELO FORMATION (Upper Moicene)

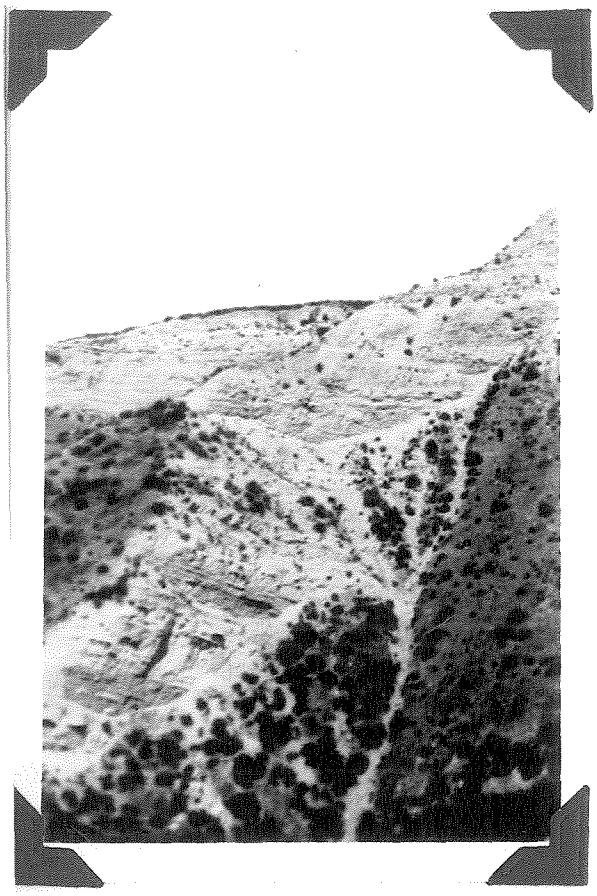
The Modelo formation covers the south western $\frac{1}{4}$ of the area. It lies unconformably upon the Mint Canyon. (See Structure).

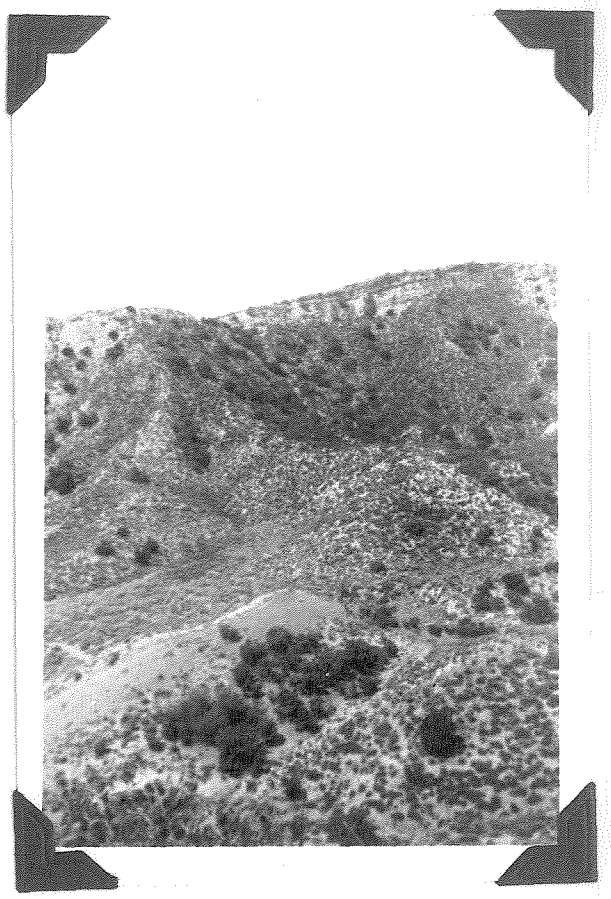
This angular unconformity is readily noticeable along portions of the contact. The Modelo formation is topographically characteristic because of its relative greater height than the surrounding Mint Canyon formation and also because its greater resistance to erosion produces high cliffs and peaks. (See Figures (5&6).

This formation consists of conglomerate, sandstones and shales and a few small layers of interbedded gypsum. Colors are light browns, greys, and buffs. Massive beds of sandstone predominate. On the whole, stratification is well developed and dips and strikes may be quite easily obtained. The sandstones are very well cemented throughout different parts of the formation. In places where the hard consolidated material overlies the softer sandstones differential erosion has undercut the harder beds and left them as protruding ledges. This phenomenon is especially noticeable along the southern contact. The northeast contact of the Modelo formation is marked by a resistant ledge of well consolidated conglomerate. This conglomerate is a typical basal one for it lies on the unconformity between the two formations. The conglomerate as it outcrops here is traceable for about three quarters of a mile. Its thickness is variable but a good average is about 15 feet. (See Figure(4). Rocks in this conglomerate vary in size from boulders of nearly a foot in diameter to small pebbles. It consists of subangular granites, schist, graphic granite, and quartz embedded and cemented in a sandstone matrix. This conglomerate can be followed for only several hundred feet westward along the southern contact where it is soon lost under the large mass of sandstones.

In spite of the lithologic differences between the Modelo and Mint Canyon formations, the actual contacts is, in places, difficult to distinguish. This is especially true in the southern part of the

Figure 5 & 6





The first picture shows the steep cliffs commonly found in Modelo formation.
The second picture shows the resistant basal conglomerate of the Modelo formation capping the softer Mint Canyon sediments.

area where the sandy clays of the Mint Canyon resemble the somewhat argillaceous sandstones of the Modelo and little or no basal conglomerate is present to mark the dividing line.

The Modelo formation is of marine origin and is Upper Miocene in age. No fossils were found in the formation here but a meager fauna of pecten have been found in the type locality.*

QUATERNARY ALLUVIUM

The Quaternary alluvium is characterized topographically (see topography) by flat mesas or tablelands, (Fig.(2), lying at different levels on the Mint Canyon and Modelo formations. This alluvium of a deep brownish red color contains pebbles and some boulders over a foot in diameter. Fragments from the Pelona schist, granites, quartz and quartzites are the chief rocks in this sediment. It is only poorly stratified and was probably deposited on long alluvial fans or as flood plain material. The thickness of this alluvial cover varies considerably throughout the area; the maximum thickness found exceeded 75 feet. The various elevations at which it stands is indicative of several periods of uplift.

RECENT ALLUVIUM

The alluvium of the present valleys and canyons is a roughly stratified sandy sediment. In some places it is being tilled by the small farmers of the area.

*U.S.G.S. Bulletin 753

GEOLOGIC STRUCTURE

REGIONAL

About fifteen miles to the north of this area lies the San Andreas fault. Less distant to the south is the San Gabriel fault. These two large faults have considerable influenced the regional structure which trends, in general, in an east-west direction. Major compressive forces have acted mostly in a north-south direction. Shearing forces set up by the San Andreas may also be in part cause for the east-west axial trend of anticlines and synclines.

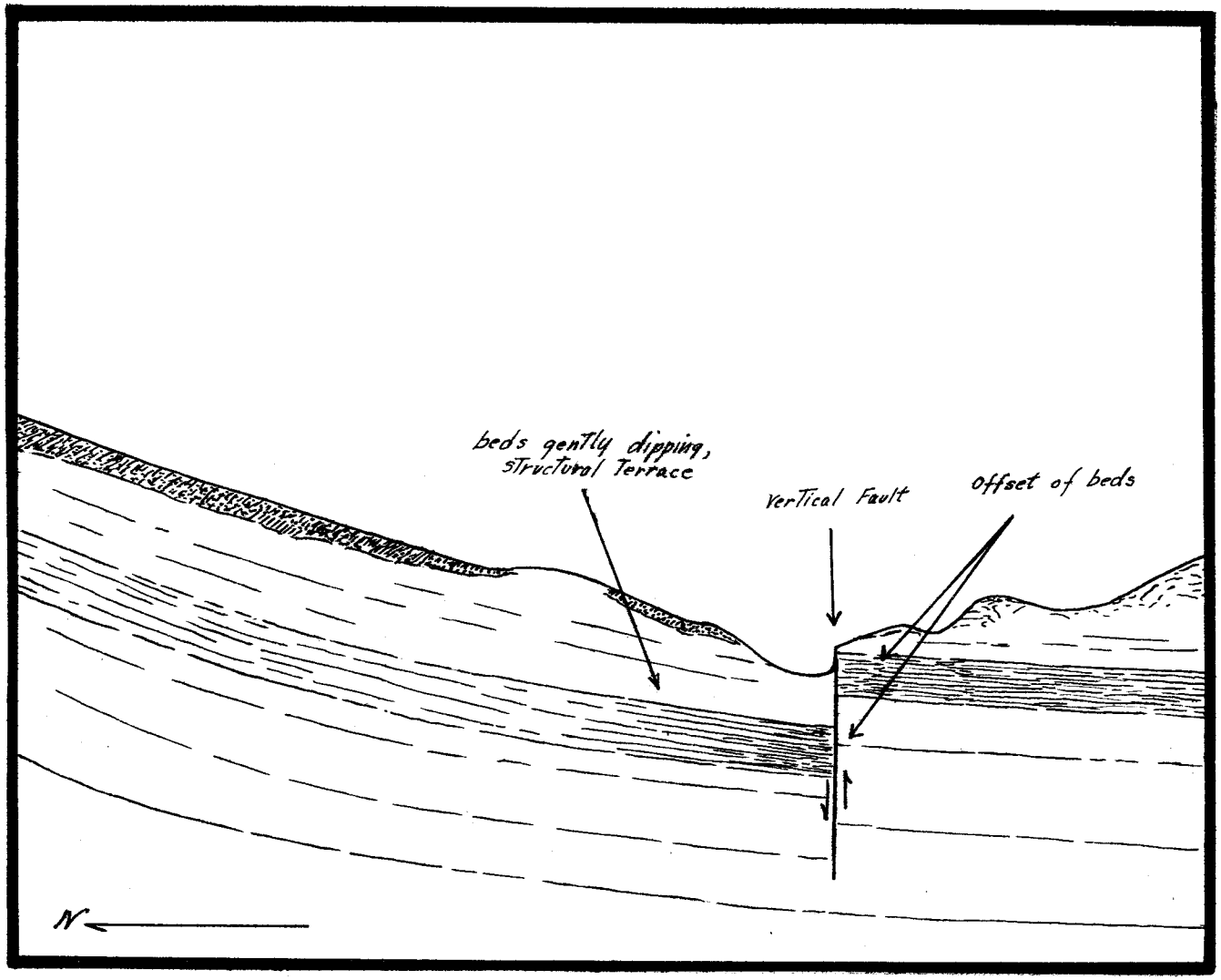
LOCAL

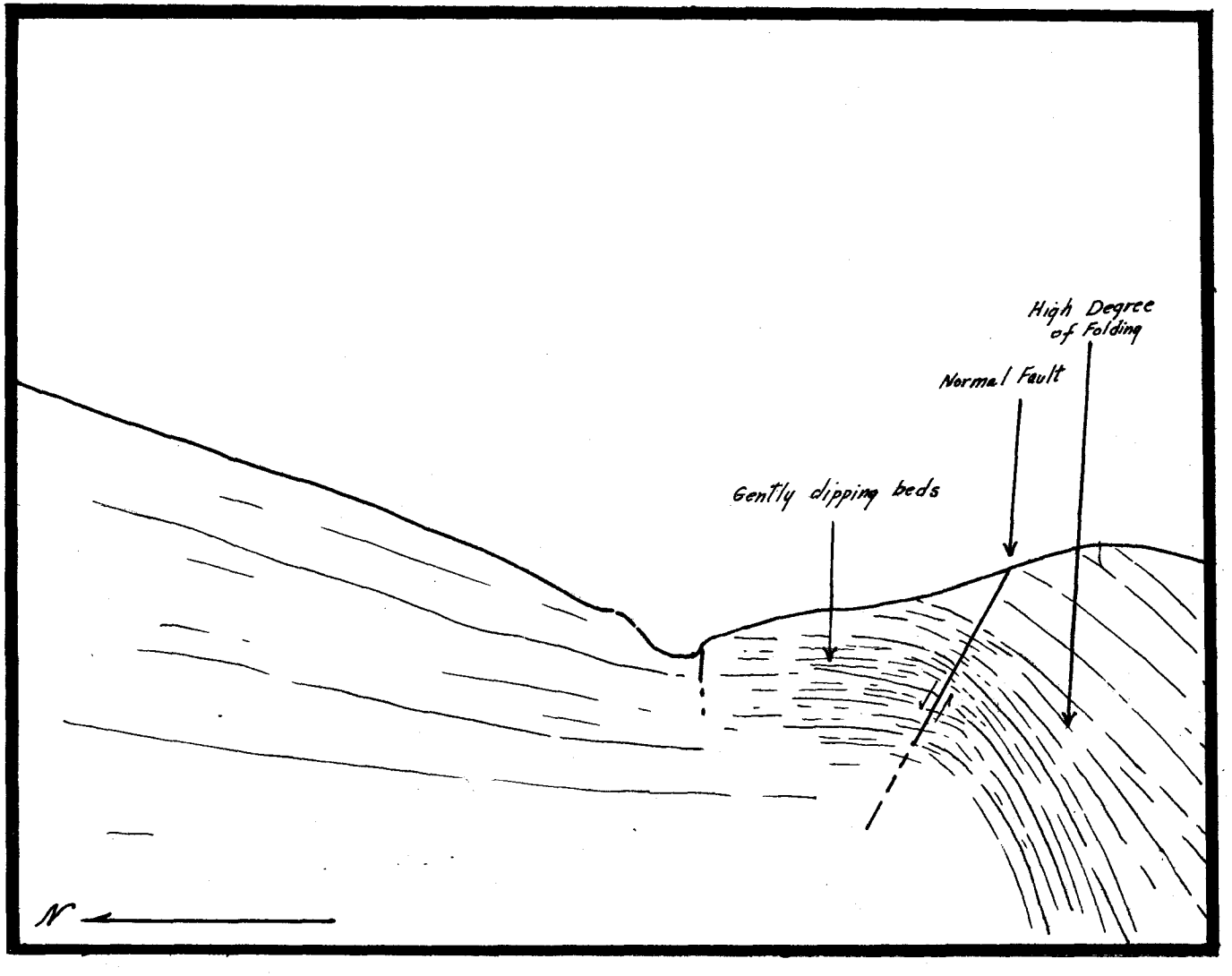
Faulting

The area is quite free of faulting. Faults which are present are small and local in extent. The trend of these small faults is mostly in an east-westerly direction. The two faults shown south-east of the central portion of the area can be easily distinguished by the well developed saddle here (Fig. (7) and definite offsetting of beds. A few feet to the north of these faults the beds in the Mint Canyon have a very flat dip (approximately 3 degree to the south); the beds immediately to the south of the faults dip very steeply (50 degree to 60 degree) southward--dips become less steep thereafter. (See Illustration) The north fault here is nearly vertical. It strikes in nearly the same direction as the beds which it cuts; it is a dip-slip strike fault with a vertical displacement of about 15 feet, the relative movement being a raising of the southern block. The south fault shown here is more complex and only its general attitude could be obtained. It strikes northwest and appears as a normal fault with a relative displacement similar to the first one. (Illustration). These faults may be in part responsible for the sudden change in dip of the sediments but it

Figure 7

Faintly visible in the background can be seen a fault saddle.


beds gently dipping,
structural Terrace
Vertical Fault
Offset of beds
N


High Degree of Folding
Normal Fault
Gently dipping beds
N

is more probable that the distorting stresses which produced the small structural terrace here have also caused the faulting. Both of these faults are minor structures on the layer break of the terrace, and it seems more logical to suppose that possible stresses causing the terrace also produced the faults.

The north-south striking fault shown in the stream canyon northeast of the center of the area is somewhat anomalous. This fault lies on the southern slope of an east-west trending anticline and seems to cut the structure for no apparent reason. The fault could not be traced and was only visible in a gully entrenched on the flank of a steep slope. It is probable that this is merely a small local gravity fault that has originated due to the settling of unconsolidated sediments. Displacement was very slight--a few feet at most.

Other faults in the area are of minor importance and may be seen on the map. In passing, however, it might be noted that the fault shown cutting the ash bed near the center of the area was mapped because of a definite offset in the bed here; no other evidence for faulting was found.

The age of these faults is difficult to determine as their relations cannot be referred to several beds of known ages. On the whole, they appear to be quite young as no cementing has occurred along the fractures.

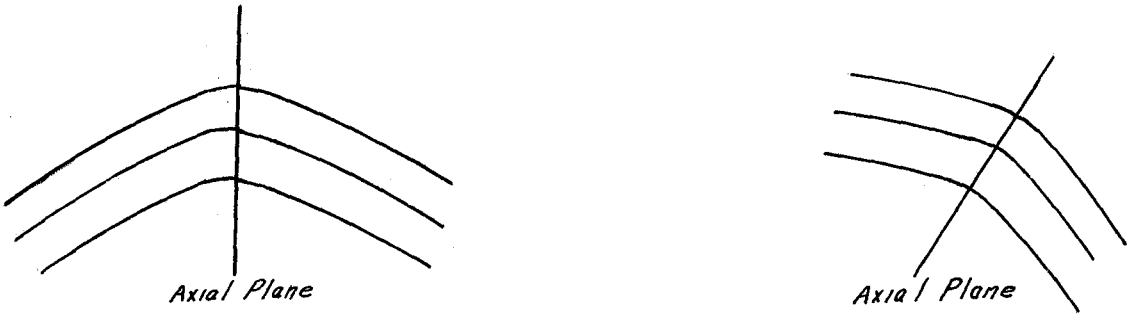
FOLDING

At least two distinct periods of folding have taken place in the area. This is definitely established by the fact that folding has occurred in two formations separated by an angular unconformity--namely the Mint Canyon and Modelo formations. Folding in the Mint

Canyon is more extensive and of a much higher degree in this region. than in the Modelo; this folding will now be discussed.

The regional dip of the Mint Canyon formation is somewhat obscured by the large amount of folding and reversals in dip. It is estimated to be about 40 degree in a southwesterly direction. The anticlines and synclines shown in the central part of the map (See Map) can be traced not only by reversals in dip but also to a considerable extend by the ash beds which bend around the structures. Following the southernmost pair of ash beds, it is seen that they trend northwest and dip to the southwest. These two beds converge towards the axis of the first anticline but disappear before they can be seen to bend around the end of the fold. Near the end of this fold but on the northern limb, this time, the two beds are again visible. They next bend around the end of the adjacent syncline, reverse their dip again and at least one of them can be followed as it again reverses dip and bends around the last anticline. All of these structures plunge westward in different degrees. The central syncline is the only one of this group of structures whose plunge can be readily measured. Dips taken in the ash bed as it rounded the end of this syncline showed its plunge to be westward at about 50 degree. The northern syncline and anticline are larger structures than the southern pair. They can be traced from the eastern part of this area, where they disappear under the alluvium, westward into the area mapped by Mr. Regan. In general, the northern limbs of the anticlines have steeper dips than the southern limbs. They are asymetrical in this respect with their axial planes inclining towards the south.

The southern anticline and adjacent syncline disappear westwards in the valley alluvium and no evidence of their continuation was discovered in that part of the Mint Canyon formation just east of the Modelo contact. It will be noticed that these two folds end rather abruptly on the central ridge and no continuation of the structures was found to the east. However, the ash beds which lie on the southern limb of the anticline continue east for about 1000 feet and then turn abruptly southeast. This turning point is located near the lower break of the structural terrace. It might possibly be assumed that this terrace is the result of a southwards overturning of the anticline. (Illustration below).



If such were the case, the southern anticline might be assumed to curve southeast and pass through this point. Besides the general lack of structural evidence to support this hypothesis there is the additional fact that dips on the southern part of the ridge just east of the central one, and through which a prolongation of the anticline would have to pass, are to the south. (See Map).

Two minor flexures of local extent are present in the Modelo formation of this area. By a consideration of the dips and strikes on the flanks of these folds it is evident that they plunge gently towards the west.

FIELD RELATIONS OF FORMATIONS

As has been previously mentioned the Modelo and Mint Canyon formations are separated by an angular unconformity. The difference in dip of the two formations near the contact is about 10 degree--the average dip of the Modelo being about 30 degree, while that of the Mint Canyon is approximately 40 degree. There are no noticeable variations in strike of the two formations. Two small portions of Modelo were discovered to the south of and isolated from the main part of the formation. These two patches are remnants of the large body of Modelo which once extended over the southern part of the area. The contact is in part dotted here because the lithologic similarity between the rocks of the two formations in this locality makes difficult the determination of the actual dividing line. These isolated Modelo patches might have been mapped as part of the Mint Canyon if it had not been for the presence of outcrops of characteristic basal conglomerate.

ECONOMIC CONSIDERATIONS

This area is quite free of habitation and only a few small farms are present in some of the larger valleys. Small scale gold mining is being carried on in some of the stream canyons where gold values have washed down from the terrace gravels. In one instance the author witnessed the recovery of some small nuggets by one of the miners. The Modelo formation is of general importance because of the oil frequently found associated with it.

HISTORICAL GEOLOGY

I LOWER-UPPER MIOCENE

- A. Deposition of Mint Canyon formation
  1. In part deposited on valley floors and partly in the shallow lakes of this time.
  2. Intermittent volcanic action during which accumulations of ash were deposited.
- B. Folding and faulting of the formation
- C. Development of streams.
- D. Period of erosion.

II UPPER MIOCENE

- A. Subsidence of the region and intrusion of the sea to a point a little north of the present Modelo--Mint Canyon contact.
- B. Deposition of the Modelo sediments in this sea.

III POST MIOCENE

- A. Uplift and renewed folding and faulting.
- B. Renewed cutting by the older streams and development of a few new drainage patterns.

IV QUATERNARY

- A. Deposition of terrace gravels.
- B. Repeated uplifts of the region and raising of the terrace materials to various heights (100 to 500 feet) above the floor of Bouquet Canyon.
- C. Erosion and Deposition of recent alluvium in the present canyon floors.
- D. Gentle uplift causing present streams to gully the valley alluvium.

Cross Sections