GEOLOGY
OF A PORTION OF THE
SANTA SUSANNA MOUNTAINS

Los Angeles County, California

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INDEX

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INTRODUCTION

The Santa Susanna Mountains lie to the west and north of the City of San Fernando, California. The mountains form the northwest boundary of the San Fernando Valley, which is separated from Los Angeles and its suburbs by the Santa Monica Mountains.

About five and one-half square miles of country were mapped, this area lying north-northeast of Santa Susanna Pass, at the northwest corner of San Fernando Valley. The valley is noted for its productive farm land. In the foothills of the Santa Susanna Mountains there are many week-end cabins, together with cattle ranches. Cattle are grazed principally on the Modelo formation, which, because of its character, allows good grass to grow.

While there has been a little oil prospecting and drilling, no oil has been found in the area mapped. There are, however, good producing fields on the north side of the Santa Susanna Mountains.

ACKNOWLEDGMENTS

Much credit is due Dr. S. W. Kew, who during the field seasons of 1917, 1918, and 1919 mapped this portion and a large amount of surrounding country for the United States Geological Survey. His report of this work is given in Bulletin 753 of the Survey. Credit is also due to Barney Flynn, a rancher in the area, for material assistance in the field.

CLIMATE AND VEGETATION

The region is typically semiarid. Rain is the usual form of precipitation, although some snow may fall during the winter, and in occasional years a great deal of snow may fall.

During the winter and spring there is plenty of water in this area, but in the summer the streams dry up, and water has to be obtained from springs. All of the water has a high content of sulphur, which one may sometimes smell at a great distance.

Vegetation depends mainly on the kind of soil prevailing. Grass is found on the Modelo shale, together with a very light growth of sage in some places. On the other formations chaparral grows, and in some places is so dense that geologic work becomes very difficult. Oak trees are present in the canyons, together with an occasional sycamore.

COLUMNAR SECTION

Period	Formation	Thickness	Character of Formation
	Terrace Deposits	50'±	Loose sand and gravel
Quaternary	unconformity		
Pliocene	Saugus	2000'±	Loosely compacted gravel, sand, and conglomerate. Marine and fossiliferous.
	unconformity		
	Intrusive Basalt	20'	Basalt
	unconformity		
Miocene	Modelo	2000'±	Laminated hard siliceous shale. A few thin beds of an impure gray limestone are present.
	unconformity		
	Topango?	300'±	Yellow and grayish coarse sandstone.
	unconformity		
Eocene	Meganos	1500'±	Brown, gray, or bluish fine sandstones. Some brown conglomerate.
	unconformity?		
	Martinez	1000'±	Massive brown conglomerate.
	unconformity		
Cretacious	Chico	300'±	Heavy bedded light brown and tan sandstone.

STRATIGRAPHY

General Character

All of the rocks are sedimentary, with the exception of a small basalt dike along the Santa Susanna overthrust fault. The rocks range in age from Upper Cretaceous to Recent, and include the Chico formation (Upper Cretaceous), Martinez formation (Lower Eocene), Meganos formation (Middle Eocene), Topanga formation (Middle Miocene), Modelo formation (Upper Miocene), Saugus formation (Upper Pliocene and Lower Pleistocene), terrace deposits (Pleistocene), and alluvium (Quaternary). Every Tertiary period but the Oligocene is represented. The basalt dike is of Upper Miocene age.

The time relationships, the thicknesses of the formations, and the general character of the rocks is given in the accompanying columnar section.

Chico Formation

Only a small portion of the Chico formation of the Santa Susanna Mountains is included within the boundary of this report. The strata of the Chico are almost flat, and are at the north end of a very broad, shallow syncline.

The portion of the Chico mapped is about

300 feet in thickness, and is comprised of heavy bedded sandstone. Its texture and color are very uniform, being almost universally light brown in color and medium grained in texture. The grains are about the size of shot, and are fairly well cemented. The sandstone is principally quartzose, but contains in addition a little biotite and a larger amount of feldspathic material.

The sandstone weathers out in large blocks, which roll down to the canyon bottoms, where they further disintegrate.

No fossils were found in this formation, but on the basis of fossil material secured by C. A. Warren, the beds were referred to the Chico (Upper Cretaceous).

The Chico in the area mapped is unconformably overlain by the Martinez. The angle of unconformity is nearly ninety degrees.

Martinez Formation

The Martinez consists of massive brown conglomerate at the base, followed by a small section of dark gray shale. The total thickness is about 1000 feet. The constituents of the conglomerate range up to two inches in size, are well rounded, and very firmly cemented.

The Martinez, as has been mentioned,

unconformably overlies the Chico, the angle of unconformity being about sixty degrees. The next younger formation, the Meganos, is separated from the Martinez by a fault, so that no evidence could be obtained as to the original relationships between the two formations. Kew, however, has found that the Martinez and Meganos are conformable in other places, and separates them by their characteristic fauna.

No faunas have been found in the Martinez, although other workers have collected a fauna which indicates a Lower Eocene age.

Meganos Formation

The Meganos formation consists of about 1500 feet of brown, gray, or bluish fine sandstone. As a rule, the sandstone is brown. Associated with the sandstone are a few beds of brown conglomerate. The cobbles in the conglomerate are sparse, and are made up mostly of acidic intrusives and extrusives.

As in the majority of the other formations within the area, no fossils were found in the Meganos, but in certain surrounding localities many fossils have been found. These indicate a Middle Miocene age.

The Meganos is unconformably underlain by the

Martinez, and overlain unconformably by the Topanga, the latter unconformity being about six degrees.

Topanga Formation

The Topanga formation appears as four separate patches in the area mapped. The maximum thickness, so far as can be determined, is about 300 feet. The two patches on the lava in the eastern half of the map are entirely sandstone, tan in color and coarse in texture. The two patches in the west are mainly brown sandstone, with some conglomerate. The conglomerate is derived largely from granitic rocks.

Fossils found by other workers indicate the age of the sandstone to be Middle Miocene.

In the east the Topanga is unconformably overlain by the Modelo shale, the angle of unconformity being about four degrees. The Topanga forms the bottom of the overthrust block which has overridden the Saugus. Through the fault plane a small intrusive dike of basalt has benn injected.

In the west the Topanga is unconformably overlain by the Modelo shale, at an angle of thirteen degrees, and unconformably underlain by the Meganos, at an angle of six degrees.

Modelo Formation

The Modelo formation consists of 2000 feet of a laminated hard siliceous shale, with here and there a few thin beds of an impure gray limestone.

Kew gives the age of the Modelo as Upper Miocene.

The Modelo is unconformably overlain by the Saugus, at an angle of about eighteen degrees. The Modelo in turn unconformably overlies the Topanga, at angles which vary from four to thirteen degrees.

Saugus Formation

The Saugus consists of 2000 feet of loosely compacted gravel, sand, and conglomerate. The conglomerate is composed of pebbles and cobbles of quartzite, gneiss, and granite. The constituents are rounded to subrounded. Some have been worn very smooth.

The greater part of the Saugus in the west is marine in origin. One prominent bed contains oysters, pectins, and sand dollars in large quantity. The lime content in one place is very high, with a low manganese content. Because of this, the bed is commercially valuable, and a group of men plan to mine the bed at the right angle bend in Aliso Canyon, at the top of section 36.

In the eastern part of the area the Saugus has more of the characteristics of an alluvial deposit, of a river delta progressively sinking. The prominent fossiliferous bed overlies this portion, so it would seem that the upper portion of the Saugus in this region is marine, while the lower portion is alluvial.

From fossils found in the Saugus, and from published reports, the age of this formation has been determined as Upper Pliocene and Lower Pleistocene, being transitional between the two periods.

The Saugus unconformably overlies the Modelo formation, at an angle of about eighteen degrees. In turn the Saugus is unconformably overlain by the terrace deposits at varying angles.

Terrace Deposits

The terrace deposits consist of unsorted and angular to subangular conglomerate and gravel. The particles have been derived principally from the Modelo formation.

Intrusive Basalt

Basalt of a reddish or greenish color has been intruded along the Santa Susanna overthrust

plane. The rock is compact, and not vesicular. The intrusion is of Miocene age.

STRUCTURE

General Features

The structure of the region mapped is typical of the California Coast Ranges, and comprises a series of roughly parallel faults and folds. The trend of these structures is west-northwest.

The folding and faulting did not take place all at once, as some of the strata are folded more than others, and younger deposits were laid down on the upturned and eroded edges of the older beds.

The evidence of the Santa Susanna overthrust, and the east-west trending faults and folds indicates that the deformation resulted from compressive stresses exerted in a north-south direction.

Faults

The Santa Susanna overthrust fault is one of the major structural features of the region. This overthrust is continued westward as the more steeply dipping reverse San Cayetano fault, and

eastward as the more steeply dipping reverse Sierra Madre fault.

The fault plane of the Santa Susanna fault dips, in general, about 15 degrees north. The fault plane, as one goes from east to west, presents a wavy surface. The most prominent wave is a depression in the western half of section 30, and the eastern half of section 25. This is responsible for a tongue of Modelo shale which projects forward from the main overthrust mass. The tongue is imbricated slightly. In several places this tongue has shown slickensides in the beds. Most of these slickensides trend in an east-west direction, but in one place they are in a north-south direction.

Some of these slickensides are undoubtedly due to the settling and contortion of the overthrust beds. The strata dip in nearly all directions, and because of this complexity dips and strikes mean very little when taken in the overthrust Modelo ~~when taken~~ near the edge of this overthrust tongue just described.

The amount of the overthrust could not be determined, but it must be a good deal.

The basalt dike along the overthrust plane, and which reaches the surface in sections 29 and 30, has already been described.

There are two other faults in the area. Both of these lie in sections 25 and 26. They are close together, and roughly parallel. The northern fault is nearly vertical, and as can be seen from structure section A-A', the northern part has moved down with reference to the southern part. There has also been lateral movement, but no estimate of the amount of lateral movement can be made. If there was no Saugus west of section 25, some estimate of the lateral movement might be made, but the presence of a patch of Saugus in section 26 shows that the Saugus formation at one time covered the Martinez, Meganos, and part of the Modelo shale under the overthrust. Hence the interesting plan in the southern half of section 25 has been caused in part by erosion, and is not due to faulting alone.

Movement has taken place along this fault at least at two different times. As can be seen from the structure section, one movement is post-Saugus, and amounts vertically to 300 feet. Section A-A' also shows that the fault originated in pre-Saugus time, because the Topanga and Modelo do not occur south of the fault. Of course the two latter formations must have occurred on the Meganos if the structure north of the fault originally continued southward. Presumably, however, the southern fault

has elevated the Modelo and Topanga, so that these formations were eroded away before the deposition of the Saugus.

The southern fault, as seen from the map, runs under the Saugus in the northwest corner of section 36. Just how far the fault continues could not be determined.

On the basis of the above reasoning, the age of the southern fault is between Modelo and Saugus times. The first movement on the northern fault also took place between the time of the deposition of the Modelo shale and the Saugus, or between Upper Miocene and Upper Pliocene times. From the meager evidence on hand, the time relationship of the two faults could not be determined, although it is suspected that the first movement on the northern fault was prior to that on the southern fault. The second movement on the northern fault tool place in the Pleistocene, after the deposition of the Saugus.

The Santa Susanna Fault occurred, of course, after the deposition of the Saugus, since this formation is overthrust in the eastern part of the area. The age of the overthrust would thus be placed in the Pleistocene.

Folds

In the eastern half of the region mapped

there are three major folds, a syncline and the two adjoining anticlines. These are shown in structure section B-B'. In general the folds could not be traced for long distances, because in the east a large amount of shale fragments from the Modelo cover the Saugus.

In section 36 there is an overturned anticline in the Martinez. Underneath the unconformably overlying Saugus the Martinez strata dip southward at an angle of about 45 degrees. In the bottom of Devil Canyon, just below, the strata dip northward at an angle of about 55 degrees. The axis of this overturned anticline can not be definitely located on the map, because of the position of the anticline.

As the folds trend with the trace of the Santa Susanna overthrust in general, the majority of the folds were probably contemporaneous with the overthrusting. The overturned anticline previously mentioned may antidate the other folds.

Oil Drilling

A few wells have been drilled in this area to test the productiveness of the folds. They have not shown any oil, however. A little gas has been obtained. The folds seem to be shallow, which is not a favorable structure when the type of formations present is considered.

HISTORY

Unfortunately a detailed account of the geologic history can not be given. There are two reasons why the history can not be discussed as fully as one might desire. In the first place, the area mapped was small, and in the second place, a detailed analysis of the petrography was not made.

The Chico was the first formation deposited. This formation has been found over a very long area on the coast, hence the Pacific Ocean extended considerably further inland than it does at the present time.

A relatively small break is recorded between the Chico and the Martinez. Depostion was continuous from the Martinez through the Meganos, but at the end of Meganos time (Middle Eocene) the land rose and the waters receded from the area. In the Upper Eocene, the Oligocene, and the Lower Miocene the area remained above the surface of the sea, but in the Middle Miocene the waters again encroached on this area, and the Topanga formation was liad down.

At the end of the deposition of the Modelo, in uppermost Miocene time, the water again receded, and there was another period of erosion. In the Upper Pliocene the land began sinking, and while the water was still shallow the lower part of the Saugus was laid down as a delta deposit progressively sinking.

By the Upper Saugus (Lower Pleistocene), the river delta stage had vanished, and the strata were relatively much deeper beneath the sea's surface. Soon after the deposition of the Saugus the land again emerged from the water.

There are thus three advances and retreats of the sea clearly indicated in the columnar section.

In places there is evidence of remnants of old wide valley floors about 200 feet above the present stream levels. This indicates that the last uplift was not constant in character.

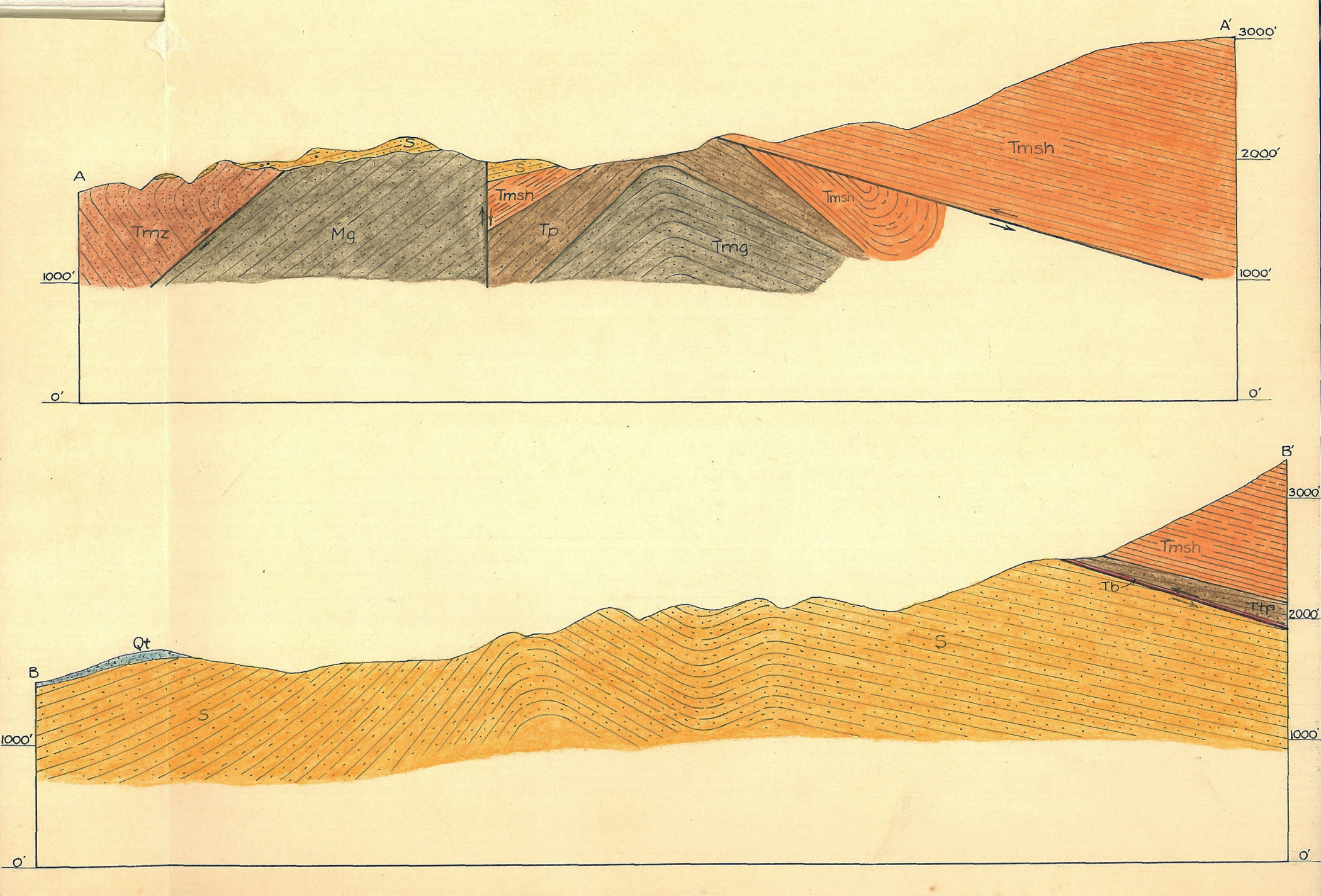
It is to be noted that the two periods of faulting can be associated with the rising of the land in pre-Saugus and post-Saugus times.

SUMMARY

This area is interesting stratigraphically because all periods back to and including the Cretaceous are represented, with the exception of the Oligocene. All of the rocks are sedimentary, with the exception of a small basalt dike.

The faults and folds of the region trend in an east-west direction. The Santa Susanna overthrust is the last expression of faulting in the area, and is the most interesting fault. Most of the folds were probably caused by the same force which is responsible for the overthrust.

There have been three clearly indicated advances of the sea over this area, two in Tertiary time, and one in the Mesozoic. Two retreats of the sea have occurred in the Tertiary, and one retreat in the Pleistocene.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