THE UPPER CRETACEOUS PALEONTOLOGY AND STRATIGRAPHY OF THE SIMI HILLS, LOS ANGELES AND VENTURA COUNTIES, CALIFORNIA.

by

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A Thesis Submitted in Partial Fulfillment
of the Requirements for the
Degree of
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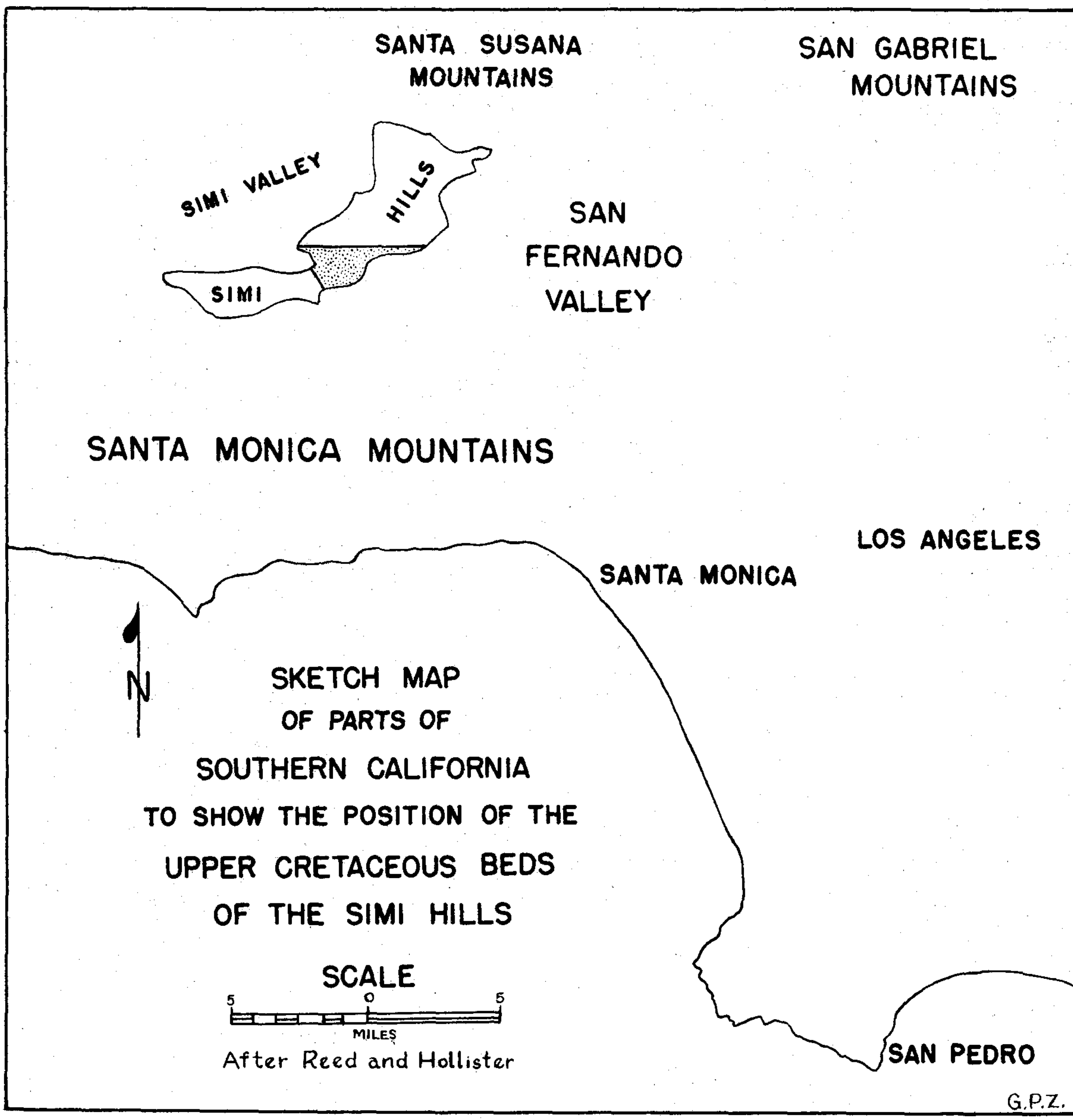
1943

Figure 1.


SANTA SUSANA MOUNTAINS
SAN GABRIEL MOUNTAINS
SIMI VALLEY
HILLS
SIMI
SAN FERNANDO VALLEY
SANTA MONICA MOUNTAINS
LOS ANGELES
SANTA MONICA
N
SKETCH MAP OF PARTS OF SOUTHERN CALIFORNIA TO SHOW THE POSITION OF THE UPPER CRETACEOUS BEDS OF THE SIMI HILLS
SCALE
5 0 5
MILES
After Reed and Hollister
SAN PEDRO
G.P.Z.

ABSTRACT

The Upper Cretaceous strata of the Simi Hills in the region of Dayton and Bell Canyons are divided into two series of lithologically dissimilar beds. The lower shale series is further divisible into three members. The basal member of the lower series is a fossiliferous shale, probably 200 feet thick, which is overlain by an alternating series of fossiliferous, calcareous sandstones and sandy shales, attaining a thickness of approximately 1,000 feet. The upper member of this group is an unfossiliferous gray shale with an estimated average thickness of 200 feet. The beds of the lower shale series are unconformably overlain by the Topanga formation and faulted against the massive sandstones. The upper massive sandstone series is remarkable for its lithologic homogeneity and uniform development throughout the area of its exposure. Broken in only two places by relatively thin shale beds, the monotonous layers of arkose total 5,500 feet in thickness. Due to faulting and differential overlap by other formations, the total thickness of the Upper Cretaceous deposits cannot be measured. The structure, though locally complex, is in the main rather simple. The Simi Hills form the southeastern flank of the Simi syncline. An accessory syncline is developed in the northern stretches of the Upper Cretaceous exposure. Three moderately large

faults are present in the area of the report.

The species assemblage is similar to that of the Glycymeris veatchii fauna of the Santa Ana Mountains. It can be divided into two subdivisions which are referred to the Turritella chicoensis perrini division and the Metaplacenticeras pacificum division of the upper part of the Glycymeris veatchii fauna.

The incomplete basal shale member in the Simi Hills is correlated with the upper portion of the Holz shale member of the Williams formation in the Santa Ana Mountains. The middle and upper members of the lower shale series, and at least the lower 1,500 feet of the massive sandstone series are termed equivalents of the Pleasants sandstone of the Williams formation which forms the uppermost member of the Cretaceous deposits of the Santa Ana Mountains.

PURPOSE OF REPORT

A general study of the detailed stratigraphy and faunal divisions of the Upper Cretaceous of the Pacific Coast, especially the California region, has been instituted by Dr. W. P. Popenoe of the California Institute of Technology. He has published[1] a complete discussion of

1/ Popenoe, W.P., "Upper Cretaceous Formations and Faunas of Southern California," Bull. Amer. Assoc. Pet. Geol. (1942), Vol. 26, No. 2, pp. 161-187.

the Upper Cretaceous deposits of the Santa Ana Mountains, southern California. As yet incomplete is a similar paper on the deposits of Shasta County. Numerous areas of Upper Cretaceous age have been well known for many years since they form the classical type localities for most of the fauna. Recently H. D. B. Wilson undertook to correlate the deposits of the Santa Monica Mountains and his conclusions are included in a paper by Popenoe[2].

2/ Popenoe, W.P., ibid., pp. 176-180 and 186.

The writer took this present problem under the instigation of Dr. Popenoe in order to clarify the faunal and stratigraphic relation of the Upper Cretaceous of the Simi Hills to the Santa Ana Mountains section. Only the critical fossiliferous beds underlying the massive sandstones of the Simi Hills are included in this study, for the sandstones have been so characteristically barren of fossils, except for two widely separated localities, that they have been regarded at times as of continental and on other occasions as of marine origin (figure 2). The purpose of this report is, therefore, to make a detailed study of the biostratigraphy of the Simi Hills and the relationship of its faunal history to that of the Santa Ana Mountains.

In conclusion, this thesis is submitted in partial fulfillment of the requirements for the Degree of Master of Science to the California Institute of Technology.

ACKNOWLEDGMENT

This problem was first suggested and generally supervised by Dr. W. P. Popenoe of the California Institute of Technology. In the conduct and completion of the research recorded in the present thesis it has been my very good fortune to partake in the comprehensive program of studies on the Upper Cretaceous of the Pacific Coast undertaken by Dr. Popenoe. He has not only guided me in the study of the fauna from the Simi Hills, but has assisted me in placing at my disposal all of the fossil invertebrate collections from the Santa Ana and Santa Monica Mountains that he, Dr. B. N. Moore and Dr. H. D. B. Wilson have collected in past years. Dr. Chester Stock has critically reviewed the completed manuscript and in the course of study has aided in many ways. The conduct of the field work and the study of the structural details in the area have been carried out under the direction of Dr. F. D. Bode. His suggestions and criticisms have helped materially in working out some of the problems encountered in the field.

All of the residents of the area in which the writer has worked have cooperated most generously. Permission to trespass private property, and information on the location of fossil beds, names of canyons, and past history of the region were freely given. Special courtesy has been extended the writer by L. J. Burrud of the Hearst Sunical

Land and Packing Co., C. L. Martin of Dayton Canyon, and by Paul Johnson of the Johnson Citrus Fruit Ranch.

REVIEW OF PREVIOUS LITERATURE

Approximately seventy-five years ago W. M. Gabb first called attention to the Pacific Coast Cretaceous deposits and faunas. Since then many authors have contributed papers on the stratigraphy and paleontology of this period. But not until 1936 was a key to the faunal succession in all but the broadest aspects presented. In that year the Upper Cretaceous molluscan sequence in the Santa Ana Mountains was presented in detail, furnishing thereby a basis for further study to understand the relationships of the several units of the Upper Cretaceous on the Pacific Coast[3/].

3/ Popenoe, W.P., California Inst. Tech. Ph. D. Thesis (1936).

Although the Simi Hills show only a small section of Upper Cretaceous rocks, a number of published accounts relate or refer to these deposits. In the closing decades of the 19th century the massive sandstones of the area were examined with a view to utilizing this material as building stone. W. A. Goodyear (1)[4/] and W. H. Storms (2) described

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4/ The numbers in parentheses refer to the bibliography included at the end of the report.

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the presence of the stone, but gave no age determination. It is interesting to note that the massive sandstones were later quarried in the vicinity of Chatsworth and utilized in the construction of the Los Angeles Harbor breakwater. In 1899 Stephen Bowers collected fossils in the region of Dayton Canyon (our locality 1159 in this area) and made this material available to paleontologists of the Pacific Coast. J. P. Smith (3), in 1900, noted the occurrence of Placenticeras californicum Anderson in the material comprising Bowers' collection, thus assigning a "Chico" Cretaceous age to the Simi Hills deposits. Several years later F. M. Anderson (4) revised this genus, designating it Metaplacenticeras californicum (Anderson), and noted its "Chico" age.

One of the major contributions to the stratigraphy of the Simi Hills was that of C. A. Waring (5), who, although primarily interested in the Martinez Eocene, published a long faunal list and the first detailed map of the "Chico" Upper Cretaceous beds. W. S. W. Kew (7) later mapped the distribution of the geologic formations in this region and briefly discussed the massive sandstones and underlying shales of the "Chico" beds, basing the age determination of the formation on the work of Waring. In the more recent work by W. P. Popenoe (8,9,10) the faunal succession and correlation of these deposits have been revised in the light of the sequence of late Cretaceous rocks of the Santa Ana Mountains.

Throughout the history of the discussion of "Chico" strata in the Simi Hills, various authors have correlated this horizon with the "Chico" in other California Cretaceous sections. Smith (3) and Anderson (4), on the basis of the presence of Metaplacenticeras californicum (Anderson). referred the Simi Hills beds in time to those at Henley, Siskiyou County, and Arroyo del Valle, Alameda County, California. Waring (5) considered the basal sandstones of the "Chico" in the Santa Monica Mountains as the approximate equivalent of the upper massive sandstones in the Simi Hills. The upper "shales" in the former region formed the top of a combined section which was tentatively correlated with the "Chico" of northern California[5/]. Kew (7), on purely litho-

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5/ Waring, C.A., "Stratigraphic and Faunal Relations of the Martinez to the Chico and Tejon of Southern California," Proc. California Acad. Sci. (1917), 4th Ser., Vol. 7, No. 4, p. 56.

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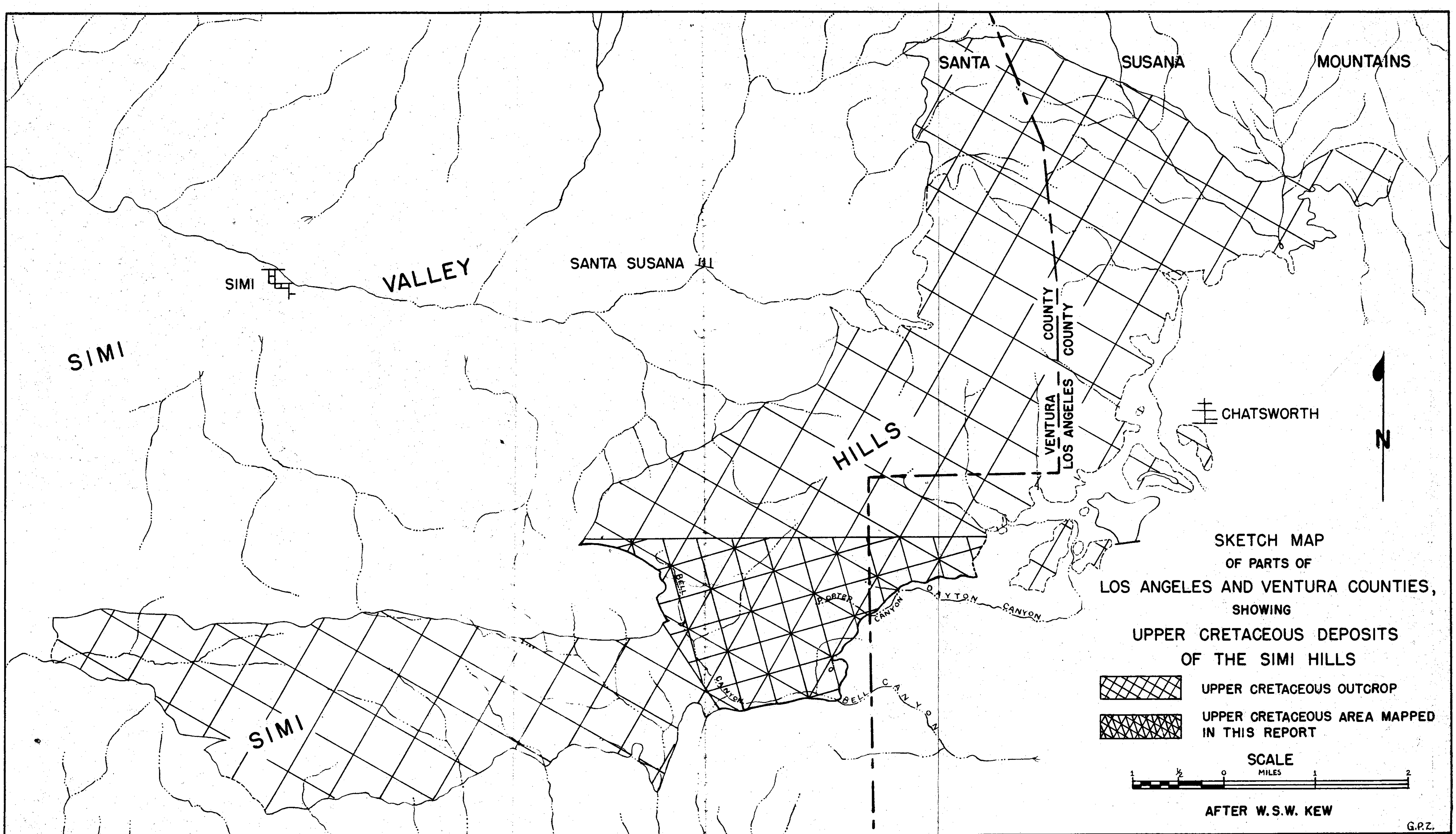
logic grounds, pointed out the resemblance of the massive "Chico" sandstones to the Panoche formation of the Coalinga region, Fresno County, California. The assemblage of fossils from the Upper Cretaceous of the Simi Hills is very similar in its specific representation and relative abundance of individual forms to that found in the uppermost divisions of the Santa Ana Mountains section of Popenoe (10), and to that occurring in the upper fossiliferous Cretaceous strata of the Santa Monica Mountains described by Wilson (10).

Figure 2.



SANTA
SUSANA
MOUNTAINS
SIMI
VALLEY
SANTA SUSANA
SIMI
HILLS
COUNTY
COUNTY
VENTURA
LOS ANGELES
CHATSWORTH
N
BELL
PORTER
CANYON
DAYTON
CANYON
CANYON
BELL
CANYON
SIMI
SKETCH MAP
OF PARTS OF
LOS ANGELES AND VENTURA COUNTIES,
SHOWING
UPPER CRETACEOUS DEPOSITS
OF THE SIMI HILLS
UPPER CRETACEOUS OUTCROP
UPPER CRETACEOUS AREA MAPPED IN THIS REPORT
SCALE
MILES
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AFTER W.S.W. KEW
G.P.Z.

LOCATION AND GENERAL GEOLOGIC FEATURES

Location of Area

The Simi Hills are a low northeasterly trending range forming the western boundary of the San Fernando Valley. They are situated about 25 miles northwest of the business district of the city of Los Angeles. The range is bounded on the north by the Santa Susana Mountains, its border being coincident with the Santa Susana thrust fault. On the south the gentle slopes of the hills descend into the Conejo Valley immediately north of the extreme western end of the Santa Monica Mountains. The Upper Cretaceous deposits make up the summit areas and the southeastern and eastern flanks of the range. Their slightly curving outcrop extends on either side of the Los Angeles-Ventura county line. The Cretaceous belt is approximately 16 miles long and varies from 2 to 3 miles in width. These well stratified deposits of resistant sandstone structurally control the trend and shape of the Simi Hills.

Vegetation and Culture

An airplane view of the Simi Hills shows that almost half of the region is composed of bare rock outcrops of thick bedded, moderately tilted, complexly jointed, massive sandstones. In much of this area cliffs that are nearly vertical are a dominant feature of the landscape. Steeply eroded beds piled one on top of the other make of each canyon wall a series of giant steps. Moderately dipping "strike ledges" on which the gradient is too steep to permit formation of a soil mantle are formed by a deeper weathering and retreat of each overlying bed. However, on the wider "strike ledges" a dense interwoven growth of tall chaparral and small scrub oak, almost impenetrable, makes geologic work difficult. On the north sides of the hills and canyons the vegetal cover is even denser and with a paucity of roads and trails further hinders a detailed examination of the region. Tall coarse grass, weeds, scrubby black walnut trees and great stretches of sage-brush are found on the shaley soils of the basal beds. So characteristic is this plant cover that the soils derived from the shales can readily be distinguished on this basis from those of the sandstones. All of the canyons with intermittent streams support a dense growth of poison oak and groves of sycamore, California live oak, and cottonwood.

A small portion of the area is under cultivation and feed is raised for winter stock. In the shaley areas, on canyon bottoms and flat summit meadows grow an abundance of grass utilized for grazing. Along the base of the hills and in the protected valley lowlands of both the San Fernando and Simi Valleys are abundant orchards of citrus trees and walnuts. Only two dry-weather roads cross the Simi Hills. These are both U. S. Forest Service roads.

However, the ruggedness of the topography and the denseness of the brush make the Simi Hills a very difficult region to traverse.

Physiography

The Simi Hills rise above the floors of the Simi and San Fernando Valleys to an average height of 2,000 feet above sea level, with the crest line remarkably constant at that elevation. As previously mentioned, the massive Upper Cretaceous sandstones structurally control the shape and trend of the Simi Hills. The northern part of the range curves gently around the northeastern end of the Simi syncline which is the dominant fold of the area. However, an accessory fold, the Santa Susana syncline, affects the Cretaceous sandstones, for these are involved in the folded strata.

The eastern flank of the range presents a steep erosional scarp bounding the San Fernando Valley synclinorium, while to the west the hills slope gently into the syncline of the Simi Valley. The summit area of the range is unusually flat and in places is slightly alluviated forming wide meadows along the Cretaceous exposures. The eastern and western borders of the interior meadow areas are respectively, the projected dip slopes of the massive sandstone layers as they rise toward the high eastern erosional scarp, and the western cliffs of the basal

Martinez (lower Eocene) conglomerates. Consequently the central region is drained by a linear series of extended subsequent streams whose tributaries form a rude trellis pattern. Most of the remaining streams of the Simi Hills are obsequent with subsequent headwaters and tributaries flowing through deeply incised canyons.

The shale area between Dayton and Bell Canyons has weathered into a grayish-buff soil which contrasts with the red colored coarse soils derived from the sandstones. The topography of the more deeply eroded shale region is low and rolling with wide canyons in which the streams meander. In marked contrast is the sharp angular topography produced by the erosion of the massive sandstones. The deep narrow canyons often end blindly against a sheer cliff of massive resistant beds, and the canyon walls are usually a series of giant steps formed by the erosional retreat of each overlying layer. Locally on the ridge crests and canyon sides, there is often developed a "rock city" type of topography. Waterfalls, rapids, caves, aeolian fretwork and other minor but interesting geomorphological features abound in the great expanse of bare rock outcrops.

Structure

Broadly speaking, the Simi Hills form the southeastern flank of the Simi syncline. The general structure of the Upper Cretaceous beds and in fact the whole of the Simi

Hills region is rather simple, though locally complex. The main structural feature of the Upper Cretaceous deposits is the east-west trending fault crossing the range in the region of Dayton Canyon and the upper stretches of Bell Canyon. This fault tends to separate the Cretaceous exposure into two parts, each having a slightly different grain. North of the fault the massive sandstones have a regional dip of approximately 30° to the west and their strike forms an arc around the eastern end of the westwardly plunging Santa Susana syncline. The steep and rugged eastern erosional scarp of the range, as its name implies, probably results from an ancient sea-cliff topography. It shows a very steep sinuous outline with no suggesting of faulting, for in the vicinity of the Chatsworth Reservoir a group of low outliers whose beds conform in strike with the main sandstone body, are definitely exposed. The development of a flat anticline whose axis lies along the continuously alluviated valley area between the massive sandstone scarp and the outliers is suggested because low eastern dips are recorded on the most southerly exposure of this group. This feature is also borne out by Kew[6] and

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6/ Kew, W.S.W., "The Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California," U. S. Geol. Survey Bull. 753 (1924), plate I.

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is furthermore indicated on the tectonic map of Reed and

Hollister[7], probably on the basis of the information sup-

[7] Reed, R.W. and Hollister, J., "Structural Evolution of Southern California," (1936), plate I.

plied by Kew.

South of the main fault the massive Cretaceous sandstones show a homoclinal dip of approximately 30° to the west, steepening a bit as the beds approach the fault zone. The strike of this portion of the section parallels the trend of the Simi syncline which forms the main structural feature of the northern portion of the Calabassas Quadrangle.

The region of this report contains almost all of the faults now known in the Simi Hills. The previously mentioned main fault of the area truncates the other two and in both cases tends to slightly obscure their relationships both to each other and to the massive sandstones. The large fault truncates the sand and shale beds of the lower shale section of the Upper Cretaceous at the head of Dayton Canyon, and to the east cannot be traced beyond the unconformable contact with the Topanga formation (middle Miocene). To the west the fault trace takes the shape of a large flat parasigmoid curve, extends across the strike of the Upper Cretaceous sandstones, and can be traced into and through the basal conglomerates, sands and shales of the Martinez formation. According to Kew[8] it is finally

[8] Kew, W.S.W., op. cit., plate I.

lost at the base of the Sespe formation (Oligocene) after passing through the Martinez, Meganos (middle Eocene) and Tejon (upper Eocene) formations. Thus its age can be determined as post-upper Eocene and pre-Oligocene. It is a high angle normal fault trending approximately east and west across the central portion of the Simi Hills. The displacement, shown by offset basal beds of the Martinez formation, is in the vicinity of 3,500 feet. The downthrown side is to the south. The fault plane can be easily traced in the region of the Martinez formation but within the massive Cretaceous sandstones it can only be determined by a concentration of shattered rock close to the fault zone and by great slabs of calcite strewn on the surface which show the presence of several generations of slickensides.

Next in importance is the fault which brings the almost vertically dipping lower shale section into contact with the massive sandstones. This fault parallels the sinuous contact of the Topanga formation and trends northeasterly between Bell Canyon and Dayton Canyon, being slightly oblique to the strike of the shale beds. It is definitely a high angle fault, but whether it is of normal or reverse type is a matter that cannot easily be determined. The amount of displacement is unknown but in all probability it is nor large since the upper beds of the shale section and the lower portion of the massive sandstones carry very similar faunas. The shales on the east side of the fault have been upthrown against the massive sandstones on the west. The northern end of the fault is truncated by the main fault and its southern end is covered by the beds of the Topanga formation. Only future drilling records in the .region will bring to light the correct displacement on this fault.

The third fault of the region forms the western boundary of a trigonal block of massive sandstone whose strike is approximately normal to the strike of the main body of massive sandstones. The dip of this block, though steepening to approximately 45° in the western corner, is similar to that of the rest of the section. The genetic relations of this fault to other faulting in the region is rather obscure, for no hint of its northward development can be traced from the point where it is truncated by the main fault, and its southern trace gradually disappears within the Cretaceous sandstones near Bell Canyon. All of the beds to the southwest of this fault show a great deal of drag folding and the offset of a small area of Martinez conglomerates and sandstones forms an excellent means of measuring the maximum displacement. The writer has mapped this fault as a high angle, obliquely slipping fault with the horizontal movement probably dominant. The southwest side has moved southeast and down in relation to the northeast side. The displacement is of the magnitude of 1,000 feet.

In mapping this portion of the Calabassas Quadrangle, the writer has found no discrepancies between his work and that of Kew [9]. Hence field mapping has been considered

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9/ Kew, W.S.W., op. cit., pp. 11-13, plate I and II.

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relatively unimportant and in the present thesis problems of taxonomy and correlation have received principal attention.

UPPER CRETACEOUS STRATIGRAPHY OF THE SIMI HILLS

Introduction:- Detailed reconnaissance mapping of the Upper Cretaceous strata in the region covered by this report (figure 2) failed to reveal any noteworthy differences in the distribution and relationships of strata as determined by Kew[10/]. For that reason, a detailed account of the lithology and stratigraphy is presented, and only minor additions are made to the brief discussion by Kew[11/]. Because of the brevity of the present report, the minor economic importance of the Simi Hills, and the fact that geologic correlation is stressed particularly, no attempt is made to classify the stratigraphy. It likewise suffices for present purposes to employ the more general term "massive Upper Cretaceous sandstone" for a particular horizon rather than designate it by a formational name.

The Upper Cretaceous deposits of the Simi Hills consist of two very distinct units. The lower shale unit can be subdivided into three members on the basis of lithology. The upper massive sandstone unit is remarkable for its uniform development and similarity over the entire region.

10/ Kew, W.S.W., op. cit., plate I.

11/ Kew, W.S.W., ibid., pp. 11-13.

<u>Upper Cretaceous Shale Series</u>:- The basal shale series of the Cretaceous is exposed in the form of a narrow sliver between Dayton Canyon and Bell Canyon. Its limited geographic extent is due to faulting and the overlap of the Topanga formation (middle Miocene). The total thickness of this unit is approximately 1,000 to 1,300 feet. Lithologically, it can be subdivided into three members.

The basal member, 200± feet thick, is composed of thin bedded, dark gray, grayish-buff weathering, concretionary shales. It contains many intercalated layers of buff, medium grained, arkosic sandstones and a single thicker bed of extremely fossiliferous calcareous sandstone. The only exposure of this member is in Bell Canyon.

An intermediate member, consisting of medium grained, gray, brown to white weathering, calcareous sandstones, interspersed with beds of sandy shale which progressively thicken toward the base, forms prominent "strike ridges" where it outcrops in the region of Dayton and Porter Canyons. This member is approximately 1,000 feet thick and in some areas is so richly fossiliferous that it could be termed a coquina. The sandy binding material of these limy beds is very arkosic and contains concretions of fine, gray, micaceous sand.

The upper member is a thin bedded, greenish-gray, grayish-buff weathering, unfossiliferous, concretionary shale. Although it is only 200± feet thick its presence is well defined by a series of deep cols along the strike.

This steeply dipping (averaging 73°) lower portion of the Upper Cretaceous section is so badly faulted that it is almost impossible to obtain a true picture of its normal development; hence, the thicknesses listed are only approximates. Since the shale series is faulted against the massive sandstones and both are progressively overlapped to the northeast by the basal conglomerate and limy beds of the Topanga formation, the total thickness of the section cannot be measured.

Upper Cretaceous Massive Sandstone Series:- Dominating the areal exposure of the Upper Cretaceous of the Simi Hills is a tremendous development of massive sandstones. This series, 5,500 feet in thickness[12/], extends along the summit region

12/ Kew, W.S.W., op. cit., p. 12.

of the range, an area 16 miles long and 2 to 3 miles wide. In the portion exposed north of the main fault of the Simi Hills, where the section is most complete, the dip is remarkably constant, averaging approximately 30°, while the strike of the beds curves gently around the Santa Susana syncline. The axis of this syncline lies a little north of the main arterial crossing Santa Susana Pass and connecting the San Fernando and Simi Valleys. West of Bell Canyon the beds have a similar dip, but tend to strike parallel to the main Simi syncline. The topographic expression of the massive sandstone series has been described in the preceding discussion on the physiography of the region.

The individual strata of the massive sandstones vary in thickness from 6 to 100 feet. Each bed is separated by thin bands of silt or fine sandstone, usually from 6 inches to several feet in thickness. Oxidation of the rich biotite content of the partitioning laminae tends to color them dark brown. Almost all of these silty layers carry abundant impressions of plant remains and some contain foraminifers.

The massive sandstones are gray, buff to brownish-orange weathering and highly arkosic with a remarkably uniform grain size from the bottom of the section to the top. At frequent intervals throughout the section small pebble to cobble size conglomerate lenses occur, usually immediately above the silty partitioning layers. It is in these lenses that the rare fossils of the series occur. Scattered irregularly throughout almost all of the individual sandstone beds are isolated pebbles and cobbles, the largest observed being about the size of a pair of doubled fists. These rock fragments, all well water-worn and universally spindle-shaped, tend to weather out of the sandy matrix to form small clusters of loose pebbles in any slight depression and form the dominant tools of the streams of the region. Also incorporated in the massive strata are large concretionary masses, spherically weathering, that usually form the erosion-nuclei for the many small caves developed by both wind and water.

The monotonous regularity of the massive beds is broken in only two places by brown weathering, iron-stained, gray shales. One bed outcrops near the middle of the section in the vicinity of Box Canyon and the other close to the top of the section near the Chatsworth approach to the Santa Susana Pass road. The lower shale bed is approximately 200 feet and the upper only 100 feet in thickness.

The feldspar content of the arkosic massive sandstones is dominantly orthoclase. Microcline follows in relative abundance and oligoclase and andesine are sparingly represented by isolated crystal fragments. Two distinct types of quartz are present in all thin sections. One type is badly strained and invariably contains bubble-like inclusions and fine cracks; the other is free of all distinguishing features. Biotite, although plentiful throughout the sandstone beds, is concentrated in the silty, organically rich interstratal partings. The only other minerals present in important or distinguishable amounts are the alteration products of the feldspars, sericite and kaolinite, and the oxidized and hydrated limonitic derivative of the rich biotite content. In the lower part of the massive sandstone section most of the fractures and fissures have been filled with fine grained secondary calcite probably derived from the calcareous beds below.

The source rock for these massive sandstones was undoubtedly granitic and/or gneissic. The low degree of rounding of all constituents belies the possibility that the source was an older sand.

The sandstone series is unconformably overlain by the basal conglomerates of the Martinez formation. In the writer's opinion these conglomeratic boulders, though of approximately the same composition as the pebbles and cobbles contained in the Upper Cretaceous sandstones and thereby indicating a common source, could not possibly have originated from the reworking and concentration of the underlying Cretaceous sandstones. The fragments of the Tertiary conglomerate average approximately 6 inches in diameter, but only rarely is a spindle-shaped cobble having a long axis with that dimension found in the Cretaceous beds. Unless the basal beds of the Martinez formation were derived from a horizon containing such particles in the massive sandstones and which has been completely removed, it is probable that the source of these coarse constituents is elsewhere. However, the arkosic interstitial material of the conglomerates and the overlying buff sandstones of the Eocene formation may well be derived from a reworking of the massive Upper Cretaceous sandstones.

Figure 3.

STRATIGRAPHIC DISTRIBUTION OF MOLLUSCS

UPPER CRETACEOUS OF SIMI HILLS

Fauna / Locality →	1154	1155	1156	1159	1534	1535	1536	1537	1157	1158	1538
Metaplacenticeras californicum (Anderson)	■	●	■	●	●	X		■			
Turritella chicoensis perrini (flat-whorl)				X							X
Margarites ornatissimus (Gabb)	●		●	■		■		■		●	X
Legumen ooides (Gabb)								X			
"Odostomia" santana (?) Packard				X							
Meekia navis Gabb	●		X	X				X			X
Cymbophora ashburnerii (Gabb)	■	●	■	■		●	X	■	X	■	X
Trigonocallista bowersiana (Cooper)	X	●	●	■	●	●		■	■	■	X
Martesia n. sp. (not M. clausa Gabb)				X				X			
Cymbophora gabbiana (Anderson)	X	●	■	●	●			X		X	X
Gyrodes expansa Gabb	X		X	■						●	
Oligoptycha obliqua (Gabb)	■		■	■	■	●	●	■	●	■	X
"Fulgur" hilgardi White				●							
Flaventia lens (Gabb)	●		●	■	X			●		X	
Cucullaea youngi Waring	X	X	X	■				X	X		X
Anomia lineata Gabb	X	X	X	X		X	X	●			X
Glycymeris veatchii (Gabb)	●	●	■	■				■	●	■	●
Cylichnina sp. cf. C. costata Gabb			X	●				X			
Tenea inflata (Gabb) (large variety)	X	X		X						●	
Dentalium sp. cf. D. whiteavesi Anderson	X			●			●	●		X	X
Crassatella lomana Cooper			X	■				X	■	X	X
Acila demessa Finlay	X	X	●	●						X	
Clisocolus cordatus Whiteaves	X		X	■		X		●		X	
Volutoderma averillii Gabb				●				X		X	X
Perissytis breviostris (Gabb)		X		●					X	■	X
Baculites chicoensis Trask			●	■		●	●	■			●
Trinacria cor Popenoe	●		X	X				■			
Trigonia sp. cf. T. evansana Meek	X	X		■			X	■	●	X	X
Lysis californiensis Packard				■						X	
Turritella ossa Popenoe									■		
Turritella chicoensis perrini Merriam	X		X	X				X	■		●
Anchura sp. cf. A. falciformis Gabb				X							
Euspira shumardiana Gabb				■				●	X	■	
Parallelodon brewerianus Gabb				■		●		X	X	■	
Eriphyla ovoides (Packard)										X	
Tessarolax distorta Gabb										X	
Eriphyla lapidis Packard										X	
Pachycardium coronaense (Packard)			X	●				X		X	
Inoceramus whitneyi Gabb	■	●	■	X	●		●	■		X	X
"Linearia" sp.			●		X						
Eriphyla lenticularis (Gabb)								X		●	
Cucullaea sp. cf. C. truncata Gabb				X				X		X	
Corbula sp. cf. C. parilis Gabb	X		X					●		X	
"Tellina" sp. cf. "T." parilis Gabb								●			
Nuculana n. sp. (poor specimen)				X							

X	Rare
●	Common
■	Abundant

UPPER CRETACEOUS PALEONTOLOGY OF THE SIMI HILLS

Introduction:- The Upper Cretaceous fauna of the Simi Hills is represented by 46 species and varieties derived from 11 fossil localities. These species are specifically identified, 38; of doubtful specific character, 4; compared to closely related or similar species, 7; or only generically determined, 3. The fauna consists of 27 members of the pelecypod group, 12 gastropod species and varieties, 3 cephalopod species, and one doubtfully determined scaphopod. In addition approximately 28 additional species were collected. Most of these are new, several probably represent new genera, and others which are probably different but are so broken or distorted that correct identification could not be undertaken. Many fragmental and undeterminable specimens of echinoids and crustaceans; shark's teeth and fish scales; as well as representatives of the brachiopod, bryozoan, coral and foraminifer groups were to be found during the preparation of the mollusc material. These forms, however, were not included in the faunal list.

A faunal check list which accompanies this report (figure 3) gives the species collected at each locality and their relative abundance. The writer endeavored to collect as large a representative group of species from each locality as possible, took great care in selecting those localities having the same stratigraphic position, and extracted the fossils from the matrix in exactly the same relative proportion in which they occurred. The species are represented on the chart by symbols denoting their abundance in each locality. In the locality collections, if more than 20 specimens of one species were obtained, it is termed "abundant," if there are more than 4 and less than 20 specimens the species is "common," and forms represented by less than 4 individuals are "rare." Locality numbers from the catalogue of invertebrate fossil localities of the California Institute of Technology are those appearing on the check list. The localities are arranged in descending stratigraphic order from left to right. All localities in the 1100 group were collected by Dr. Popenoe in 1935 and supplemented by the writer; those in the 1500 group were collected by the writer in 1941-42.

Review of the Upper Cretaceous Fauna of the Santa Ana Mountains 13/ :- The work of W. P. Popenoe in the Santa Ana

13/ Popenoe, W.P., "Upper Cretaceous Formations and Faunas of Southern California," Bull. Amer. Assoc. Pet. Geol. (1942), Vol. 26, No. 2, pp. 180-185.

Mountains is of paramount importance in the problem of the detailed and systematic correlation of the Upper Cretaceous of the Pacific Coast. His methods and results have been utilized and followed in the preparation of this paper and the Simi Hills Upper Cretaceous section is correlated with that developed by Popenoe in the Santa Ana Mountains.

The fossils of the Santa Ana Mountains are divided into two main faunal divisions: the lower Glycymeris pacificus fauna and the upper Glycymeris veatchii fauna. In turn, the Glycymeris pacificus fauna is subdivided into two less well defined subzones: the Trigonarca californica division comprising the lower unit and the Cucullaea gravida division, the upper. None of the characteristic species of these divisions is present in the Simi Hills, except for a few long-ranging species such as Trinacria cor, Parallelodon brewerianus, Eriphyla lapidis and Anchura sp. cf. A. falciformis. With the exception of Parallelodon brewerianus these species are comparatively rare in both the Simi Hills and the Santa Ana Mountains. The three subdivisions of the Glycymeris veatchii fauna are the Turritella chicoensis (typical) division, the Turritella chicoensis perrini division and the uppermost Metaplacenticeras pacificum division. Though many of the forms which range down into the lower Turritella chicoensis (typical) division are present in the Simi Hills, the common dwarf form for which the division was named is not present and the only members of the Turritella chicoensis group represented are the giant round-whorled variant and the giant flat-whorled form, which in the Santa Ana Mountains have never been found in the stratigraphic confines of the *Turritella chicoensis* (typical) division. In the Simi Hills the absence of this division is due to the overlap of the Upper Cretaceous beds by the Topanga formation or possibly to its complete lack of development in the area. Consequently the lowest determinable fauna of the Simi Hills belongs to the intermediate subzone of the *Glycymeris veatchii* fauna, namely the *Turritella chicoensis perrini* division.

However, the complete fauna is a facsimile, with few exceptions, of the *Glycymeris veatchii* fauna as normally distributed in the Santa Ana Mountains. Moreover, the assemblages of species of the *Glycymeris veatchii* fauna in the Simi Hills show, as Popenoe similarly demonstrated, "a considerable uniformity from top to bottom of the section ...."[14/]

14/ Popenoe, W.P., California Inst. Tech. Ph. D. Thesis (1936), pp. 39-40.

Hence, one of the peculiarities that would seem to be encountered in subdividing the uniform *Glycymeris veatchii* fauna of the Santa Ana Mountains and the Simi Hills is the difficulty of assigning certain definite and short-ranging "zone-index fossils" to certain zones. On a broader scale the fallacy of this reasoning is excellently shown by the state of the stratigraphy of the Upper Cretaceous before Popenoe instigated his work. All of the exposures were areally mapped and termed "Chico," reference was made to their resemblance to other localities on a lithologic or on a faunal basis usually using certain ammonites as "index fossils," and the exposures were finally relegated to an indefinite and vacillating position in the Cretaceous column by placing them in the subdivisions of the European sections. Popenoe explains this peculiarity and suggests that it can be alleviated by detailed and complete collections from every possible locality with the localities accurately plotted [15]. In this manner an abundance of individuals of each species are obtained and the zoning can be easily accomplished by determining the differences in the relative abundance of assemblages of species which usually have overlapping ranges. Then should certain zones be found to contain species of wide geographical occurrence and short time range, the dual prescence of these species and the similarity in the faunal assemblages would lead to an excellent means of exact correlation.

15/ Popenoe, W.P., op. cit., pp. 39-40.

Turritella chicoensis perrini Division [16] :- The lowest faunal division of the Upper Cretaceous of the Simi Hills is represented by the fauna of the basal shale member of

16/ Popenoe, W.P., "Upper Cretaceous Formations and Faunas of Southern California," Bull. Amer. Assoc. Pet. Geol. (1942), Vol. 26, No. 2, pp. 183-184, figure 4.

the "Upper Cretaceous shale series." This member outcrops almost vertically in Bell Canyon. From it two large collections were obtained at localities 1157 and 1158, both at relatively the same stratigraphic horizon. The abundant and characteristic species of this division are: Cymbophora ashburnerii, Trigonocallista bowersiana, Glycymeris veatchii, Crassatella lomana, Parallelodon brewerianus, Euspira shumardiana, Turritella chicoensis perrini, T. ossa, Perissytis breviostris, Oligoptycha obliqua (large form) and Margarites ornatissimus. Of these Turritella ossa is the only form which does not range higher in the section.

Only a small proportion of the fossil species indigenous to the basal beds fail to appear in overlying strata. These forms, Turritella ossa, Eriphyla lapidis and Tessarolax distorta, are rare (except T. ossa) and also occur at a low horizon with very limited ranges in the Santa Ana Mountains. On the other hand Margarites ornatissimus, present in limited numbers in this fauna in comparison to all overlying localities, ranges below its lowermost limit in the Santa Ana Mountains. Apparently the range of this distinctive species has to be extended. Metaplacenticeras californicum is conspicuously absent from these beds despite the richness of the fauna. Therefore, its absence, since it seems to be a short-ranging ubiquitous form in all of the localities where it appears in California and Oregon, is an even more important indicator of the position of this assemblage as the lowest subdivision of the Glycymeris veatchii fauna in the Simi Hills, than the presence of the rare short-ranging forms mentioned above with the possible exception of Turritella ossa. One of the peculiarities of this fauna is the giant size of Oligoptycha obliqua which develops to almost twice its normal size. The other members of this faunal subdivision are only average-sized individuals in comparison with their development in the overlying beds. The species represented and the relative abundance of the specific fauna correlates very favorably with the Turritella chicoensis perrini division of the Santa Ana Mountains fauna, hence its designation as such.

Metaplacenticeras pacificum Division[17/] :- Stratigraphically

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17/ Popenoe, W.P., op. cit., p. 184, figure 4.

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the highest division of the Santa Ana Mountains fauna, this subzone was named after the abundant presence of the characteristic ammonite, Metaplacenticeras pacificum. Usually intimately associated with this form is the related type, Metaplacenticeras californicum. Elsewhere, as in central and northern California, southern Oregon and the Santa Ana Mountains, these two forms have always occurred together. However, in the Simi Hills fauna only Metaplacenticeras californicum is represented and in the Santa Monica Mountains only Metaplacenticeras pacificum is preserved. This is not a problem in differential facies, nor is it one of geographical range, for all of the localities have similar lithology and faunas. Popenoe assumes that the question is answered by postulating slight differences or overlappings in the time-range of the two species.

The intermediate calcareous sandstone and interbedded shale member of the Upper Cretaceous shale series is characterized by the abundant presence of Metaplacenticeras californicum and Turritella chicoensis perrini. By far the greatest portion of the total fauna collected in the Simi Hills comes from this stratigraphic horizon. Comprising 41 species, 15 of which do not occur lower than this division, the fauna is an extremely rich and well-preserved one. Characteristic and abundant forms include the ever-present Glycymeris veatchii and Oligoptycha obliqua, Margarites ornatissimus, Cymbophora ashburnerii, Trigonocallista bowersiana, Crassatella lomana, Trigonia sp. cf. T. evansana, Inoceramus whitneyi and Turritella chicoensis perrini. The common types that are limited to this horizon are: Trinacria cor, Turritella chicoensis perrini (flat-whorled variant) and the important duo, Metaplacenticeras californicum and Baculites chicoensis.

The stratigraphic level of this faunal subdivision lies approximately 500 feet above the horizon represented by the "Turritella chicoensis perrini division" fauna. The collecting localities in the sandy member vary from the middle to the top of the section. Ammonites are rare in the white weathering beds of localities 1159 and 1535 which represent the lowest collecting horizon in this member. The rich fauna of locality 1537, containing an abundance of ammonite specimens, was collected from the uppermost sandstone bed.

The stratigraphic interval between the fossiliferous horizons of the shale series, which is wedged in between the fault separating it from the massive sandstones and the basal beds of the transgressing Topanga formation, lies across the floor of a widely alluviated valley. The writer could not follow the trace of these beds across this area due to the soil cover and the lack of topographic expression within the valley. Since the strike of the lower shale member and that of the intermediate sandy member do not ocincide, an unconformity may exist between the two units. However, it cannot be proved with the evidence at hand and it is doubted that it will be proved unless future drilling is done in the region. Also, any unconformity that may possibly exist at the base of the massive sandstone section cannot be determined unless the area proves to be of economic value for petroleum exploitation. To date this possibility seems remote as, for instance, the work of Kew[18] demonstrated.

18/ Kew, W.S.W., op. cit., p. 13.

Correlation of this fauna with that of the Metaplacenticeras pacificum division in the Santa Ana Mountains presents its difficulties due to the absence of the short-ranged ammonite species whose name the subdivision bears. Though the species included are very characteristic and similar, there is a slight indication for considering the Simi Hills fauna as representing a different time interval, either earlier or later, than the Santa Ana Mountains fauna. That this factor is almost negligible in correlating the faunas of the two regions is borne out by Popenoe[19]. Due

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19/ Popenoe, W.P., California Inst. Tech. Ph. D. Thesis (1936), pp. 47-48.

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to the occurrence at localities 1159 and 1535 of the unique assemblage, Parallelodon brewerianus, Euspira shumardiana and Lysis californiensis and the sparse representation of Metaplacenticeras californicum, it is probable that this portion of the fauna may predate the typical time unit denoted by the Metaplacenticeras pacificum beds in the Santa Ana Mountains. Some of the above named species are found in the fauna of the Schulz conglomerate and the beds carrying this fauna in the Simi Hills may be its equivalent. The horizon of locality 1537, on the basis of species represented and their relative abundance, is more probably the correlative of the Metaplacenticeras pacificum beds of the Santa Ana Mountains.

Within the stratigraphic confines of the Upper Cretaceous massive sandstones a number of isolated fragments of Baculites chicoensis have been collected by the writer. Several geologists previously examining the area have reported the occurrence of this species in the massive sandstones beneath the basal beds of the Martinez formation[20].

20/ Popenoe, W.P., op. cit., p. 47.

Hamites sp. has been collected in this section immediately below the basal conglomerate of the Martinez formation near the contact of the Simi Valley alluvium[21].

21/ Personal communication addressed to W.P. Popenoe by George Richards, May 1941. Locality of Gordon White.

Approximately 1,500 feet above the base of the exposed section of the massive sandstones lies the fossil locality, 1538. The fauna of this locality was found in a coarse cobble conglomerate near the crest of the eastern portion of the Simi Hills. The occurrence was first viewed as probably representing reworked material from the horizon of the sandy member of the lower shale section, but during preparation of the fossil material it was noted that even the minute initial whorls of the Turritella specimens were present. This should obviate the possibility that the specimens are water-worn as a result of transportation from some other stratigraphic level. Moreover, none of the fossils was included in sandstone cobbles in the conglomerate, but was definitely contained in the matrix between rock fragments. The fossils were also related to the bedding plane of the fragments in a manner that betokened primary deposition at this horizon.

The fauna is characteristically that of the Metaplacenticeras pacificum division. The ammonite was not present but the following species were collected: Turritella chicoensis perrini (giant flat-whorled variant), T. chicoensis perrini, Margarites ornatissimus, Cymbophora ashburnerii, Meekia navis, Trigonocallista bowersiana, Cymbophora gabbiana, Glycymeris veatchii (giant form), Perissytis breviostris, Volutoderma averillii, Crassatella lomana and Baculites chicoensis. In the Santa Ana Mountains, Turritella chicoensis perrini (giant flat-whorled variant), Margarites ornatissimus and Meekia navis are restricted to the Metaplacenticeras pacificum division. As mentioned previously, the range of Margarites ornatissimus should be extended, but the presence of the other forms denote the position of this fauna quite accurately. With the exception of Anomia lineata, Turritella chicoensis perrini (giant flat-whorled variant) and Baculites chicoensis, all of the other species of this fauna range through the entire fossiliferous Upper Cretaceous section in the Simi Hills. It is therefore placed in the Metaplacenticeras pacificum division. This type of fauna characterized by a total lack of ammonites is often found in the collections from the Santa Ana Mountains[22]. Thus, it would seem purely

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22/ Popenoe, W.P., "Upper Cretaceous Formations and Faunas of Southern California," Bull. Amer. Assoc. Pet. Geol. (1942), Vol. 26, No. 2, figure 4.

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fortuitous or the result of facies differences; and the lack of Metaplacenticeras californicum would not appear to be of paramount importance in the determination of the position of this fauna. The stratigraphic position of this faunal locality is, however, of strategic significance, for it conclusively demonstrates that at least the basal portion of the massive Upper Cretaceous sandstones can be correlated with the Metaplacenticeras pacificum faunal subdivision of the Glycymeris veatchii fauna developed in the Santa Ana Mountains.

CORRELATION OF THE UPPER CRETACEOUS SECTIONS OF THE SIMI HILLS AND THE SANTA ANA MOUNTAINS.

The Glycymeris veatchii fauna in the Santa Ana Mountains is restricted to the upper portion of the Holz shale member of the Ladd formation and the Williams formation. The latter is divisible into two lithologic units, the basal Schulz conglomerate member and the Pleasants sandstone member. The Williams formation, approximately 500 feet thick, is composed of 200 feet of coarse sandstones and conglomerates of the Schulz member and 320 feet of fine grained sandstones intercalated with many layers of calcareous sandstone of the Pleasants member[22].

22/ Popenoe, W.P., op. cit., pp. 166-175.

The Glycymeris veatchii fauna in the Simi Hills appears throughout the complete section developed in the area. Two lithologically distinct units termed the "lower shale series" and the "upper sandstone series" combine to form the complete outcrop of Upper Cretaceous strata. The "lower shale series" is subdivided into a basal shale member, 200 feet thick, overlain by an intermediate calcareous sandstone and interbedded shale member totaling over 1,000 feet in thickness, and an upper member composed of 200 feet of shale. The "upper massive sandstone series" is of uniform lithologic character throughout its 5,500 feet of thickness.

The stratigraphic correlation of the two regions is based on the previous faunal discussion. The incompletely developed basal shale member of the "lower shale series" contains the fauna of the Turritella chicoensis perrini division as defined in the Santa Ana Mountains. This division is restricted to the upper portion of the Holz shale member of the Ladd formation. The fraction of the total thickness of the Holz shale which can definitely be determined as equivalent to the basal shale member of the "lower shale series" is 100 feet. This upper section consists of an interbedded series of sandy beds and shale in which is found an abundance of giant specimens of Turritella chicoensis perrini and Crassatella lomana with but few ammonites. It is evident that the beds with the Turritella chicoensis perrini division fauna are direct correlatives.

In the Simi Hills an ammonite fauna appears in the lower part of the intermediate member of the "lower shale series." Within this intermediate member the rich character of the fauna, the change in lithology from argillaceous to coarse calcareous sand facies and the relative abundance of the included species such as Metaplacenticeras californicum, Turritella chicoensis perrini (giant flat-whorled form), Meekia navis, Margarites ornatissimus, Cymbophora ashburnerii and C. gabbiana which are restricted to the beds of this zone and above, serve to identify this horizon as the correlative of that of the Metaplacenticeras pacificum division in the Santa Ana Mountains. Stratigraphically this division is restricted to the Pleasants sandstone member of the Williams formation. Since in all probability it represents a slight time differentiation, on the basis of the lack of Metaplacenticeras pacificum and the presence of Metaplacenticeras californicum, from the lower portion of this member in the Simi Hills, the latter may be the equivalent of the Holz-Pleasants transition zone, the Schulz conglomerate member. It surely could be no older than this zone and may be somewhat younger. An upward continuation of the Metaplacenticeras-bearing subzone in the Simi Hills is clearly indicated by the species collected at locality 1538. Situated 1,500 feet above the base of the exposed section of the "upper massive sandstone series," this locality is of strategic importance in giving a broad clue to the stratigraphic position of this long undetermined section. Both Waring[23] and Kew[24] have

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23/ Waring, C.A., op. cit., p. 50.

24/ Kew, W.S.W., op. cit., p. 12.

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concluded that it was of Cretaceous age, but only on the basis of the unconformable overlap of the Martinez formation. The fauna of this locality definitely establishes an Upper Cretaceous age determination. The species represented in the fossil fauna of locality 1538 serve to correlate the basal part of the "upper massive sandstone series" with the Pleasants sandstone member.

It is the writer's opinion that eventually the complete section of the massive sandstones will be found to be the correlative of the Pleasants member of the Williams formation. This statement is based on the lithologic and petrographic homogeneity of the sands, the isolated occurrences of fossil cephalopod material in the conglomerate lenses, the presence of foraminifera in some of the silty partitioning beds and the unbroken outcrop which constitutes a good field for future detailed petrologic work.

Hence, in the Simi Hills, the basal member of the "lower shale series" is equivalent to the upper 100 feet of the Holz shale member of the Ladd formation in the Santa Ana Mountains. The lower portion of the intermediate sandstone and shale member of the "lower shale series" is correlated with the Schulz conglomerate transition zone between the Holz shale and Pleasants sandstone or possibly with the basal beds of the latter. The upper ammonite-bearing part of the intermediate member and the upper shale member of the "lower shale series" and the lower 1,500 feet, at least, of the "upper massive sandstone series" in the Simi Hills can be correlated with the Pleasants sandstone member of the Williams formation in the Santa Ana Mountains on the basis of common species represented and their relative abundance.

APPENDIX A

Revision of the Faunal List of Waring's Report

A revision of those species appearing in the check list of Upper Cretaceous ("Chico") fossils from the Simi Hills collected in 1910-1917 by C. A. Waring, is deemed essential by the writer in order to obviate any confusion or misunderstanding in the differences of specific nomenclature between this report and that of Waring[1].

1/ Waring, C.A., "Stratigraphic and Faunal Relations of the Martinez to the Chico and Tejon of Southern California," Proc. California Acad. Sci. (1917), 4th Ser., Vol. 7, No. 4, pp. 56-71.

The classical localities of the older report form the nucleus of the collections utilized in this report. Waring's locality 1 is equivalent to locality 1159 and locality 2 probably coincides with locality 1157. The former is also the locality from which Stephen Bowers obtained the first collection from this region in 1900 upon which J.P. Smith based the first age determination[2].

2/ Smith, J.P., "The Development and Phylogeny of Placenticeras," Proc. California Acad. Sci. (1900), 3rd Ser., Geol., Vol. 2, No. 1, p. 26.

In most cases final authority for the revision of the specific determinations is based on the reorganization of Gabb's original generic nomenclature by Stewart[3]. In

3/ Stewart, R.B., "Gabb's California Cretaceous and Tertiary Type Lamellibranchs," Acad. Nat. Sci. Phil. Spec. Pub. No. 3 (1930), pp. 1-314, plates 1-17.

Stewart, R.B., "Gabb's California Fossil Type Gastropods," Acad. Nat. Sci. Phil. Proc. (1926), Vol. LXXVIII, pp. 287-447, plates 20-32.

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some cases the detailed taxonomic and curatorial work of Popenoe has justified a few changes which are herein introduced[4].

4/ Popenoe, W.P., California Inst. Tech. Ph. D. Thesis (1936), pp. 63-158, plates 9-13.

PELECYPODA

Acila demessa Finlay

1864 Nucula truncata n. sp., Gabb, Paleo. California, Vol. 1, p. 198, pl. 26, fig. 184, 184a and b.

1866 Nucula (Acila) truncata Gabb, Gabb, Am. Jour. Conch., Vol. 2, pp. 88 and 92.

1917 Acila truncata Gabb, Waring, Proc. California Acad. Sci., Vol. 7, pp. 56.

1927 Acila demessa n. n., Finlay, Trans. and Proc. N. Z. Inst., Vol. 57, p. 522.

1930 Acila demessa Finlay, Stewart, Acad. Nat. Sci. Phil., Spec. Pub. No. 3, p. 45, pl. 3, fig. 6.

Parallelodon brewerianus (Gabb)

1864 Arca breweriana n. sp., Gabb, Paleo. California, Vol. 1, pp. 193 and 235, pl. 25, fig. 181.

1879 Nemodon vancouverensis (Meek), Whiteaves, Geol. Sur. Can. Mes. Foss., Vol. 1, pp. 163 and 392, pl. 19, figs. 1 and 1a.

1917 Nemodon (Arca) breweriana (Gabb), Waring, Proc. California Acad. Sci., Vol. 7, pp. 57 and 106, pl. 7, figs. 5 and 6.

1930 Parallelodon brewerianus (Gabb), Stewart, Acad. Nat. Sci. Phil. Spec. Pub. No. 3, p. 69, pl. 3, fig. 1.

Crassatella lomana Cooper

1894 Crassatella lomana n. sp., Cooper, California State Min. Bur. Bull. No. 4, p. 48, pl. 3, fig. 47.

1916 Crassatella lomana Cooper, Packard, Univ. California Pub., Bull. Dept. Geol., Vol. 9, No. 12, p. 146.

1917 Crassatellites tuscanus Gabb, Waring, Proc. California Acad. Sci., Vol. 7, No. 4, pp. 56 and 108, fig. 4.

1936 Crassatella lomana Cooper, Popenoe, California Inst. Tech. Ph. D. Thesis, pp. 98-99, pl. 8.

Clisocolus cordatus Whiteaves

1879 Clisocolus cordatus Meek and Hayden, Whiteaves, Geol. Sur. Can. Mes. Foss., Vol. 1, p. 157, pl. 18, figs. 3 and 3a and b.

1903 Clisocolus cordatus Whiteaves, Whiteaves, ibid., p. 384.

1917 Isocardia chicoensis n. sp., Waring, Proc. California Acad. Sci., Vol. 7, No. 4, pp. 57,62 and 108, pl. 8, fig. 3.

1930 Clisocolus cordatus Whiteaves, Stewart, Acad. Nat. Sci. Phil., Spec. Pub. No. 3, p. 157.

Flaventia lens (Gabb)

1864 Meretrix lens n. sp., Gabb, Paleo. California, Vol. 1, p. 164, pl. 23, fig. 143.

1879 Cyprimeria lens (Gabb), Whiteaves, Geol. Sur. Can. Mes. Foss., Vol. 1, pt. 2, p. 152, pl. 17, figs. 15 and 15a.

1903 Cyprimeria lens (Gabb), Whiteaves, ibid., p. 379.

1917 Dosinia milthoidea n. sp., Waring, Proc. California Acad. Sci., Vol. 7, No. 4, pp. 57, 60 and 108, pl. 8, fig. 5.

1930 Flaventia (?) lens (Gabb), Stewart, Acad. Nat. Sci. Phil., Spec. Pub. No. 3, p. 247, pl. 4, fig. 6.

Trigonocallista bowersiana (Cooper)

1864 Meretrix nitida n. sp. (?) Gabb, Paleo. California, Vol. 1, pp. 165, 166 and 231, pl. 23, figs. 145 and 146.

1894 Cucullaea bowersiana n. sp., Cooper, California State Min. Bur., Bull. No. 4, pt. 5, p. 48, pl. 5, fig. 16.

1917 Macrocallista cordata n. sp., Waring, Proc. California Acad. Sci., Vol. 7, No. 4, pp. 57, 62 and 108, pl. 8, fig. 1.

1922 Meretrix nitida Gabb var. major n. var., Packard, Univ. California Pub., Bull. Dept. Geol., Vol. 13, No. 10, p. 425, pl. 31, fig. 2.

1930 Aphrodina nitida (Gabb), Stewart, Acad. Nat. Sci. Phil., Spec. Pub. No. 3, pp. 250, pl. 5, fig. 10, pl. 6, fig. 6.

1935 Aphrodina major (Packard), Anderson and Hanna, California Acad. Sci. Proc., Vol. 23, No. 1, p. 28.

1936 Calva major (Packard), Popenoe, California Inst. Tech. Ph. D. Thesis, pp. 117-118.

1937 Calva bowersiana (Cooper), Popenoe, Jour. Paleo., Vol. 11, No. 5, pp. 396-397.

1942 Trigonocallista bowersiana (Cooper), Popenoe, Bull. Am. Assoc. Pet. Geol., Vol. 26, No. 2, p. 184, fig. 4.

Cymbophora gabbiana (Anderson)

1864 Mactra ashburnerii n. sp., Gabb, Paleo. California, Vol. 1, p. 153.

1902 Mactra gabbiana n. sp., Anderson, California Acad. Sci. Proc., Vol. 2, No. 1, p. 74, pl. 7, fig. 156.

1916 Spisula gabbiana (Anderson), Packard, Univ. California Pub., Bull. Dept. Geol., Vol. 9, No. 16, p. 299, pl. 27, fig. 2.

1917 Mactra gabbiana Anderson, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 63 and 108, fig. 11.

1930 "Mactra" gabbiana Anderson, Stewart, Acad. Nat. Sci. Phil., Spec. Pub. No. 3, p. 211.

1936 Cymbophora gabbiana (Anderson), Popenoe, California Inst. Tech. Ph. D. Thesis, pp. 123-125, pl. 13, fig. 2.

GASTROPODA

Margarites ornatissimus (Gabb)

1864 Angaria ornatissimus n. sp., Gabb, Paleo. California, Vol. 1, p. 121, pl. 20, fig. 78.

1879 Margarita ornatissima (Gabb), Whiteaves, Geol. Sur. Can. Mes. Foss., Vol. 1, pp. 128 and 368.

1917 Solariaxis templetoni n. sp., Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 68 and 110, pl. 9, fig. 22.

1926 Margarites ornatissimus (Gabb), Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 315, pl. 24, fig. 1.

Gyrodes expansa Gabb

1864 Gyrodes expansa n. sp., Gabb, Paleo. California, Vol. 1, p. 19, figs. 62, a, b and c.

1917 Gyrodes canadensis Whiteaves, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57,66 and 110, pl. 9, fig. 7.

1926 Gyrodes expansa Gabb, Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 328, pl. 22, fig. 1a, 3.

Euspira shumardiana (Gabb)

1864 Lunatia shumardiana n. sp., Gabb, Paleo. California, Vol. 1, pp. 106 and 224, pl. 19, fig. 61.

1917 Gyrodes compressus n. sp., Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57,67 and 110, pl. 9, fig. 6.

1926 Polinices shumardiana (Gabb), Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 325, pl. 21, fig. 11.

1936 Euspira shumardiana (Gabb), Popenoe, California Inst. Tech. Ph. D. Thesis, pp. 130-131, pl. 13, fig. 3.

Lysis californiensis Packard

1917 Lysis suciensis Whiteaves, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57 and 62, (tentative identification of poor specimen).

1922 Lysis californiensis n. sp., Packard, Univ. California Pub., Bull. Dept. Geol., Vol. 13, No. 10, p. 431, pl. 37, figs. 2 and 3.

Turritella chicoensis perrini Merriam

1864 Turritella chicoensis n. sp., Gabb, Paleo. California, Vol. 1, p. 133, pl. 21, fig. 91.

1917 Turritella chicoensis Gabb, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 69 and 110, pl. 9, fig. 12.

1941 Turritella chicoensis perrini n. var., Merriam, Univ. California. Pub., Bull. Dept. Geol. Sci., Vol. 26, No. 1, pp. 38, 66, pl. 2, figs. 1, 2, 3, 4, 6, 7, and 8.

1941 Turritella chicoensis perrini (giant flat-whorled variant), Merriam, ibid., p. 65.

Anchura sp. cf. A. falciformis (Gabb)

1864 Aporrhais falciformis n. sp., Gabb, Paleo. California, Vol. 1, p. 127, pl. 20, fig. 83.

1917 Anchura sp., Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57 and 65.

1926 Anchura falciformis (Gabb), Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 360, pl. 22, fig. 9.

1936 Anchura sp. cf. A. falciformis (Gabb), Popenoe, California Inst. Tech. Ph. D. Thesis, p. 140.

Perissitys breviostris (Gabb)

1864 Perissolax breviostris n. sp., Gabb, Paleo. California, Vol. 1, p. 126, pl. 20, figs. 82, 82a and 82b.

1917 Perissolax breviostris Gabb, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57 and 67.

1926 Perissitys breviostris (Gabb), Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 426, pl. 20, fig. 4.

Volutoderma averillii (Gabb)

1864 Fusus averillii n. sp., Gabb, Paleo. California, Vol. 1, pp. 83 and 222, pl. 18, fig. 34 (immature individual).

1876 Volutoderma navarroensis n. sp., Gabb, Proc. Acad. Nat. Sci. Phil., Vol. XXVIII, p. 289.

1889 Fulguraria gabbi White, Diller, U. S. Geol. Sur. Bull. 51, pp. 23-25, pl. 3, fig. 1.

1890 Rostellites gabbii n. sp., (unknown, not White), Dall, Trans. Wag. Inst., Vol. 3, p. 71.

1903 Rostellites gabbii Dall (not R. gabbi White), Whiteaves, Geol. Sur. Can. Mes. Foss., Vol. 1, pt. 5, p. 356.

1917 Rostellites gabbi White (fide Whiteaves), Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 68 and 110, pl. 9, fig. 8. See above.

1926 Volutoderma averillii (Gabb), Stewart, Nat. Sci. Phil., Proc., Vol. LXXVIII, pp. 409-410, pl. 22, figs. 10 and 11.

Oligoptycha obliqua (Gabb)

1864 Cinulia obliqua n. sp., Gabb, Paleo. California, Vol. 1, p. 111, pl. 19, figs. 64, 64a, 64b and 64c.

1917 Cinulia obliqua Gabb, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 66 and 110, pl. 9, fig. 2.

1926 Oligoptycha obliqua (Gabb), Stewart, Acad. Nat. Sci. Phil., Proc., Vol. LXXVIII, p. 436, pl. 24, fig. 14.

CEPHALOPODA

Metaplacenticeras californicum (Anderson)

1900 Placenticeras californicum Anderson, Smith, California Acad. Sci. Proc., Vol. 1, No. 7, p. 203, et. seq., pl. 25, figs. 1-8, pl. 28, fig. 6.

1902 Placenticeras californicum n. sp., Anderson, California Acad. Sci. Proc., Vol. 2, No. 1, p. 78, pl. 8, figs. 173-177.

1917 Placenticeras californicum Anderson, Waring, California Acad. Sci. Proc., Vol. 7, No. 4, pp. 57, 70 and 110, pl. 9, figs. 16 and 17.

1927 Metaplacenticeras californicum (Anderson), Reeside, U. S. Geol. Sur., Prof. Paper 147, pp. 1-2, pl. 2, figs. 14-16.

Species Listed in Both Reports

Pelecypoda

Cucullaea youngi Waring

Glycymeris veatchii (Gabb)

Inoceramus whitneyi Gabb

Trigonia evansana Meek

Gastropoda

Turritella chicoensis Gabb

Cephalopoda

Baculites chicoensis Trask

Hauericeras transitionale Waring

Species Represented in Waring's Report Only

Amauropsis oviformis Gabb

Cancellaria crassa Waring

Pecten cowperi Waring

Turris plicata Waring

APPENDIX B

California Institute of Technology

Upper Cretaceous Localities in Simi Hills

1154 Southeast side of the Simi Hills on the Ventura-Los Angeles county line, on spur between north and south branches of Dayton Canyon, 3,150 feet N 76° W of the southeast corner of Sec. 28, T 2 N, R 17 W, Calabasas Quadrangle, Ventura-Los Angeles county boundary line, California.

1155 Limy sandstone beds in sandy shale on south side of south fork of Dayton Canyon (Porter Canyon), 3,850 feet S 81° W of the southeast corner of Sec. 28, T 2 N, R 17 W, Calabasas Quadrangle, Ventura County, California.

1156 Sandstones outcropping on ridge crest about 300 feet southwest of locality 1155. Southeast slope of Simi Hills, Calabasas Quadrangle, Ventura County, California.

1157 North bank of Bell Canyon in shales of bluffs above stream channel, about 59 feet below base of massive Cretaceous sandstone, one mile straight west of the Los Angeles-Ventura county line on the boundary between T 1 N and T 2 N (extended to Bell Canyon), Calabasas Quadrangle, Ventura County, California.

1158 Southeast slope of Simi Hills about 1.15 miles due west of Los Angeles-Ventura county line on the boundary between T 1 N and T 2 N (extended to Bell Canyon), Calabasas Quadrangle, Ventura County, California.

1159 Prominent fossil bed on crest of spur between forks of Dayton Canyon, about 400 feet east of Los Angeles-Ventura county line and about 6,000 feet N 23° W of the southeast corner of Sec. 33, T 2 N, R 17 W, Calabasas Quadrangle, Los Angeles County, California.

1534 Gray calcareous sandstone outcropping on crest of ridge between Dayton Canyon and Porter Canyon about 375 feet N 75° E of locality 1159, Calabasas Quadrangle, Ventura County, California.

1535 White weathering calcareous sandstone, 150 feet south of locality 1159, Calabasas Quadrangle, Los Angeles County, California.

1536 Gray sandstone cropping out on ridge crest about 110 feet N 45° E of locality 1535, Calabasas Quadrangle, Ventura County, California.

1537 Brown weathering sandstone outcropping on north side of ridge between Porter Canyon and Dayton Canyon about 1,745 feet N 65° W of the southeast corner of Sec. 28, T 2 N, R 17 W, Calabasas Quadrangle, Ventura County, California.

1538 Small pebbly conglomerate lens in massive Cretaceous sandstones near crest of Simi Hills about 0.8 miles west of Los Angeles-Ventura county line and 1.55 miles N 60° W of the southeast corner of Sec. 33, T 2 N, R 17 W, Calabasas Quadrangle, Ventura County, California.

<u>Hamites</u> sp. locality of Gordon White

(See page 33)

419 Simi Hills, a few hundred feet stratigraphically below basal Martinez beds on south side of Simi Valley, approximately 11,400 feet S 70° E of Santa Susana townsite, B.M. 961, on Southern Pacific Railway, Santa Susana Quadrangle, Ventura County, California.

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