THE GEOLOGY OF A PART OF THE RAVENNA QUADRANGLE, CALIFORNIA

A Thesis

by

Haddon W. Agnew

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INTRODUCTION

The Ravenna quadrangle includes the easternmost part of the Ventura Basin in Los Angeles County, California and together with adjoining quadrangles constitutes an area of which little or no detailed geological work has been published. Ravenna station is situated on the Southern Pacific Railway and the present work involved the investigation of an area of about five square miles surrounding Ravenna and extending about two miles north and the same distance west of the station while at the same time including a narrow strip to the south of and paralleling the Santa Clara River. The area is readily accessible over excellent motor roads from the city of Los Angeles which lies forty to fifty miles to the southwest. Branch roads, in less excellent state of repair, lead from the main highways into the area, relatively little of which cannot be reached by automobile.

The object of the present work was to obtain as much information as possible concerning the geological relations of a series of interbedded conglomerates and volcanic flows while at the same time to contribute towards the completion of a detailed study of the entire Ravenna and adjoining quadrangles.

Problems requiring solution involved principally the origin of the deposits, their geological relationships to each other, their structural features and their respective ages.

All these problems have been attacked but their solution has been met with only varying degrees of success.

The field work upon which this report is based was carried on from March to June, 1946. A total of eighteen days was spent in the field during that period. The work was carried out by plotting the geology directly on field maps supplied by the California Institute of Technology. These maps had been enlarged to twice the scale from United States Topographical maps published on a scale of 2000 feet to 1 inch.

Rock samples were collected and their locations plotted on the map then a megascopic examination was made in the office. No microscopic examinations were made so that the only descriptions included in this report are megascopic with the exception of certain references where noted.

GEOGRAPHY

Climate

The climate of the region is typically semiarid, with an annual rainfall of ten to fifteen inches. All the streams in the region, with the exception of the Santa Clara and a few of its larger tributaries, are intermittent and the flow of even these diminishes considerably during the summer months. In the area described in this report only the Santa Clara persists the year around.

Temperatures are higher here than along the coast and help to account for the semiarid climate and typical vegetation associated with this climate. The vegetation consists of grasses, sage and chapparal but locally the type depends on

the soil. Nevertheless the north slopes invariably have the densest growth as here the vegetation is less exposed to the direct rays of the sun. Within the map area relatively little of the surface is obscured by growth too dense to travel through.

A very small part of the region is suitable for agricultural use and such areas are confined to alluvial benches along the Santa Clara River. Some sheep and cattle are grazed, during the spring and summer months, in the hills throughout the area.

Physical Features

The area under consideration is hilly to rugged in detail but the ruggedness of the topography is of a degree between that of the San Gabriel Mountains to the south and the Ventura Basin proper, to the west. Differences in elevation vary considerably, from relief of 1200 feet within half a mile to as little as 500 feet in the same or even greater distance but with a general decrease in relief and ruggedness as one progresses westward.

The higher, generally narrow ridge tops, and the bottoms of most of the tributary streams supply fairly continuous exposures of bedrock. Elsewhere a mantle of overburden obscures the rocks and some of the valley slopes are strewn with talus debris. The valley bottom of the Santa Clara River consists of recent stream deposits, in places of considerable thickness, which completely obscures the underlying geology. Elsewhere in the area, however, the bedrock is well exposed.

PREVIOUS WORK

The first comprehensive geological field work done in this

region and which included the Ravenna quadrangle began with reconnaissance surveys and mapping by W. S. Kew of the United States Geological Survey in 1919. This early reconnaissance was carried on in an effort to determine the possibility of oil occurrences in Los Angeles and Ventura Counties. The results of this work was published in 1924 as United States Geological Survey Bulletin 753.

The next major work which includes the area discussed in this report, was that of W. J. Miller, who published "The Geology of the Western San Gabriel Mountains" in 1924.

Most of the geological work done in an effort to determine the age of the individual members of the sedimentary series occurring in the Ventura Basin has been done by Stock, Maxson, Stirton and Jahns in the time intervening between Kew's publication and that of Jahns in 1940.

BIBLIOGRAPHY

The following list of references contains the more important reports, abstracts and papers bearing on the district and is arranged in chronological order. Some of the publications do not actually contain a description of the area dealt with in this report but are pertinent to the discussions, particularly of the age relationships of the various rock formations occurring therein.

Kew, W. S.	Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California, U.S.G.S. Bull., 753, 1924.
Maxson, J. H.	Carnegie Institute Washington Publication No. 404, paper 111, 1930.
Miller, W. J.	Anorthosite in Los Angeles County California, Journal of Geology Vol. 39, No. 4 pp. 331-344, 1931.
Miller, W. J.	Cenozoic History of the San Gabriel Mountains of California G.S.A. Bull., Vol. 44 No. 1 pp. 166-167, 1933.
Stirton, R. A.	American Journal of Science 5th series. Vol. 26, 1933.
Miller, W. J.	Geology of the Western San Gabriel Mountains of California. Publication of the U.C.L.A. in Maths. and Phys. Sciences. 1934.
Sharp, R. P.	Geology of the Ravenna Quadrangle, (abstract) Pan American Geologist, Vol. 63 p. 314. 1935.
Oakeshott, G. B.	Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County California. Cal. Jour. of Mines and Geology p 215 & on. 1937.
Jahns, R. H.	Stratigraphy of the Easternmost Ventura Basin, Balch Graduate School of Geological Sciences. 1940.

GENERAL GEOLOGY

Regional geology

The oldest rocks in the region consist of a crystalline "basement complex", which, like many of the igneous areas of the Cordilleran and coast regions are difficult to interpret in their structural and age relationships because of their complexity.

This complex is in turn overlain by a much younger sedimentary series of predominantly continental deposits several

thousand feet thick. These are distributed in a basin-like manner, with tilted, uplifted borders lying unconformably upon the "basement complex". Progressing from northeast to southwest this series decreases in age as well as becoming markedly less consolidated.

Local geology

The local geology includes a part of the "basement complex", part of the basal member of the sedimentary series referred to above and known as the Vasquez and also unconsolidated material of the Pleistocene and Recent.

The following table, therefore, indicates only the geological formations present within the area described in this report. The geological ages assigned to most of the map units are tenative only. Fossil evidence is completely lacking and the correlation of both the sedimentary and igneous rocks of this area with those of other areas has been difficult and in some instances led to much controversy.

Era	Period	Formation	Lithologic description
Quaternary	Recent	stream deposits	gravel, sand, silt, clay, soil.
	Pleistocene	terrace deposits	gravel, sand, silt.
Tertiary	Oligocene or Lower Miocene	Vasquez series	conglomerate, arkose, sandstone, basalt, andesite.
Mesozoic or Pre-Mesozoic	Pre Cretacious	"Basement complex"	quartz diorite, anorthosite.

"Basement complex"

The "basement complex" is the oldest formation in the area and is composed of metamorphic and igneous intrusive rocks. It occupies a large area both within and adjoining the map area. The igneous rocks of the "complex" range from normal gabbro to anorthosite, but within the map area only two principal types occur. These two types are first anorthosite and secondly an intrusion of quartz diorite referred to as Parker quartz diorite because of its typical occurrence on Parker mountain about two miles north of Ravenna station.

Anorthosite

The anorthosite, of particular interest as it is the only occurrence in the United States west of the Rockies, is considered to be the older of the two igneous members occurring in the area[1] and is associated in time and space with diorite and gabbro facies which according to Miller are different facies of a single plutonic body.

The anorthosite underlies about one quarter of the map area, chiefly in its southern part. This rock is in fault contact with both the Parker quartz diorite and the Vasquez sediments to the north. This fault appears to be normal with the anorthosite on the upthrown side. It is discussed in greater detail in a later section of this report.

The anorthosite ranges from an almost pure blue-grey plagioclase-rich rock through gabbroic to diorite facies and these variations make it difficult to differentiate, in some

[1]Miller, W. J. Cenozoic History of the San Gabriel Mountains of California. Pub. of the U.C.L.A. in Maths. and Phys. Sciences, 1933.

places, between the Parker quartz diorite and this older intrusion. Typically, the anorthosite is composed of plagioclase feldspar amounting to 90% or more of the rock. It is medium to coarse grained. Dioritic and gabbroic facies occur in the vicinity of Ravenna station adjacent to the Parker quartz diorite, making it somewhat difficult to establish the fault contact between the two with the same degree of accuracy as is possible farther east or west.

The plagioclase has been determined by previous workers[1] to range in composition from oligocene to labradorite. Accessory minerals which can be determined megascopically consist chiefly of augite and biotite.

The age of the anorthosite intrusion was impossible to determine owing to the lack of evidence, bearing on the question, in the map area. Obviously the anorthosite is older than the sedimentary beds as much of this rock is incorporated in the sediments.

Field relationships of the Parker quartz diorite and the anorthosite found in adjoining areas indicate the anorthosite is older than the diorite and so it is tenatively assigned to the Paleozoic by Miller[2].

As no further evidence can be produced by the writer regarding the age of the anorthosite it is here considered as merely Pre-Cretaceous in accordance with the conclusions of most of the previous workers in this area.

1 Miller, W. J. Anorthosite in Los Angeles County, California. Jour. of Geol. Vol. 39, No. 4. pp 331-344

2 op. cit.

Parker quartz diorite

The Parker quartz diorite occupies the eastern postion of the map area extending from points slightly north of the Santa Clara River, where it is in fault contact with the older anorthosite, to points beyond the north and east boundaries of the area. On the west it is overlain by the sedimentary-volcanic series, the contact extending north to northwest to points beyond the map boundary.

The quartz diorite is a light grey medium-to-coarse-grained intrusive rock composed chiefly of plagioclase and horneblende with subordinate quartz and orthoclase. Horneblende occurs typically as large crystals and crystal groups. Some biotite and abundant grains of light brown titanite can be easily identified in hand specimens.

The Parker quartz diorite is gneissic to varying degrees but almost everywhere shows a foliated structure that is emphasized by parallel arrangements of the dark minerals.

Numerous lamprophyric and aplitic dykes cut the Parker formation. The lamprophyres are more common than the aplite. These dykes were not mapped, nor was any attempt made to determine the structure of the diorite intrusion through a detailed study of the dykes, joints foliation and other features.

The age of the Parker quartz diorite is no more readily determined from field evidence gathered than is that of the anorthosite. Field evidence gathered by Miller[1] in other parts of the San Gabriel Mountains indicates fairly reliably the relative ages of the various igneous rocks of the "basement complex".

1 op. cit.

Miller has tenatively placed the Parker quartz diorite in the Jurassic. Certainly no evidence gathered by the writer would warrant contrary conclusions.

As in the case of the anorthosite, it is obviously older than the sedimentary rocks to the west and for the purposes of this report will be simply considered as Pre-Cretaceous.

Vasquez series

The name Vasquez was given by Sharp[1] to a series of clastic, pyroclastic and intercalated volcanic rocks that are spectacularly exposed at Vasquez Rocks, northwest of the map area. This series is well represented in the area described, with volcanic rocks predominating. These occupy the major portion of this part of the Ravenna quadrangle.

A total thickness of 9000 feet has been indicated for the series, by previous workers. About 3000 feet is represented in the map area. Here the base of the series is fairly well exposed and is in depositional contact with the Parker quartz diorite on the east and in fault contact with the anorthosite on the south.

The most abundant sedimentary type is conglomerate, with which are intimately interbedded sandstone, arkose, and tuffaceous clastic rocks. The conglomerate of the Vasquez series is rather resistant to erosion, possibly due in part to hardening and baking by the volcanic flows and thus generally forms good outcrops and hold up many ridges. The conglomerate could be more accurately described as a fanglomerate as they appear to be the consolidated remains of alluvial fans. They

1 Sharp, R. P. The Geology of the Ravenna Quadrangle, California.

are coarse massive-bedded rocks composed of angular to sub-angular pebbles of local origin varying from two to three inches in diameter but frequently containing boulders of two feet, and commonly more, in diameter. These pebbles and boulders consist almost wholly of Parker quartz diorite with minor quantities of anorthosite fragments. In just one instance was volcanic material found incorporated in the conglomerate. The pebbles of the conglomerate are imbedded in a fine to coarse grained, reddish, highly ferruginous matrix of sand and fine gravel which imparts its reddish colour to much of the sedimentary material throughout the area.

The imperfect rounding together with the unsorted aggregation of the pebbles and boulders suggests a rapid deposition probably by sheet floods under arid to semi-arid conditions. Eventually a series of alluvial fans was formed and finally, at least in some cases, the fans coalesced to form continuous, massive-bedded layers of poorly sorted conglomeratic material. The size of both pebbles and matrix of the conglomerate decreases as the beds extend westward. Locally the normal conglomerate of the area is interrupted where, during more quiet periods of deposition, sandstones, conglomeratic sandstones, beds of arkosic and tuffaceous material have been laid down.

These beds are fine to coarse grained and vary in color from bright green, on fresh fractures, to a decidedly reddish brown. These greenish beds were considered to be of tuffaceous material.

In general, the beds dip southwest at angles of fifteen degrees to as much as thirty degrees and strike a few degrees west of north. Local anomalous strikes and dips appear to have caused by faulting.

The source of the material that constitutes the sedimentary deposits is from the igneous intrusions of the "basement complex" to the east and south.

Volcanic rocks

The volcanic members of the Vasquez series occur as large and small layers and irregular masses that underlie at least half of the map area. These bodies of igneous rocks are easily discriminated from the interbedded sediments. They appear to be predominantly, if not entirely, of volcanic origin, though minor shallow intrusive phases may be present. If so, they are intrusive only into the volcanic flows, as nowhere in the area were they found to be intrusive into the sediments.

Normally the rock is dark, greenish and fine grained but in places veries from porphyritic to highly vesicular and amygdaloidal. Such structures do not appear to be confined to the margin of a given flow but pervade the entire mass.

The most characteristic feature of the volcanics is an amygdaloidal structure. In most places the amygdules, some as much as three inches in diameter, are filled with layers of chalcedony but a few are lined with quartz crystals.

Pillow, or ellipsoidal structures were not observed, on the other hand neither were intrusions nor apophyses of the igneous rock found in the sediments. These facts, together with

the appearance of the rock and its highly scoriaceous and vesicular nature, indicate an extrusive origin.

The volcanic rocks are typically basaltic flows[1] but Kew[2] and Miller[3] have determined some of the flows as andesitic in nature.

Normally the rock is dark green on fresh fractures, but varies locally from dark grey to black and from reddish to mottled green and reddish. In some of the specimens phenocrysts of feldspar are visible to the unaided eye but typically the rock is too fine grained for the identification of the rock minerals.

Fossil remains are lacking in the Vasquez so that age determination by this method is impossible. Previously the Vasquez has been considered as middle Miocene in age. Although the middle Miocene was a period of active vulcanism over large areas of the western United States, the fact that the Vasquez is overlain by the Tick Canyon formation, which has recently been determined as Lower Miocene[4], eliminates the middle Miocene age assigned by Miller and others by correlating the Vasquez with beds of like thickness, lithology, and of known age, found in other areas of California. Elsewhere rocks that probably are age equivalents of the Vas-

1 Sharp, R. P. Geology of the Ravenna Quadrangle, Calif. Pan American Geologist, Vol. 63, p 314.
2 Kew, W. S. W. Geology & Oil Resources of a Part of Los Angeles and Ventura Counties, Calif. U.S.G.S. Bull. 753.
3 Miller, W. J. Geology of the Western San Gabriel Mountains of California. Publication of the U.C.L.A. in Maths. and Phys. Sciences.
4 Jahns, R. H. Stratigraphy of the Easternmost Ventura Basin, Balch Graduate School of Geological Sciences.

quez are underlain unconformably by Lower Eocene beds so that the age of the Vasquez series is evidently confined to the Lower Miocene, the Oligocene, or the Upper Eocene. A compromise would therefore assign the Vasquez to the Oligocene, or Lower Miocene, which is in agreement with the tenative age assignment made by Jahns[1], which work is the most recent and detailed publication dealing in detail with the age relations of the members of the Tertiary series in the Ventura Basin. Tenatively therefore, the age of the Vasquez will be considered as Oligocene or Lower Miocene.

Quaternary deposits

The Quaternary formations consist of unconsolidated and poorly sorted gravel, sand, silt, clay and soil that form both the Pleistocene and Recent stream deposits. Most of the Pleistocene deposits cap prominent river terraces, but those found within the map area are not as well developed as elsewhere in the Ventura Basin. These terraces are merely the remnants of originally much more extensive erosion surface since partly removed by Recent stream erosion. Their best development is seen along the sides of the Santa Clara Valley.

Recent deposits of like material may be closely associated with and gradational into Pleistocene deposits, but on the whole may be readily distinguished from the Pleistocene by their difference in colour. The terrace deposits are a reddish brown colour in contrast to the grey of the Recent deposits.

Recent alluvial deposits form broad flats in the valley

1 op. cit.

of the Santa Clara and extend as long arms up the larger canyons. Throughout the area a mantle of gravel and soil covers bedrock wherever slopes are gentle.

STRUCTURAL GEOLOGY

Structural problems of the area have proved somewhat complex. Some of the chief difficulties in their solution have been: (1) Uncertainties concerning the order of formation of the igneous plutonic rocks within the map area; (2) Little evidence that could be used to differentiate between intrusives and extrusives of similar appearance within the volcanic rocks of the Vasquez series; (3) Insufficient evidence of faulting within homogeneous rocks.

The broadest structural feature of the sedimentary series within the map area is a syncline of which only a part of the eastern limb remains. Only the Vasquez is represented in this limb of the syncline, although a much greater thickness of beds of younger age occur in areas adjoining on the west. The dip of the beds within the map area varies from 15 to 30 degrees to the west but is in any case probably a combination of initial dip accentuated by later deformation.

The major structural feature of the area is the Soledad fault. This fault extends along the north side of the Santa Clara River valley and all other map units abruptly terminate against it. The actual fault plane is nowhere well exposed, but the breach is none the less readily mapped owing to the float and consequent change in colour of the overburden on either side of the fault. Other faulting in the area is mainly minor.

Subsequent to deposition folding and faulting have occurred in the Vasquez but the faulting is not as readily discerned and is in some cases hypothetical (see map). A fault in the western part of the map area occurs solely within the volcanics and is best observed near the head of the canyon, in which it is exposed. Here its trace is disclosed by a small scarp extending some distance down the canyon. Farther down the canyon the steepness of the walls combined with intrusive shearing is further evidence of faulting which makes it possible to trace the fault for a considerable distance. A branch fault that strikes southeast from the above-mentioned fault is shown by offsetting of beds and a decided change in dip and strike of the sedimentary beds on either side of the break.

In the northeastern section of the area a fault is suggested by the abrupt termination of the conglomerate of the Vasquez sediments against the volcanic rock but further work outside the area to northwest along the strike of this probable fault likely would shed more light on the relations. Other minor faults occur throughout the area but are not shown on the map. The average strike of the faults within the Vasquez rocks is northwest and the dip is steeply southeast. All appear to be normal faults.

GEOLOGIC HISTORY

The geologic history of the area is imperfectly known, as little evidence bearing on age relations has been collected. Only a summary will be attempted here.

The history apparently started with the Pre-Cretaceous and

possibly even Pre-Cambrian intrusion of anorthosite into a covering of which no evidence remains as it is now completely eroded. This was followed by the intrusion of the Parker quartz diorite stock, again apparently in Pre-Cretaceous time.

These plutonic rocks were completely unroofed and themselves partly eroded before early Tertiary time. Deposition of the Vasquez sediments commenced during Oligocene or Lower Miocene time contemporaneous with extrusion of andesitic and basaltic lavas. Faulting occurred from Pre-Cretaceous time to at least Post-Oligocene time as evidenced by offsets in the Parker quartz diorite and the Vasquez, while folding, in contrast, is probably confined to Post-Oligocene.

CONCLUSIONS

The economic possibilities of the district have not been considered. Although some mineral deposits occur in the area, no time was available for their investigation. Copper-bearing deposits were noted occurring in the Parker quartz diorite. In addition to the investigation of the economic possibilities of the area, which should constitute an important part of the report, further work in the area should shed much light on many of the problems involved. Further work in the Ravenna quadrangle, as well as those quadrangles adjoining, would no doubt produce additional information regarding all the problems presented in this report and their solution barely started. Problems of particular interest, such as the structural features of the area, the respective ages of the formations and the

origin, particularly of the volcanic flow rocks, would all require a great deal of additional time in the field in order to present their solution or even partial solution in a satisfactory way.