S E N I O R   T H E S I S

GEOLOGY OF AREA NEAR SUNLAND CALIFORNIA

By

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I Introduction

An area of approximately four square miles lying 20 miles northwest of Pasadena California was mapped to satisfy the senior thesis requirement in geology at the California Institute of Technology. The area mapped lies around the mouth of Big Tujunga Canyon which in turn is 2 miles east of Sunland, Calif.

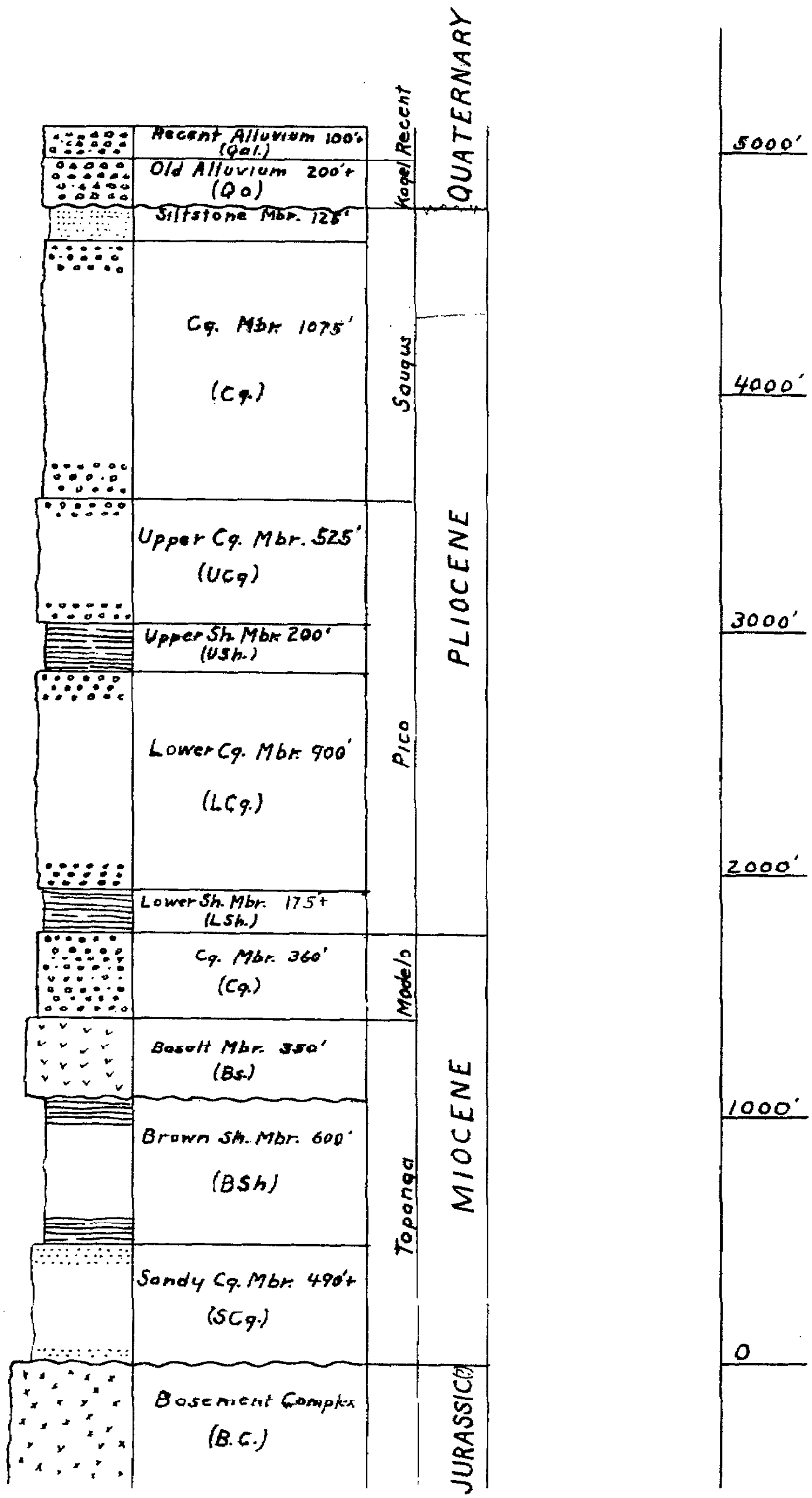
II Physical Conditions

A series of sediments and volcanies was mapped which lie at the base of the western slope of the San Gabriel Mts. between elevations of 1400' and 2300'. The relief on the whole is rugged and of the early mature stage. The area is divided into two zones by Big Tujunga Canyon. Drainage in the northern zone is at right angles to the trend of the mountains, the streams running north and south and emptying into Big Tujunga River. Exposures in the western part of this zone are excellent, the streams having eroded steep walled canyons across the strike of the sediments. The exposures grow progressively fewer to the east, more of the country being covered by alluvium and brush. The zone lying south of Big Tujunga Canyon runs north and south. Approximately the northern 1/3 of this zone drains northward into Big Tujunga Canyon. The remainder drains westward into Tujunga Valley. Exposures in this zone are few, most of the surface being covered by recent alluvium and heavy brush.

III Field Methods

Mapping was done on the La Crescenta and Sunland quadrangles of the Los Angeles County topographic sheets, scale 1:24,000. The Brunton Compass was the only instrument used. Locations were determined by re-section and are accurate to 100'. Dips and strikes are accurate to 5 degrees.

COLUMNAR SECTION



IV Geological Conditions

This area presents a section of varied rock types including coarse plutonics and metamorphics, basaltic flows, and sediments ranging from shales to fanglomerates. The time interval represented in the rocks extends from Jurassic or older to recent. The record is far from complete. There is a long break from the intrusion of the Jurassic (?) plutonics to the deposition of the Miocene Topanga formation. The Pliocene is represented by the Pico and Saugus formations and the Quaternery by alluvium deposits.

V Stratigraphy and Lithology

A. Basement Complex (Jurassic ?)

The basement complex forms the high parts of the ridges to the north and east of the sediments. No field mapping was done in the basement, but three rock types were absbserved. The greater part of this complex is a medium to coarse grained quartz diorite. Study of a thin section showed that the rock contains oligoclase, quartz, orthoclase, biotite and some apatite and magnetite. This quartz diorite is cut by numerous aplite dikes. Zones of a quartz-feldspar-biotite gneiss which may be pre-Cambrian are numerous. The Quartz diorite is probably Jurassic in age.

B. Topanga (Miocene)

The Topanga formation consists of steeply dipping strata of sandy conglomerates, sandstones, shale, and intrusive and extrusive basalt. Marine fossils found in the sandy conglomerate to the west of the area mapped were determined as Topanga in age by Mr. Hayward of the California Institute. The section is similiar in its main features to the Topanga section found in the Santa Monica Mts.

Region North of Big Tujunga Canyon

The northern 1/3 of the sediments exposed north of Big

Tujunga Canyon are Topanga in age. The contact with the basement complex to the north, probably a fault, is buried by the basalt flow. To the south the Topanga is faulted against the Saugus formation. The Topanga formation in this region is divisible into three distinct members. The lower member is a sandy conglomerate, the middle is a brown shale, and the upper is intrusive and extrusive basalt.

Sandy Conglomerate Member

The sandy conglomerate member consists of a series of overturned strata varying from mudstone to sandy conglomerate. 490' of the member is well exposed in Doan Canyon. The strata here dip approximately 80 degrees north. The oldest (most northern) bed is a massive blue gray highly biotite mudstone which contains shell fragments. A 20' layer of a dark gray medium grained sandstone which contains numerous marine fossils overlies the sandstone. The exposed parts of the remainder of the member consist of a series of massive bouldery sandstone strata. Individual beds average 20' in thickness. The sandstone is medium to coarse grained, angular, highly arkosic, white to buff colored but generally had iron stained streaks. The pebbles and boulders as a rule make up less than 25% of the volume. They reach a diameter of one foot, are sub-rounded to round and well polished. They are mostly of very hard granitic and metamorphic rocks. Pebbles of volcanics which are different in composition from the Topanga basalt are common. The strata show some cross-bedding and are jointed to a slight extent.

Brown Shale Member

600' of thinly bedded shale, mudstone and sandstone are exposed in Doan Canyon. This shale member lies above and south of the sandy conglomerate member. A soft brown finely laminated punky shale makes up the major part of this member. This shale contains numerous white inclusions of a chemical origin which are well exposed along bedding planes. Interbedded with the shale is a hard medium grained sandstones. Layers of a blue gray, massive mudstone some feet in thickness are common. Both the shale and the mudstone are gypsiferous. The shale member is strongly deformed, showing much minor folding and crumpling. No micro or mega fossils were found. Outcrops of the shale member support a growth of grass and are distinct from outcrops of the other members which support brush.

Basalt Members

The basalt member lies both on the sandy conglomerate and on the basement complex. It has flowed across the sandy conglomerate and just east of Doan Canyon also across the shale member. West of the area mapped a locality was seen where the basalt has definitely intruded the sandy conglomerate. Apophyses of the basalt have extended up into the sandstone and solutions from the basalt have flowed into fractures in the sandstone. The basalt then is younger than the sandy conglomerate. There are five possible explanations of the tongue of basalt referred to above which cuts across the shale member:

(1) The basalt tongue has been faulted into its present position.

Rejected because marker beds andsandstone on either side fo the tongue line up exactly, making the required displacement impossible. Furthermore the shale-Saugus contact 300' south has not been displaced.

(2) The tongue has been land-slided into position.

Highly improbable. The basalt of the tongue shows no sign of having been shattered and moved. The shale basalt contact is nearly horizontal and continuous. There is no hill to the north from which the slide could have come. This theory has been rejected by Dr. Bode of the California Institute.

(3) The basalt has flowed across the Topanga sediments after they had been folded and elevated to their present position.

Very improbable. The Topanga strata have been elevated by post-Saugus faulting. (see section on Sunland Fault.) Because of this the flow would have to be Quaternary in age. Volcanic activity this recent has not occured in this general region.

(4) The tongue is an intrusive dike which originally extended almost vertically up into the sediments. Folding and uplift have placed the tongue in the position it now has.

Possible but not probable. Neither the basalt-shale contact or the basalt itself show any effect of intense buckling. If this theory is true, there would have been slipping and faulting in the sediments with consequent fracturing and desplacement in the basalt as the strata were folded against the adjacent basement complex. In addition numerous amgydules and vesicles indicate that little of the basalt was intrusive. There is an amygdaloidal zone along the bottom of the basalt tongue next to the shale.

(5) The basalt is a flow which was extruded on the folded and eroded Topanga sediments. The flow and sediments were covered by Pliocene deposits. Uplift due to faulting followed by erosion has uncovered the flow and underlying sediments.

This theory is the most plausible one. The basalt then is younger than the shale member which corresponds to the upper Topanga shale member in the Santa Monica Mts. (*1) and older than the Pliocene sediments. The absence of pebbles of basalt similar to that of the flow in the Toganga strata and the presence of such pebbles in the Pliocene strata confirm this age. In the southeast corner of the area mapped and elsewhere in this general region the basalt flows are overlain by Modelo sediments. (*2.) The basalt then is between upper Topanga and Modelo in age. It brobably corresponds in age to some of the flows in the Santa Monica Mts. (*1.) The best exposure of the basalt was found in Akens Canyon. The major portion is a hard black fine grained rock which had been locally jointed and fractured. Secondary deposition of a calcareous substance has taken place along some of the breaks. A sample of the black basalt taken near the middle of the flow had a diabasic texture. The groundmass consisted of small labradorite laths. Larger crystals of olivine highly altered to iddingsite were distributed through the groundmass. Minor amounts of ferromagnesian minerals were present. Samples takes farther from the center of the flow showed a more typical basaltic texture. The groundmass was wholly of glass, with small crystals of plagioclase. The basalt near the borders is fine grained, deep red in color and contains numerous vesicules and amygdules of calcite and azeolite up to 1" in diameter.

In summary the lava is a olivine basalt which has a texture approaching that of a diabase in its interior. This basalt has come up through and is in part intrusive in the sandy conglomerate member. The presence of numerous vesicles and and amygdules indicate that most of the basalt is extrusive in origin.

Region South of Big Tujunga Canyon

A small block of sediments and basalt has been faulted into place in the extreme south east corner of the area mapped.

Basalt Member

Basalt flows are interbedded with pyroclastic tuffs and agglomerates in this region. The tuff is distinguished by its softness and by its brick red color. The agglomerate consists of basalt boulders in a matrix of tuff material. Three flows and two interbedded tuff and agglomerate layers are exposed. The basalt member in this region is evidently entirely extrusive in origin.

C. Modelo (Miocene)

Region South of Big Tujunga Canyon

A section of conglomerate and sandstone immediately north of the lava in the south east corner of the area may be Modelo in age. A 360' section of conglomerate overlies the lava. The conglomerate is mostly of angular granitic boulders up to some feet in diameter. Large boulders of a basalt similar to that of the underlying flow are numerous. The boulders are cemented by a coarse angular sandstone. Bands of caliche are present. Overlying this conglomerate is a well consolidated and well cemented sandstone. The sandstone is made up of large feldspar and quartz grains. Numerous flakes of muscovite and pebbles of lava occur. The two beds exposed are buff colored but iron stained.

The tilting of these strata combined with their stratigraphic position immediately above the lava places them in the Modelo. The conglomerate may be the same as the Modelo Conglomerate overlying the lava on the south side of Tujunga Valley (*2.)

D. Pico (Pliocene)

The Pico formation is exposed on both sides fo Big Tujunga Canyon. The major part lies in the hills south of the canyon, but a thin strip has been left along the north wall. The Pico is made up of massive conglomerate with minor amounts of sandstone and shale. The strata have been folded and for the most part dip steeply north.

Region North of Big Tujunga Canyon

Erosion by Big Tujunga River has left only a thin band of upper Pico north of the canyon. The section varies from 0 to 200' in thickness and dips about 50 degrees north. An very resistant conglomerate which stands in almost vertical cliffs is the dominant rock. The boulders are from a fraction of an inch to on foot in diameter, well rounded and strikingly smoothed and polished. They are mainly from coarse granitic and gneissic rocks. Pebbles of basalt similar to that of the Topanga flow are numerous. The cementing material is a fine to medium grained arkosic sandstone which is free of clay material. This sandstone is very well compacted. Lenses and beds of sandy shale from ¼" to some feet in thickness occur.

Region South of Big Tujunga Canyon

South of Big Tujunga Canyon a folded series of marine sediments which are probably Pico in age are exposed. The position of the Pico-Modelo contact in the general region has never been definitely established. If Mason Hill's (*3) assumption that Modelo strata occur north of Tujunga Valley is correct, then these sediments are at least in part Modelo. However the present tendency is to place the Pico-Modelo contact on the west side of Tujunga Valley. In this report it is assumed that the contact lies in the latter place. Because of their stratigraphic position above the contact and their general resemblence to the Pico strata on the south side of Tujunga Valley (*2), these beds are classified as Pico. Minor folding makes the thickness of the section difficult to estimate. There are about 1800' of sediments exposed. There are four distinct members: (1) a lower shale, (2) a lower conglomerate, (3) an upper shale, (4) and an upper conglomerate.

Lower Shale Member

175' of folded and crumpled shale beds in the core of the anticline are exposed along Big Tujunga highway. The lower 75' of the member is made up mostly of a grey to brown, fine grained, very hard shale. Interbedded with this shale are thin layers of a medium grained, well compacted sandstone. A soft brown finely laminated shale makes up most of the upper 100'. A blue grey silty thick bedded shale is common. A 2' bed of very white, soft, finely laminated distamaceous shale 20' from the top of the member is distinctive. Minor amounts of hard white cherty shale and soft grey sandstone occur. The shale beds here, as in the Topanga, are marked on the surface by a growth of grass.

Lower Conglomerate Member

There are 900' of massive sandy conglomerate strata in this member which are exposed east and west of the lower shale. Individual beds range from 2' to 60' in thickness. The matrix of the conglomerate is a coarse arkosic iron stained sandstone which contains a large amount of biotite and shows some cross bedding. The number of boulders in the strata vary, the individual beds varying from almost pure sandstone to conglomerate. The boulders are sub-rounded, polished and iron stained. They are mostly of coarse granitic rocks, but basaltic boulders are common and there are a few pebbles of shale. The lower part of the member contains a few beds of grey silty biotitic shale. In the eastern exposure these conglomerate beds grade into land laid deposits of angular granitic boulders. The matrix here is a coarse gray angular fairly well consolidated sandstone. Boulders of lava occur. Bands of caliche are numerous.

Upper Shale Member

The upper shale member is approximately 200' thick. It is exposed on the eastern and western flanks of the anticline. The beds show a great deal of minor folding, but the dominant dip is toward the east. The strata that are exposed resemble those of the lower shale lithologicaly. Beds of a fairly hard, dark brown, medium grained sandstone are common.

Upper Conglomerate Member

525' of the upper conglomerate member is poorly exposed along the eastern flank of the anticline in this region. The conglomerate is made up of massive beds of rounded and polished boulders in a matrix of arkosic sandstone. The boulders are of acidic plutonic rocks and a volcanic rocks. The well rounded and polished boulders prove this conglomerate are distinct from the angular boulders of the alluvium lying to the east.

E. Saugus (Pliocene)

The Saugus formation lies above the Pico on the north side of Big Tujunga Canyon. Its thickness approaches 1200' along Ebbie Canyon, but it thins rapidly to the east. The Saugus is made up of loose pebbly sandstone, conglomerate, and siltstone. The beds are all thick, massive, poorly sorted and poorly bedded. They lack cementation but are fairly well consolidated. Lensing and lateral variation are pronounced. Poor sorting and bedding of sediments, sub-angularity of boulders, and absence of marine fossils indicate that the Saugus formation was land laid. "The distinct lithologic difference from, and superposition of the Pico allow these rocks to be tentatively assigned to the Saugus". (*4) Exposures of the Saugus are few, but there seem to be two members. The lower is of sandy conglomerate and the upper of sandstone and siltstone.

Conglomerate Member.

The lower conglomerate member reaches a thickness of 1075'. It is composed of a series of massive pebbly sandstones and sandy conglomerates. The sandy matrix is very arkosic, made up of angular grains, and is free from clay material, The boulders have diameters from ½" to 2'. They are sub-angular and mostly a granitic and gneissic rocks. Pebbles of various types of volcanic material are also common.

Siltstone Member

The upper siltstone member is 125' thick. It is distinguished by brilliant colors. Beds averaging 15' in thickness of red-brown mudstones and sandstones and green gray pebbly sandstone and siltstone form the member. Because of its striking colors, and its fair persistence, and its position at the top of the Saugus, this member makes a good marker bed.

F. Quaternary Sediments

Two Quaternary deposits are distinguished. They are both fjanglomerates of angular granitic and local basalt boulders. The matrix is a coarse sandstone. Cementation is lacking and consolidation is poor. The Kagel (older) beds are distinguished by there better consolidation, orange color, and higher topographic position. The recent alluvium is being alternately deposited and eroded in the valley bottoms. Both of these deposits lie with great angular unconformity on the Saugus and older formations and are therefore placed in the Quaternary.

VI Structure

The strata in this area have a regional dip of 45 degrees north. Superimposed on this regional dip are a number of local folds. Structually the area is again divided into two regions, north and south of Big Tujunga Canyon. The sediments north of the canyon are faulted against the basement complex. The dominant fold in this region is the Merrick Syncline. South of the Canyon the dominant fold is ananticline which pitches northward. The sediments are probably terminated to the east by a series of faults.

A. Faulting

The major faults in this area are of the reverse type, the basement complex and older formations having ridden up over the younger formations. There are two main fault zones. One is composed of a number of east-west faults which cut off the sediments to the north. The second zone runs north and south and cuts off the sediments to the east. The prominent faults, starting with the oldest, are described below.

Fault Buried By Basalt (?)

North of the basalt flow there is a steep 1000' scarp in the basement complex. If the thickness of the flow is removed, another 300' is added to the height of the scarp. This topographic feature is very possibly the result of a fault in the basement complex. The supposed fault is Middle Topanga (pre-basalt) in age. It had an unknown displacement, the north side having relatively risen. The fault was a part of the deformation at the end of the Topanga (*1.)

Akens Fault

The Topanga strata east of Doan Canyon dip north into the basement complex. The contact is therefore probably a fault. This fault dips 50 degrees north, and has had a vertical desplacement of 100' plus, the north side having gone up relative to the south side. The fault is overlain by a horizontal basalt flow at its western end and is therefore upper Topanga in age. It is also a part of the Topanga deformation.

Sunland Fault

The eastern half of the Sunland Fault forms the boundary between the basement complex and the sediments there is excellent field evidence proving the existence of this half of the fault, which consists of the following facts:

(1) The Saugus beds dip into the basement complex and in the northeastern corner of the area the Pico beds strike into the basement complex.

(2) The basement-sediment contact dips 70 to 80 degrees north.

(3) A gouge and shattered rock zone was formed in some places along the contact.

(4) There is a high scarp just north of the contact which is probably a combined fault and fault line scarp. The fault dips 80 degrees north on the average. The vertical displacement as estimated from the geight of the scarp was in the hundreds of feet. The basement complex to the north has been raised.

There is no actual field evidence for the continuation of the fault to the west between the Saugus and Topanga formations. However there are two reasons for placing the fault along this contact:

(a) A section over 3000' thick is missing north of the Merrich Syncline between the Saugus and Topanga. This fact might possibly be explained by thinning and overlap of the sediments. However it seems improbable that 2000' of fairly deep water marine strata (alternating shale and conglomerate) would pinch out in a distance of one half mile.

(b) The eastern half of the fault with its large displacement has to be continued somewhere to the west. The Saugus Topanga contact is the only place where the fault can be continued. The crumpling and folding of the Topanga shales north of the contact might be thought to be evidence for fault movement in their vicinity. However crumpling and folding is just as pronounced in the south Pico shales which have been subjected only to folding stresses. There is also a zone of weakness as evidenced by a series of saddles along the contact. However this weakness is more probably due to the low resistance of the shale member than to weakness of the faulted rock. The shale in the south Pico formation also gives rise to topographic lows.

Sterling Fault Zone (?)

There are possibly one or more buried faults running north and south between the sediments and the basement complex to the east. The sediments dip to the east as far as they are exposed. The sharp bend to the north in both the Sunland Fault and the Pico formation indicates that the block east of the fault zone moved relatively northward.

Minor Faults

1. There is a normal fault through the north side of the small hill on the south side of the mouth of Big Tujunga Canyon. The fault is made apparent by the sudden change in altitude of the Pico strata on either side of its plane. An additional evidence is the fact that the shale strata on the north side of the fault are progressively more buckled nearer the fault plane. The fault strikes North 60 degrees east and dips 50 degrees north. Assuming that the shale and overlying conglomerate north of the fault are the upper shale member and upper conglomerate member, the dipslip displacement has been 2000'. The north side has gone relatively down and northward.

2. The isolated Miocene patch in the extreme south east corner of the area is bounded on the north by a fault. This fault is a thrust, the basement complex having ridden south over the sediments. The fault strikes North 70 west and dips northward. The displacement is unknown.

B. Folding

The axis of the two large folds in the area are in each case paralled to the adjacent major fault zone. The faulting apparently has been the end product of folding.

The Merrick Syncline

The axis of the Merrich Syncline, which is located in the upper Saugus sediments, strikes North 70 west. The southern limb of the syncline is long, continuing out of the area and across Tujunga Valley except where it is terminated by a minor fault. The dip of the strata on the southern limb is 50 degrees north at the edge of Tujunga Canyon. The dips become less toward the synclinal axis. The northern limb is acute, the sediments dipping steeply to the south. The comparative shortness of the northern limb, the position close to the Sunland fault, and the trend parallel to the Sunland Fault of the Merrich Syncline indicate that the syncline has been formed by drag from movement on the fault. In the area covered by this report the syncline appears to be due to drag from the Sunland Faults. However Mason Hill in his report on the general region says that elsewhere the syncline does not follow the trend of the fault and is not a drag fold. The syncline dies out a short distance east of Akens Canyon due to its north west plunge, (*3.)

Anticline in Pico Strata

South of Big Tujunga Canyon the Pico sediments have a complex structure. From the field evidence available it appears that the strata are folded into an anticline plunging 30 degrees north. The anticline is unsymmetrical. The beds of the west limb flatten repidly away from the axis. The beds on the other limb, however, dip 70 degrees east as far east as they are exposed.

Minor Folding

There is a terrace or zone of local flattening of dips in the Saugus strata east of Akens Canyon. The beds level off from 50 degrees to about 2 degrees, then bend sharply downward again to the north.

As has been stated, the incompetent shale members in both the Pico and Topanga formations show a great deal of minor folding and crumpling.

Miscellaneous Structural Features

1. Topanga Overturned

If the Topanga formation has been folded in late Topanga and then faulted into place it is not necessarly overturned in spite of its position on the northern flank of the Merrick Syncline. However there are several reasons for believing that these beds are actually overturned. (a) The sediments become finer grained to the south. (b) There is a bed near the middle of the sandy conglomerate member which is made up almost entirely of small rounded pebbles. This bed is markedly different from any, the surrounding beds. Chuncks of this bed were observed in the lower part of the sandstone bed lying to the south. (c) The northern sandy conglomerate and southern shale members correspond respectively to the middle conglomerate and upper shale members in the Topanga of the Santa Monica Mts.(*1)

Notes on the Structure

There have been two periods of deformation in this area. The first, at the end of Topanga time, was expressed by folding, faulting, and volcanic activity. The second has affected the Saugus formation but not Quaternary deposits. The fault scarps of this period have suffered a great deal of erosion. The second period of deformation is therefore dated as Pleistocene. The major stress in both of these periods seems to have been a compression acting in a North Northeast - South Southwest direction. This compression produced folding culminating in a series of reverse faults.

VII Geologic History

Summary of the Geologic History

1. Plutonic intrusion and metamorphism in Jurassic (?) time.
2. Uplift and uncovering of plutonic rocks by erosion followed by marine invasion and deposition during the Topanga.
3. Folding, faulting, erosion followed by volcanic activity at end of Topanga.
4. Deposition of Modelo basal conglomerate and sandstones.
5. Deposition of Pico conglomerates and shales.
6. Retreat of sea followed by terrestrial deposition of Saugus.
7. Folding and uplift by reverse faulting during early Quaternary.
8. Erosion followed by deposition of terrace Kagel.
9. Renewed erosion in recent time. Minor alluvial deposition in valley bottoms.

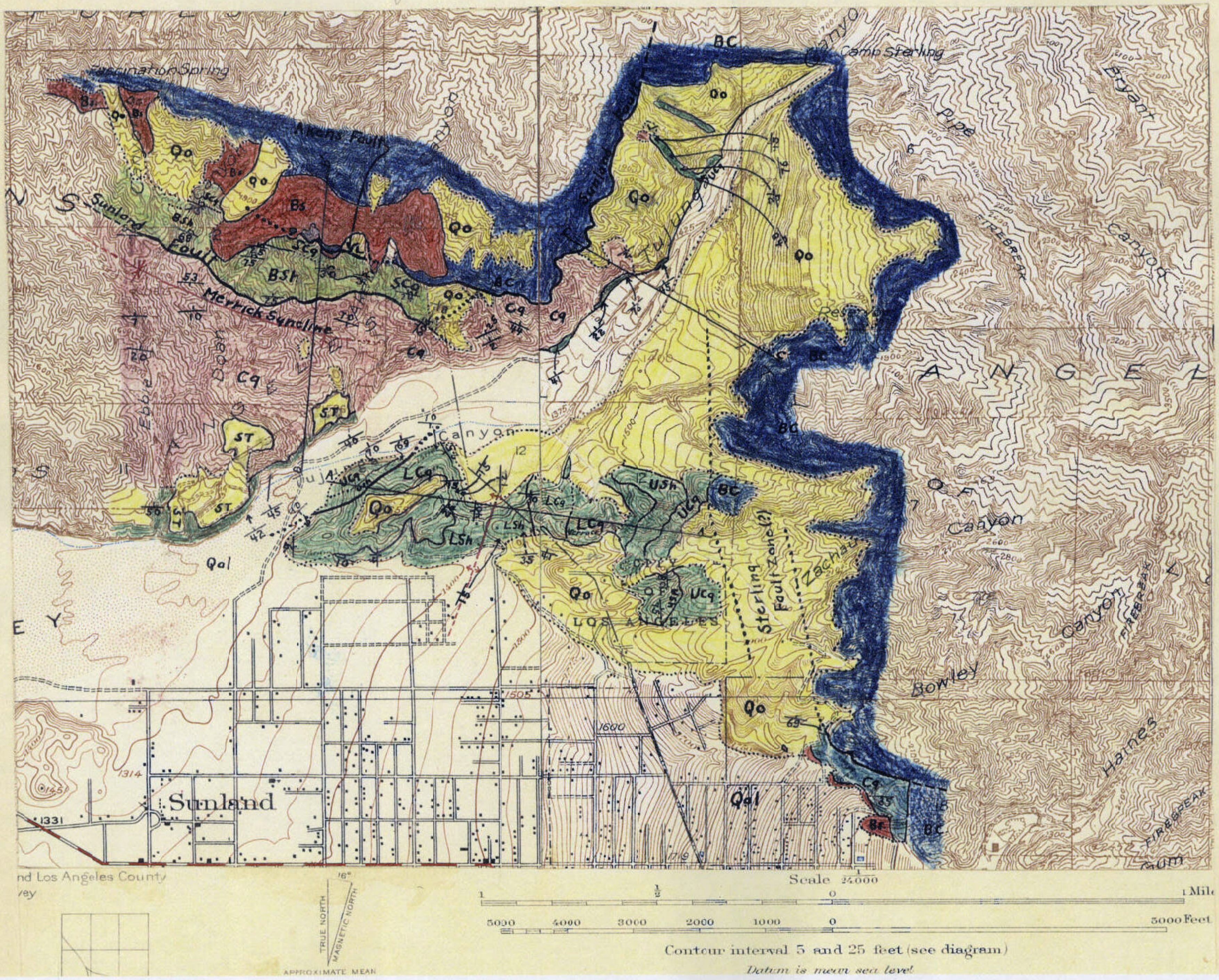
Bibliography

(1) H. W. Hoots, "Geology of the Eastern Part of the Santa Monica Mountains" U.S.G.S. P.P. 165

(2) Senior thesis of Mr. Lockwood, Calif. Inst. of Tech. 1937.

(3) Mason Hill, "Structure of the San Gabriel Mountains" U. Calif. Pub. in Geological Sciences #19

(4) W. S. Kew "Geology and Oil Resources of part of Los Angeles and Vetura Counties, California." U. S. G. S. Bull. 753


Fascination Spring
Aliens Fault
Sunland Fault
Merrick Syncline
Ebbie
Doan
Camp Sterling
Bryant
Pipe
Canyon
FIREBREAK
Sterling Fault Zone(?)
Zachau
Bowley
Haines
LOS ANGELES
Sunland
Qo
Qal
Cg
ST
BC
LCg
LSh
USh
UCg
BSt
BSh
SCg
Bs
1331
1314
1600
nd Los Angeles County
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN
Scale 1/24000
1 Mile
5000 Feet
Contour interval 5 and 25 feet (see diagram)
Datum is mean sea level

EXPLANATION

Sedimentary Rocks

Qal

Recent Alluvium

(Coarse unconsolidated deposits in valleys)

Qo

Kagel (Pleistocene)

(Alluvial terrace deposits)

Cq

Saugus (Pliocene)

(Land laid sandy cg. with some siltstone)

UCq

USh

LCq

LSh

Pico (Pliocene)

(Sh. & cg.)

Cq

ielo (Miocene)
(Cg)

BSh

SCq

Topanga (Miocene)

(Cg. & sh.)

Igneous Rocks

Bs

Basalt (Topanga)

BC

Basement Complex (Jurassic?)

(Qtz. diorite, schist.)

Contact
(Solid where traced, dotted where approximate)

Axis of anticline

Axis of syncline

Fault
(Solid where traced, dashed where approximate, dotted where buried.)

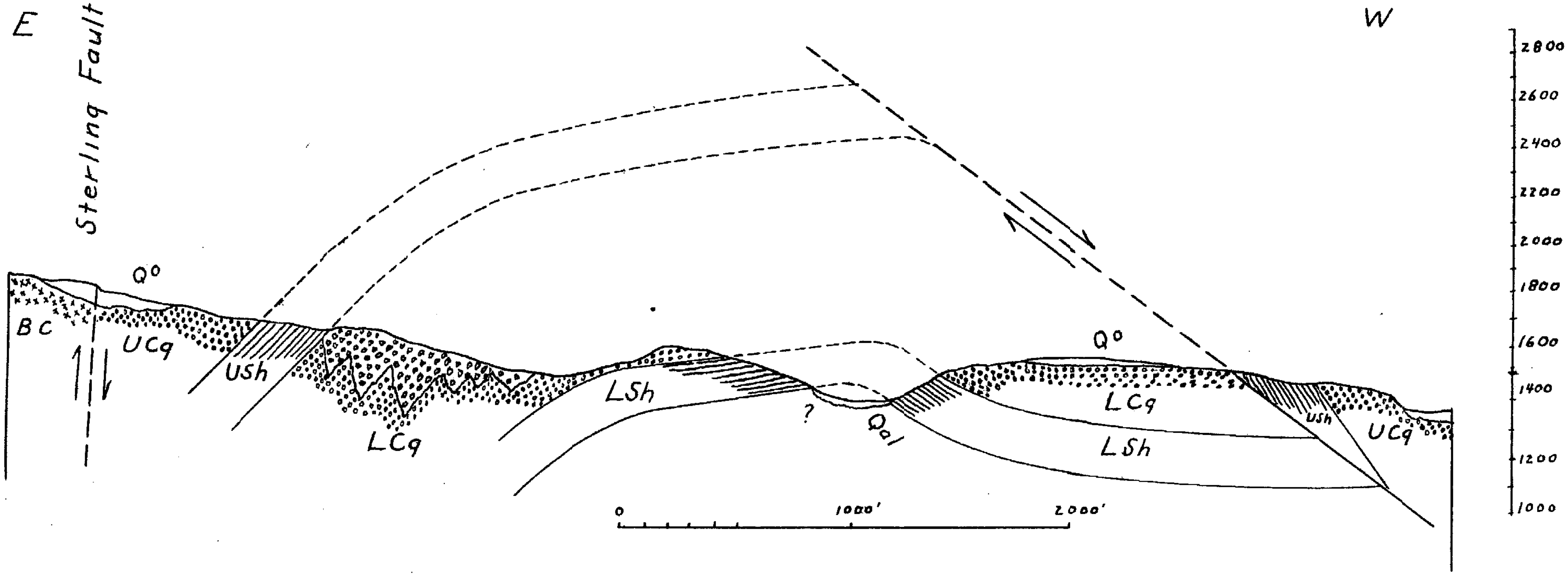
60

Dip and strike of strata

60

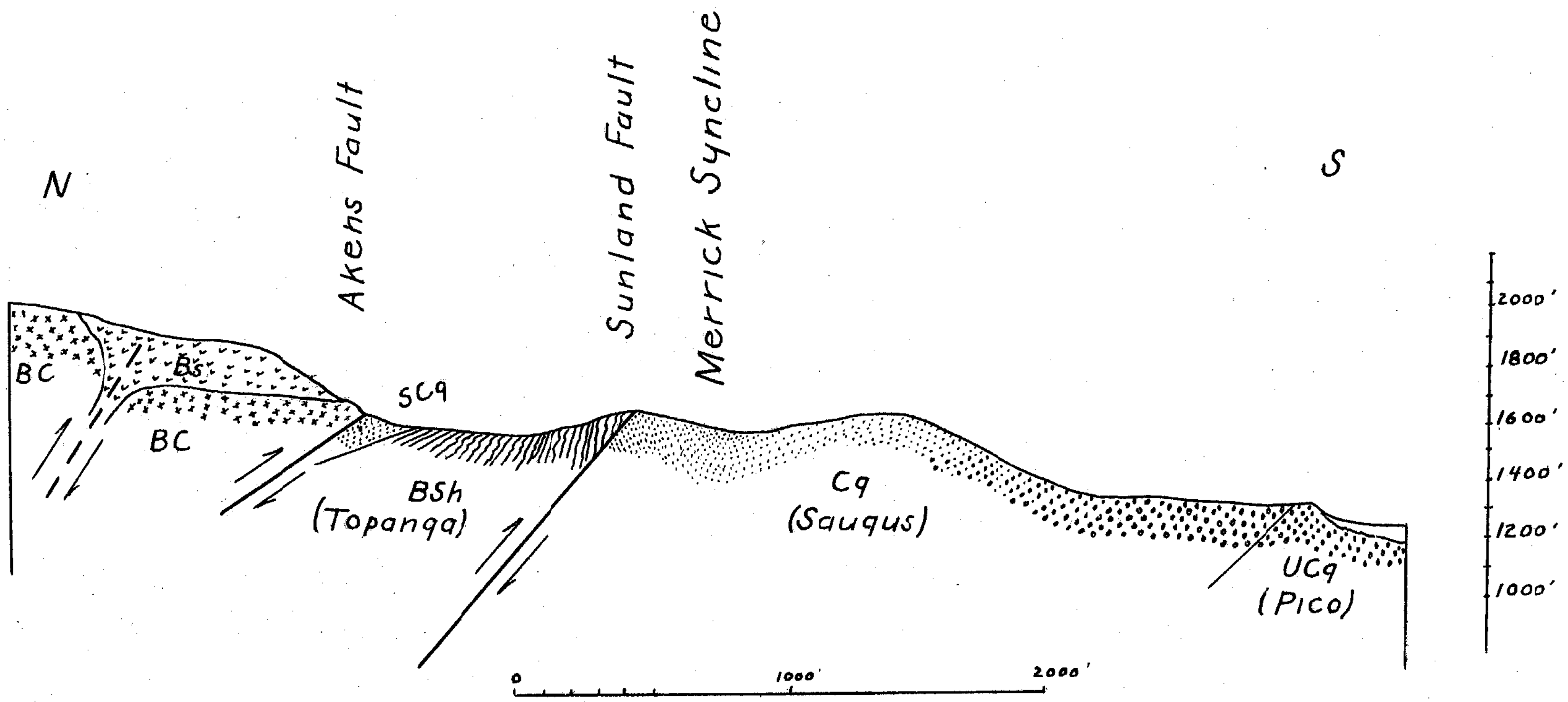
Overturned strata

Section A-A'

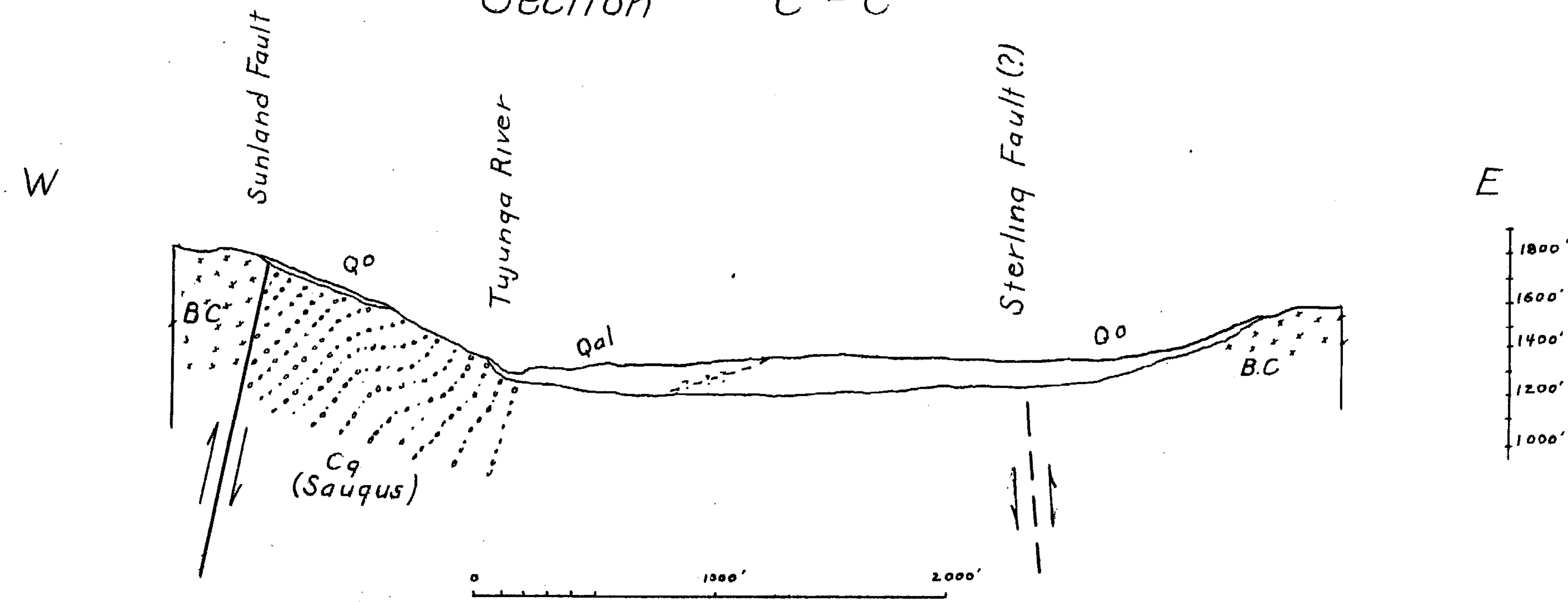


E
W
Sterling Fault (?)
Qo
BC
UCq
USh
LCq
LSh
?
Qal
Qo
LCq
LSh
USh
UCq
0
1000'
2000'
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000

Section B - B'


N
S
Akens Fault
Sunland Fault
Merrick Syncline
BC
Bs
BC
SCq
BSh
(Topanqa)
Cq
(Sauqus)
UCq
(Pico)
2000'
1800'
1600'
1400'
1200'
1000'
0
1000'
2000'

Section C - C'



W
E
Sunland Fault
Tujunga River
Sterling Fault (?)
Qo
Qal
Qo
B.C
B.C
Cg
(Saugus)
0
1000'
2000'
1800'
1600'
1400'
1200'
1000'