THE GEOLOGY OF EASTERN SIERRA PELONA RIDGE AND VICINITY, IN THE SOUTHEASTERN PART OF THE ELIZABETH LAKE QUADRANGLE, CALIFORNIA.

THESIS

presented by

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to the

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ABSTRACT

The areal geology of a part of the Elizabeth Lake quadrangle, Southern California, shows four types of plutonic rocks and their hypabyssal equivalents; an Archean metamorphic series of sedimentary origin; Tertiary volcanics, flows and associated tuffs, with basal fanglomerate beds. Faulting is extensive. The San Andreas and one other large fault border the area. Minor faults are numerous. There are no known deposits of commercial value in the area.

INTRODUCTION

THE GEOLOGY OF EASTERN SIERRA PELONA RIDGE AND VICINITY, IN THE SOUTHEASTERN PART OF THE ELIZABETH LAKE QUADRANGLE, CALIFORNIA.

This thesis, presented to the California Institute of Technology, in partial fulfillment of the requirements for the degree of Master of Science, describes an area of about twenty-two square miles in the southeastern part of the Elizabeth Lake quadrangle. It is here proposed to refer to the district as the "Vincent area", because of its proximity to the station of Vincent on the Southern Pacific railroad, which passes through the region.

Previous Geologic Investigation

Publications containing specific reference to the geology of the Vincent area are few, chiefly because past work in the Mojave desert and its environs has been entirely in the nature of reconnaissance, and because the district is a very small part of a much greater geologic province. The first reference to the geology of the area was by Blake[1], in 1856, when he passed through Soledad pass, then called Williamson pass, enroute to Los Angeles. He briefly mentions the presence of granite in the pass, and speaks of the volcanic series on the Mojave desert approach to the pass. In 1902, Hershey[2] briefly discussed the crystalline rocks west of Vincent station. He speaks of a series of schists that occupy Sierra Pelona ridge, which in turn forms the backbone of the Vincent area, and also of "... the gneiss series which ... extends from the vicinity of Soledad pass (on the east) to Texas canyon (on the west)."

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1 - Blake, W.P. Explorations and Surveys for a Railroad to the Pacific, Vol.V, pp.67.

2 - Hershey, Oscar H. Some Crystalline Rocks of Southern California. Am.Geol. Vol.XXIX, No.7, Jan. 1902, pp.273-290.

Reference is also made to the light pink granite that outcrops just east of Soledad pass, and in other parts of the area. A few months later, in 1902, Hershey[3] discussed the Tertiary rocks of the region. He mentions a red basal breccia conglomerate that may be the same as the basal member of the area. The volcanic rocks, described as occurring west of Soledad pass as the descent is made toward Palmdale, are undoubtedly the volcanic series that has been mapped. In 1905, Arnold and Strong[4] in a paper on the San Gabriel mountains, describe gneisses and plutonites that in part extend north of Soledad canyon. Baker[5], in 1911, mentions the "Sierra Pelon" ridge, and states that it has a fault along its north base. In 1912, Hershey[6], again writing on crystalline rocks, mentions the Pelona schists in connection with some schist areas of the Great Basin. In 1927, Noble[7] stated that he had mapped the rocks bounding the San Andreas fault, as far northwest as Palmdale, California. Miller[8], in 1928, discussing the geomorphology of the San Gabriel mountains, speaks of the Soledad canyon fault. Finally, in 1929, Thompson[9] mentions the rocks of the Vincent area, and discusses in detail its water resources.

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3 - Hershey, Oscar H. Some Tertiary Formations of Southern California. Am.Geol. Vol.XXIX, 1902, pp.349-372.

4 - Arnold, Ralph and Strong, A.M. Some CrystallineRRocks of the San Gabriel Mountains, California. Bull.of Geol.Soc.America, Vol.XVI,1905, pp.183-204.

5 - Baker, Charles Laurence Notes on the Later Cenozoic History of the Mojave Desert Region in Southern California. Univ.ofCal.Pub., Bull.of the Dept. of Geology, Vol.VI, No.13, 1911, pp.333-383, pls.34-43.

6 - Hershey, Oscar H. The Belt and Pelona Series. Am.Jour,of Science, Fourth series, Vol.XXXIV, 1912, pp.263-273.

7 - Noble, L.F. The San Andreas Rift and Some Other Active Faults in the Desert Region of Southeastern California. Bull.of the Seismological Society of America, Vol.XVII, 1927, pp.25-39.

8 - Miller, W.J. Geomorphology of the Southwestern San Gabriel Mountains. Univ.of Cal.Pub., Bull.of the Dept.of Geological Sciences, Vol.XVII, No.6, 1928, pp;193-240, pl.29-35.

9 - Thompson, David G. The Mojave Desert Region, California. U.S.G.S. Water Supply Paper 578, 1929.

Figure 1 - Index Map of Vincent Area

TO WILLOW SPRINGS AND MOJAVE
TO MOJAVE
TO MOJAVE, OWENS VALLEY LAKE TAHOE AND RENO MIDLAND TRAIL TO EASTERN POINTS
TO MUROC & BARSTOW
ROSAMOND LAKE
Little Buttes
Rogers School
Oban
Neenach
FAIRMONT
Antelope Buttes
Esperanza School
Roosevelt School
Redman School
Casa Desierto
LANCASTER
DEL SUR
LAKE HUGHES
ELIZABETH LAKE
PORTAL RIDGE
Quartz Hill
Denis
Belleview Sch
La Joya Lodge
Jupiter Mt
Red Mt
Clearwater
Power House No 2
AIRPORT
PALMDALE
PALMDALE LAKE
Harold
Mt. McDill
SIERRA PELONA
Bouquet Canyon
Bouquet Picnic Grounds
LITTLEROCK
Vincent
STATE HWY
Vasquez Rocks
ACTON
Parker Mt.
Little Rock Reservoir
Mt. Emma
DRY CANYON RESERVOIR
Soledad Canyon
Ravenna
Kentucky Springs
SAUGUS
NEWHALL
Humphreys
Mt Layne
Placerita Canyon
NEWHALL OIL FIELD
NEWHALL TUNNEL
Gleason Mt.
Pacifico Mt
Iron Mt.
Pacoima Reservoir
Indian Springs
Mendenhall Pk.
ANGELES
SAN GABRIEL
NATIONAL FORE
Mt Waterman
Twin Pks
Loomis Ranch
Olive View Sanitarium
U.S. Veterans Hospital
Sylmar
SAN FERNANDO RESERVOIRS
SAN FERNANDO
San Fernando Mission
Pacoima
Granada
Chatsworth
NORTH LOS ANGELES
Sepulveda
Mt Lukens
Josephine Mt
Strawberry Pk
Pine Mt
Colby Rch
Switzers Camp
Sunland
Tujunga
Opids Camp
San Gabriel Pk
Mt. Lowe
Mt. Markham
Mt Wilson
Mt. Harvard
La Crescenta
VERDUGO HILLS
La Canada
Roscoe
Dundee
RESEDA
VAN NUYS
BURBANK
Encino
NORTH HOLLYWOOD
Montrose
Flintridge
ALTADENA
GLENDALE
PASADENA
SIERRA MADRE
MONROVIA
ARCADIA
LAMANDA PARK
DUARTE
AZUSA
EAGLE ROCK
SOUTH PASADENA
UNIVERSAL CITY
Monrovia Pk
Orchard Cp
Echo Mt

Field Work and Acknowledgements

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Geography

Immediately adjacent to the Los Angeles basin, on the north, rise the San Gabriel mountains, to an average elevation of about eight thousand feet. They extend in an east-west direction for about fifty miles, and are approximately twenty-five miles across. The south face of the range rises abruptly from the Los Angeles plain; the north front, in the vicinity of Vincent, descends into Soledad canyon, and then over a small outlier ridge, known as the Sierra Pelona, to the Mojave desert basin. Between Soledad canyon and the Mojave desert in a roughly triangular shape is the Vincent area. By reference to the accompanying map the location can be more accurately determined. The area is about twenty-five miles north of Los Angeles by air, and sixty miles by road. It is limited on the north by the San Andreas fault in Anaverde valley, and merges into the Mojave desert basin. The town of Palmdale is one-half mile north of the northern boundary. The Southern Pacific San

Francisco-Los Angeles railroad runs through the area. A paved highway (Los Angeles-Owens Valley route) passes along the eastern margin. The region is traversed by several east-west and north-south poor but passable dirt roads. The character of the top soil and vegetation is such that it is possible in many places to make one's own road and to travel across the alluvium and broad fan deposits almost at will. This makes the region readily accessible. Several air lines also follow the railroad to the Mojave desert.

The region is one of slight relief, with altitudes varying from two thousand to four thousand feet. The rainfall is moderate, from ten to fifteen inches per year, with occasional snowfalls in the winter season. The physiographic features show the region to be under sub-humid to arid climate, more nearly under the influence of the arid. This makes the vegetation of characteristic bushy variety, the south slopes being covered with sage brush and sparse juniper growth, while the north slopes are cloaked with a heavy mantle of sage brush, manzanita, pinone, with occasional scrub oak. Spanish Bayonet and Cholla cactus are everywhere present.

The region, being one receiving slight rainfall, and falling under the Mediterranean desert type of climate, is one of dominantly seasonal streams, which are torrents in time of heavy rainfall and dry in summer. A great diurnal range of temperature aids decomposition, and deep soils result. Except on the north flanks of Sierra Pelona ridge, where dissection is much greater, graded valley floors extend, in many cases, almost to the summit of the range.

The best field days are, in general, in the late spring and early fall. In the winter months when the weather is clear, the days and nights are cold, and the area is often subject to bitter northeast desert winds from the higher reaches of the central basin-range province. These winds make work exceedingly unpleasant. The summers are very warm; the daily temperature seldom being less than one hundred degrees. For these reasons the early fall and late spring offer the best working days.

The drainage of all south slopes is through Soledad canyon into the Santa Clara river, and to the Pacific ocean. The north slopes drain entirely into the Mojave basin, or into the sag ponds and small sinks that form in the depression bordering the San Andreas rift.

GENERAL GEOLOGY

PHYSIOGRAPHY

PHYSIOGRAPHY

The major physiographic features of the region are the eastern Sierra Pelona ridge and Soledad pass. Sierra Pelona ridge is cut by long canyons with flat graded floors, on the northern side; on the southern side the valleys are broad and alluvial filled, and head practically at the summit of the ridge. Soledad pass is the prominent physiggraphic feature on the south. From the north, Soledad pass is not nearly so prominent. The physiographic features are controlled mainly by structure.

Figure 2 - General View of Vincent Area from Una Lake Dam.

The region is hard to classify in the cycle of erosion. The land forms approximate those of early maturity, However.

The maximum elevation is 4730 feet and the minimum 3200 feet.

The oldest erosion surface is that upon which the Tertiary formations were laid. From the nature of this contact, the surface seems to have been one of old age. Downwarping followed erosion to form a basin of deposition. The general uplift with tilting of the sediments deposited in this basin occurred near the close of the Pliocene (?) to form the surface in which the present physiographic features were carved. Erosion progressed to produce partial baseleveling on the valley floors. Thus the old Soledad pass valley may have been much wider than it is today. Rejuvenation with slight tilting has caused the revival of streams on the northern slopes of the Sierra Pelona.

GEOLOGIC HISTORY

GEOLOGIC HISTORY

The crystalline complex of the Vincent area had undergone extensive metamorphism when a thick series of shales, limestone, and sandstone were deposited. Depression of the detrital series placed the rocks in a position in which they were metamorphosed by regional forces. Intrusions of anorthosite into the crystalline complex followed. Granodiorite was next intruded, fàllowed by syenite and finally granite. Uplift caused initiation of erosion. The extent of uplift is unknown, but the region was reduced to late maturity before deposition was again inaugurated by subsidence, but no inundation of the sea. Deposition was initiated by coarse basal conglomerate members, accompanied by extensive outpourings of basalt, rhyolite, andesite, and explosive showers of tuff. These accumulated to an unknown thickness. Faulting uplifted the region and erosion progressed until alluvial material filled the canyons completely across the range in the vicinity of Soledad pass. Slight additional uplift with tilting has caused renewed downcutting on the Mojave side.

PETROLOGY

Metamorphic Rocks

Metamorphic Rocks

The metamorphic rocks occupy the largest area of any type in the Vincent district. There are two members of the metamorphic type, known as the crystalline complex and the Sierra Pelona schist.

Crystalline Complex: A series of quartzose rocks outcrops in areas of low relief in a belt that runs roughly through T5N, R12W, Sec.16, SW¼ Sec.17. These rocks are very deeply weathered. The exact character of this complex cannot be determined for this reason, but it shows well developed gneissic structures that trend roughly N40°E. It has certainly been extensively altered by intrusions, and it has been subjected to severe regional stresses. As fully as can be ascertained, the series was originally both igneous and sedimentary. Certain phases seem to represent old quartzites, while others have a distinct relic allotriomorphic texture as if the facies were originally a plutonic rock. This basement complex is cut by the anorthosite intrusive, which seems to have entered the complex in huge tongues parallel to the regional structure. These rocks are undoubtedly the oldest in the area.

Metamorphics: Sierra Pelona schists: The greatest area occupied by any single formation in the Vincent area is that in which the schist series is exposed. The entire west portion of the area that has been mapped, covering about five square miles, and from this point westward for over twenty miles, is composed of this schist series. The formation is made up of nearly every conceivable type of metamorphic rock, including several phases of mica schists, actinolite, talc, sillimanite, hornblende, garnet, and graphite schists, crystalline limestones, quartzites, and a few beds of metamorphosed volcanic rocks.

No detailed description of this series has ever been published. However, Hershey, in 1902, issued a reconnaissance map[10] and description of the formation[11]. He named the rocks the "Sierra Pelona schist series" after the Sierra Pelona ridge, the western extension of which forms the backbone of the Vincent area. Concerning this series Hershey had considerable to present. He states[12]: "The eastern portion of the valley of the Santa Clara river, in Los Angeles county, is bounded on the north by a prominent ridge, known as the Sierra Pelona. It reaches an altitude of 5000 feet and has a comparatively even crest line and narrow but rounded summit... The entire ridge from Deadman's cañon on the west to its termination eastward where it approaches Antelope valley, a distance of about 20 miles and with an average width of about four miles, is composed of a single series of schists, mostly mica schists. Strikes and dips are locally varied, but as a whole the strike seems to be prevailingly east-west and the general dip northerly at an angle of 10 to 40 degrees, averaging between 20 and 30 degrees. Going up the mountain on the southside, due north from the Mitchell ranch (west of the Vincent area) in Mint canyon, the following succession was made out:

"1. The lower slopes... are composed of a uniformly light yellowish, coarse, granular mica schist of muscovite and quartz... The estimated exposed thickness is 2000 feet. It seems in general to dip into the mountain and to pass under the darker schists of the summit, which it grades into by interstratification.

"2. A more varied and typically schistose series of a prevailingly dark color, being a dark lead-gray... These schists are coarse and granular, but muscovite is abundant...

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10 - Hershey, O.A. "The Quaternary of Southern California", U.of California. Publication Dept.Geol., Vol.III, No.I, 1902.
11 - Ref. cit. pp.1.
12 - Ref. cit. pp.1.

"At various places along the crest of the Sierra Pelona are masses of micaceous blue limestone schist... They have a regular, thin-bedded structure like lamination, apparently representing original bedding...

"At other horizons are thin-bedded quartzites, retaining sufficient of the original structure to make their detrital origin unquestionable...

"The mountain is traversed by narrow bands of a green, fine granular rock which, when unaltered, seems to be a chloritic schist, but in many places it is altered to a dull pink talc, much stained with iron oxide...

"There are also a number of narrow strips of coarsely crystalline actinolite... "

The types of schist exposed where the detailed work was done (of the eight square miles shown on the generalized map, five were done in detail) are the same as those types indicated by Hershey, with many additions and variations. Estimates of the thickness were given by Hershey for his sections. I find it impracticable and well-nigh impossible to place any estimate on the thickness of the schist series, because major and minor deformations are so great that no estimate would be nearly accurate. There are at least 2500 feet. A description of the types of schist that were studied in the area will follow.

<u>Mica schists</u>: The predominant type is mica schist. This rock makes up at least 80% of the formations in the Vincent area. The mica schists are probably the same as those referred to by Hershey as "a light yellowish, coarse, granular mica schist of muscovite and quartz[13]." The mica schists can be divided roughly into two sub-groups: 1) quartz-biotite schist, 2) quartz sericite schist.

Quartz-biotite schist: This phase is composed of quartz, biotite, and orthoclase (?), with magnetite and amphibole as minor constituents, and

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13 - Ref. cit. pp.1.

epidote and hematite as alteration products. The rock shows equidimensional grains, and is very fine textured. Megascopically, specimens show well-developed banding of the quartz and biotite, in some cases as though concentrations of the quartzitic material were due to original arenaceous lamellae of some of the sediments from which these schists were derived. In other specimens, structures are definitely of a secondary nature and were certainly formed under regional stresses that developed foliation in the rock.

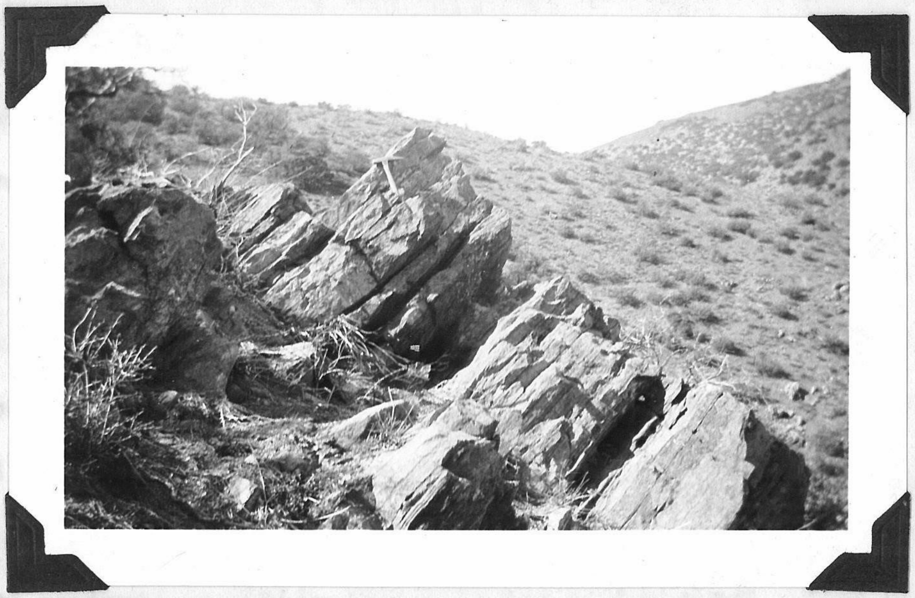

Figure 3 - Typical Exposure of Quartz-biotite Schist.
(T5N, R12W, NW$\frac{1}{4}$, Sec.12)

Quartz-sericite schist: This phase is very finely foliated. The laminae are of the thinness of paper, and are not in continuous bands such as in the foliation of the quartz-biotite schist. Mineral constituents are sericite, quartz, and a minor amount of biotite. This phase was probably developed from beds of very finely stratified mudstone or siltstone, and it is probable that foliation was developed parallel to the former bedding planes of the sediment. The fineness of the foliation makes this seem likely, as paper-like bedding would greatly aid the development of a fine foliate.

These two mica schists, with their variations, make up the greater part of the series, probably at least 80%. Besides these, there are local types. In the following descriptions I shall attempt to arrange the order so that the most abundant are described first.

Garnet-sericite Schist: This garnet schist is similar to the true sericite schist described above. The constituents of this type are garnet, in abundant euhedral crystals, up to 1/16 inch in diameter, which show nearly perfect forms, crystallizing as dodecahedrons; quartz, in anhedral grains, developed between the foliation lamellae; and a sericite mica. The foliation is very fine. This type outcrops extensively on the north side of a small canyon approximately 2800 feet S16°W of NE corner Sec.1, T5N, R12W.

Garnet-hornblende Ortho-schist: As nearly as can be determined by megascopic examination, this type is composed of pellucid, anhedral grains of quartz; elongated greenish-black crystals of an amphibole, probably hornblende; and subhedral grains and euhedral crystals of a yellowish-brown garnet. When forms are present, the dodecahedron is most common. Tetragonal trisoctahedrons were observed in combination with the dodecahedron. Some plagioclase laths may be present. This type is but slightly foliated. Its relationship to the other schists is obscure, and this type is a puzzle to the general series. It may be an ortho form, having been derived from an older plutonic rock.

Garnet-hornblende Para-schist: In contrast to the ortho-rock described above, rather extensive beds of a dark blackish-green color form a good proportion of the less common types. The chief constituent is a dark green to black amphibole, about 1/16 inch in length. These are oriented with c parallel to the foliation. Fairly clear quartz grains form in fine bands that parallel the foliation. Subhedral granular garnets are sparsely scattered through the type. In outcrop these beds may be distinguished a considerable distance away, because of their distinctive color.

Limestones: The term "limestone" is used in this discussion because the exposures have not been marmorized to a degree whereby they may properly be called marble. Some beds have been more highly recrystallized than others. The limestone may be conveniently grouped into two types: 1) bedded gray siliceous limestone, 2) massive brown quartzose limestone.

Bedded Gray Siliceous Limestone: Representing this member of the metamorphic series are three separate exposures. In each case the character of the beds is very well shown. Two of these beds are separated from one another by about 25 feet of mica schist. The beds dip S5°E at 65°, and S10°E at 56. They consist essentially of finely bedded calcium carbonate, with occasional well-rounded translucent pebbles of quartz as large as 5/16 inch in diameter. These are very sparsely distributed in the beds. The siliceous character is inferred from the conchoidal fracture that a fresh break shows. The beds are exposed as dip slopes, and the surfaces are etched by weathering. Occasional veinlets of calcite, that develop in fractures and rarely along bedding

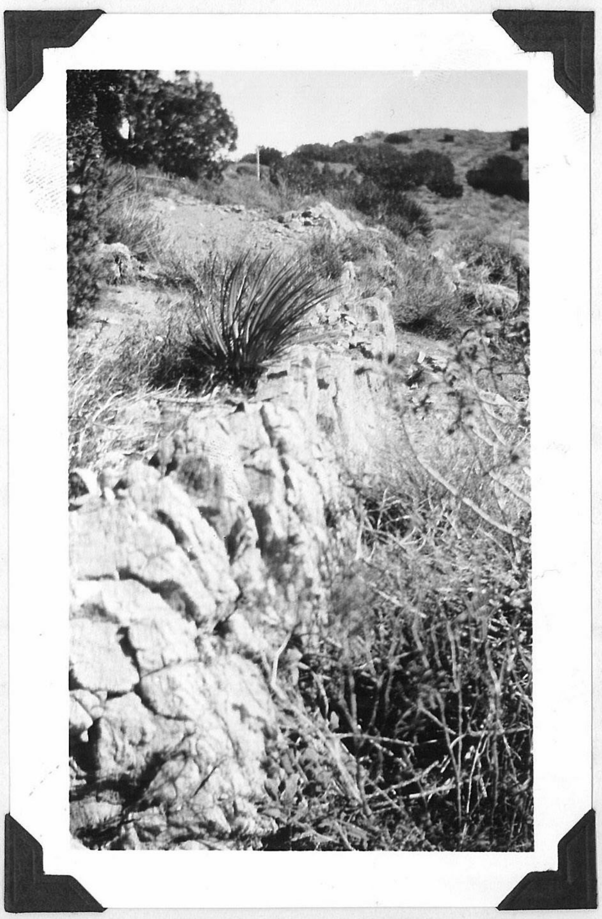

Figure 4 - Exposure of Gray Siliceous Limestone. (T5N, R12W, NE$\frac{1}{4}$, Sec.6)

planes are the only evidences of recrystallization. If fossils are present, they should be found on the weathered dip slope. As yet, none have been found. A third bed of similar character, but not in the same observable stratigraphic sequence, outcrops on the opposite side of the valley from the first two beds. These beds are typically exposed in T5N, R12W, NE$\frac{1}{4}$ Sec.6.

Massive Brown Quartzose Limestone: The massive brown limestone outcrops in two rather widely separated areas. The first exposure is of two beds of not over one foot each, separated by 18 to 20 inches of mica schist. These beds follow the crest of a small ridge, and are also exposed in dip slopes.

Figure 5 - Dip Slope Outcrop of Brown Quartzose Limestone. (T5N, R13W, SE$\frac{1}{4}$, Sec.1)

The third patch is an isolated patch of about 50 sq. yards. The constituents of the brown type are calcite grains, quartz grains, and considerable iron oxide cement. The beds are extensively recrystallized, showing rather abundant veinlets of calcite, and considerable marmorization. Weathering accentuates the quartzitic content, and a typical surface shows etching, with the hard quartz standing out, and the calcium carbonate dissolved away.

Quartzite: There are several exposures of quartzite in the metamorphic series. This type is not a predominating one, but it is of particular interest. First, the beds are never over ten inches thick, and from four to six inches is the average. There are at least seven distinct beds, outcropping through the metamorphic body. They have slight lateral extent and grade rather quickly into the mica schists that are invariably associated with them. The quartzites show excellent banding, that probably represent the former bedding. This bedding is accentuated by magnetite lamellae that separate translucent bands of quartz, well metamorphosed. In a specimen 2x3x2 inches, seven distinct quartzose layers alternated with magnetite layers. There were also several transitions. Perhaps it would be proper to refer to the magnetite bands as "heavy mineral zones", as the exact composition of the dark zone is hard to make out. Magnetite is surely present, also garnet, and possibly other minerals. Weathered beds of quartzite are deeply stained with hematite and limonite, derived from alteration of the heavy mineral zone. The detrital series from which these schists were formed was certainly lacking in pure sandstone beds, if the thickness of Quartzite compared with the amount of schist is a true indicator. The original sandstones from which these quartzites were formed were of limited extent, both horizontally and vertically, and were probably of lens-like character.

Talc, talc-actinolite, and Actinolite Schists: These three types of schist are extensively developed on the northwest, immediately above the bottom, of the anticlinal valley of the metamorphic area. They occur approximately along the axis of the anticline. Only one other area of these rocks has been observed. This is on the southwest side of the anticlinal valley on a part of the structure where deformation has contorted the beds and developed folds of all types, and abundant shear zones. These three types are found intimately associated with one another. They are of sufficient interest to warrant separate description.

Talc Schist: The talc schist is characteristically of a light greenish-gray color. It is very resistant to weathering, except when sheared, and thus it stands out in bold outcrops. In the talc are peculiar bleb-like masses, composed of limonite, that show a distinct parallelism, in the direction of foliation. These brown masses were probably once crystalloblasts of pyrite, predominantly, and some garnet. The garnet has been observed only partially weathered. Some of the cross sections of the new limonite-blasts suggest that they were derived from a mineral that crystallized in cubic form. Talc schists in small beds, without crystalloblasts, has been observed.

Talc-actinolite Schist: This type of schist is extensively developed locally, where the general series was intruded by a diorite that is now somewhat extensively altered, probably by the final forces that were completing the metamorphism of the sedimentary series. Around the margins of this small diorite intrusive, talc schist is host to countless euhedral crystals of pale green actinolite, which have grown in the talc in an interfingering pattern of many crystals of varied sizes. One crystal is 4/8 x 3/8 inches in cross-section and shows well-developed prism faces. It extends above its host about 5/8 inches. Some crystals are over an inch in length. In contrast to the talc schist, this type is non-resistant to weathering, and the indication of the presence of the type is actinolite crystal remnants in thin top soil. Talc-actinolites are also developed along the locally deformed limb of the large anticline.

Actinolite schist: The true actinolite schist is composed of granular, fibrous, and radiating masses of grayish-green actinolite that show the elongate forms of an amphibole, but no euhedral boundaries. Deformation within the radiating masses of crystals is marked. Many of the groups show stress in themselves. The bundles of crystals are as large as from two to three inches in length. Actinolite is the only megascopically determinable constituent. This type is well developed in a shear zone on the northwest flank of the anticlinal valley.

Chloritic Types: All transitions between true amphibole schists, biotite schists and chlorite schists, are obtainable. The true chloritic type is somewhat rare. One type consists of abundant chlorite, a golden yellow mica, and a few iron-stained quartz grains. It is exceedingly well foliated, the planes of schistosity being very irregular and as thin as paper.

There are three schist types of unusual interest which remain to be described. They probably occur in but a single exposure in the area, but are worth separate description.

Orthoclase (?) muscovite Schist: Rounded crystalloblasts of a pinkish feldspar, probably orthoclase, about $\frac{1}{4}$ x $\frac{1}{4}$ inches in cross section, embedded in a ground mass of muscovite and quartz characterize this type. Its appearance is very striking. The crystalloblasts are so arranged that they show the direction of well developed foliation. They evidently lie between paper-like sheets of host, along the planes of schistocity.

Sillimanite-muscovite Schist: Crystals of probable sillimanite, arranged with long axes parallel, and averaging about 5/8 inch in length, in a matrix of muscovite and quartz, is characteristic of this type. The crystals show excellent euhedral boundaries. Most of them lie parallel to the direction of foliation, but an occasional sillimanite is oriented across the plane of schistocity.

Amphibolite: Pure amphibolite is rare. Only one or two exposures were seen. This type consists of unoriented small subhedral crystals of hornblende that are grown together in a texture which suggests the type was once a plutonic rock. The exact relationship of the amphibolite to the rest of the series was indeterminate.

Other Types: Several outcrops were seen which strongly suggested that the rock was derived from a rock type of volcanic origin. Certain specimens show indication of a remnant porphyritic texture that could, without stretching the imagination too far, be said to be suggestive of an extrusion of volcanic type. Detailed petrographic studies of these types might aid one in reaching a definite conclusion in this matter. Graphite schists were observed, and one small specimen of corundum schist was obtained. The outcrop could not be located.

Transition Types: Where the granite intrudes the schist, a wide transition zone is formed, in which the granite magma and solutions from the granite have extensively altered the schist mass. In this zone were found many varieties of rock that can be definitely referred to the schist. Gneisses are characteristically present, with acid bands of the feldspatic minerals of the granite, and basic mica bands. As the granite is approached, the schistocity of the

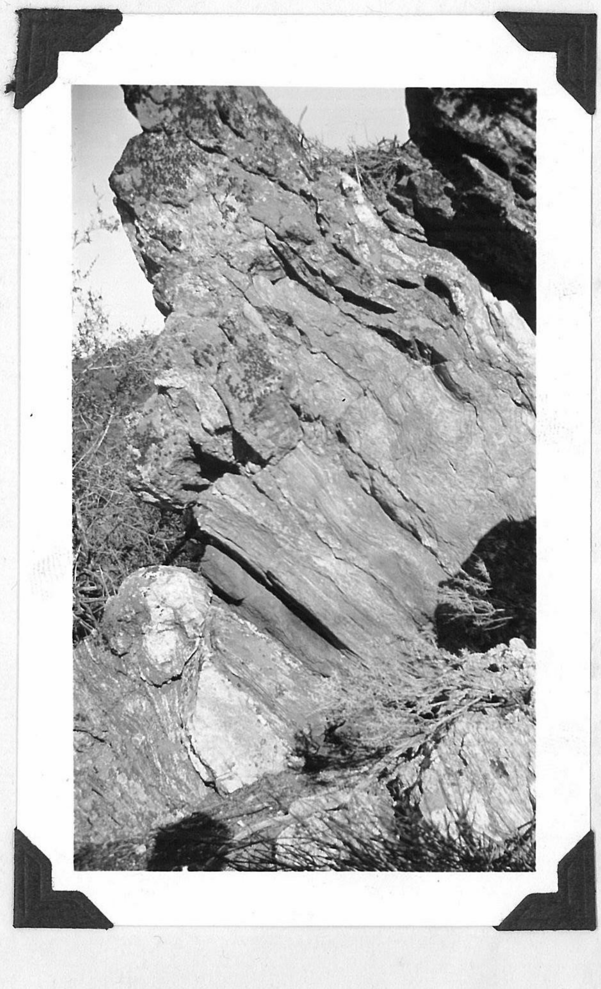

Figure 6 - Schist Cut by Granite Intrusive. (T5N, R12W, NW$\frac{1}{4}$ Sec.7)

regional rock becomes less obvious until it entirely disappears and the granite has completely assimilated and formed a hybrid rock near the contact. In this transition zone are found true schists and true granites and all gradations from one to the other.

The Pelona Schists Outside of the Area of Detailed Study: Several trips were made into the schist area to the west of Vincent. All through Bouquet canyon, which is eroded across the series, the formation seems to be very much more uniform than in the Vincent area. It is essentially of darker color, more chloritic in all its phases, and contains much less sericitic mica. The body seems to be somewhat less deformed; what deformation there is being on a larger scale rather than of local character. One would expect this to be true in passing to regions more remote from the San Andreas fault.

Origin of the Metamorphic Series

The entire section of metamorphic rocks exposed in the Vincent area is, without doubt, derived from a series of clastic sediments, predominantly shales, with some limestones, and sandstones. The presence of extensive bodies of micaceous rocks, with quartz, indicates that fine shales, in part arenaceous, probably made up the bulk of the detrital series. Little true sandstone was present, except as thin lenses which, when metamorphosed, became quartzites. The limestone beds were not extensive, but their original character was essentially the same as it is today.

Throughout the series, there is no evidence to show that the regional foliation was developed at an angle to the former bedding of the detrital series; on the contrary it seems certain that original bedding and planes of schistocity are parallel to one another. The best evidence for this is the interstratification of so-called "heavy mineral" zones, and quartzose layers, in the quartzite beds. In the mind of the writer, these zones are not the result of recrystallization, but represent original bedding. Development of foliation at an angle to original bedding would have partly obliterated, or at least altered the bedding planes. The quartzites would then show two structural planes, bedding and schistocity. Since this is not the case, it seems that metamorphism of this series of sediments was accomplished by depression of the series and intense alteration by extreme downward pressure which produced regional metamorphism, which partially recrystallized the minerals and developed foliation. Such an effect could be produced by the weight of overlying materials or the development of intense structural force. Deformation of the series was accomplished after metamorphism. This subsequent deformation probably has been a factor in the formation of the talc, talc-actinolite and actinolite schists along the axis of the steeply dipping anticline in the schists.

Hulin[14], in his discussion of the Rand mountain schist (60 miles northeast of the Vincent area, a series which is strikingly similar to that of the Vincent area, see "Correlation"), believes the actinolite- amphibole schists to have originated from sediments in a series of volcanic origin, rather than by added strength of deformation along the axis of a fold as suggested by the writer. He states: "The origin of the amphibole schists appear to offer no difficulties. Pure actinolite schists occur sharply interbedded with normal mica-albite schists, indicating sudden changes of short duration from the normal sedimentary sequence. The beds laid down during such periods are interbedded ~~in the normal sediments~~; they show no relic textures but are completely recrystallized and schistose, showing an original material highly

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14 - Hulin, C.D. Geology and Ore Deposits of the Randsburg Quadrangle of California. Calif. State Mining Bureau Bulletin 95, 1925.

susceptible to metamorphism. In the majority of cases, however, the composition of the amphibole schists suggests an admixture of a basic material with the normal shales. The only explanation which will fit all the facts is that of basic volcanic tuffs interbedded with or mixed with normal sediments. In times of intense volcanic activity, beds of nearly pure tuff would be deposited, now observed as actinolite or talc schists. During periods of lesser activity the tuffs would become thoroughly mixed with shales... Such mixture as we now find as amphibole-albite schists... "

The above hypothesis may account for the actinolite schists. On the other hand, if such be the case I fail to see why a concentration of such rocks should be present only in such a structural feature as the anticline of the Pelona series, unless the more intense deformation along the axis somehow aided the development of the talc-actinolite schists.

Correlation

As early as 1902, Hershey suggested that the Pelona schists might represent a definite widespread development in California. Since I am not familiar with any of the schist areas mentioned by Hershey, other than having visited both the Klamath and Rand region, and have but generally observed these rocks, I shall quote from various authors to show how the Pelona is placed in relation to the other schist bodies of the west coast.

In his 1902 paper Hershey says[15]: "So strongly have I been impressed by the similarity in lithology and sequence of the dark member of the Pelona schists (that member described as characteristic of the western extension of Sierra Pelona in the vicinity of Bouquet canyon) and the Abrams mica schist (Klamath mountains), and their marked dissimilarity from any schists observed anywhere else in California, that I propose to correlate them tentatively.

15 - Ref. cit. pp.1.

"The coarse yellow schists forming the lower member of the Pelona series (the so-called yellow member is the one present in the Vincent area as nearly as I can determine) have not been identified in the Klamath region. So far as known their horizon is not due at the surface as the Abrams schists have nowhere been sufficiently elevated and eroded. We, therefore, probably have in Southern California older rocks than any known in the northern part of the state."

Ten years later, in 1912, Hershey again discusses the Pelona series in connection with a paper on the Belt series of northern Idaho. He states[16]: "In discussing the Pelona schists... I suggested that they are of the same age as the Abrams mica schists of the Klamath region. Last year I became acquainted with another area of the Pelona series. It constitutes the greater portion of the Rand mountains near Randsburg in Kern County, California... In the gray schists area (of the Rand mountains) I noted bands of quartz schist, hornblende schist, chloritic schist, and actinolite schist, characteristic features of the Pelona series. Since the two areas are only about 60 miles apart, I correlate them with considerable confidence. I propose, further, to extend the name Pelona series over the Abrams and Salmon formations of the Klamath region. I believe this Pelona series has a definite time position in the Geology of the Pacific Coast country, comparable with that occupied by the Belt series of sediments. It is the youngest important Archean series... "

After reading the article from which the above quotation was taken, I looked up the latest work on the Rand schist series, by C.D. Hulin. I had already written the description of the types of the Pelona series as I had observed them before touching Mr. Hulin's paper. With this in mind,

16 - Ref. cit. pp.2.

and a recollection of the delineation of types given in the last few pages, the reader will readily see that the descriptions of this paper and that of Mr.Hulin's might easily be related to descriptions of the same set of rocks. One may clearly see why Hershey correlated the Rand and Pelona series. The descriptions as given in this paper and the one on the Rand series tally almost exactly. Hulin states as follows[17]: "THE RAND SCHIST -- Rocks of this group compose the bulk of the Rand mountains. As mapped, they cover an irregular area whose maximum extent is about ten miles from northeast to southwest and over four miles from northwest to southeast. An occasional outcrop projecting through the alluvium to the northwest of the Rand mountains indicated that the total extent of the Rand schist is probably much greater than would be indicated by the mapping. (True. I observed schists of similar character to those of the Pelona and Rand, in an island in the alluvium in the Mojave desert basin about 20 miles east of Lancaster, California, which is between the Rand mountains and Sierra Pelona ridge. This might indicate that the whole Mojave basin between these two ranges is underlain by the Pelona series.)

"Over most of the area occupied by the schists... the predominant type of rock represented is a mica-albite schist. The rock shows highly developed schistocity...

"Next in abundance are numerous amphibole schists.

"Many of the schists in this group consist of practically pure actinolite. The actinolite, light green in color, occurs in radial bunches or groups of interlocking crystals, long axes of both minerals lying in the plane of schistocity. Locally the actinolite may disappear, leaving beds of practically pure talc which may be up to two or three feet in thickness.

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17 - Ref. cit. pp.22.

In these schists hornblende may take the place of actinolite although the latter mineral is by far the most common.

"The types just described, the actinolite schist, actinolite-talc schist, talc schist and hornblende schist, are regarded as extreme types in a series, and are to be found only in comparative minor amount...

"Quartzites and limestones occur throughout the series interbedded with the mica-albite schist and the amphibole schists. They vary in thickness from a foot or possibly less to over ten feet. They form continuous beds, lensing out in all directions, at times only a few hundred feet in length; at other times traceable for over a quarter of a mile.

"The quartzites vary greatly in purity. In many cases they are massive and consist essentially of pure quartz... In other cases a coarse parallel structure is developed as a result of thin layers of light brown mica which parallel the schistocity of the adjoining rocks. (Might not these be similar to the "heavy mineral" zones, so-called, included in this paper in description of the quartzites?)

"The limestones are white to light gray in color and appear to be slightly carbonaceous but otherwise pure. Quite contrary to what might be expected, these limestones have been but very little affected by recrystallization... Limestones are considered generally to be extremely susceptible to metamorphism, but here, interbedded with rocks that have been completely recrystallized, they appear to have been one of the most resistant types."

I think that the similarity of the limestone beds, in both cases being most resistant to metamorphic effects, is one of the best points by which correlation can be made, because, as pointed out, limestones are generally very susceptible to forces of recrystallization, and here are two rather closely allied regions whose metamorphic series show similar characters, both having limestones that have been extremely resistant to recrystallization.

Age of the Pelona Series

Because of the similarity of the Rand and Pelona series, I am going to take verbatim the age discussion of the Rand series and apply it to the Pelona. At its best, the criteria applied to determine the age can only be relative and theoretical. Of the age of the Rand schist Hulin says[18]: "The age of these two groups (the Johannesburg gneiss and the Rand schist) is believed to be Archean. The age can be inferred solely from a consideration of their petrology, and comparison with formations of nearby regions.

"In the El Paso mountains across the valley to the north (10 miles from the Rand mountains and 60 from the Pelona schists), marine sediments believed to be Palezoic in age, though intruded by quartz monzonite, show practically no effects of metamorphism. Still further north, in the Inyo mauntains, marine sediments ranging in age back to the Pre-Cambrian are similarly but little altered[1].

"In the desert ranges to the north and northeast, namely the Argus, Slate, Panamint and Funeral ranges, sedimentary strata ranging from Cambrian to Permian in age are practically unmetamorphosed[2].

"In the region to the south, rocks believed to be of Paleozoic age, while more or less affected by batholithic invasion, have not been subjected

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18 - Hulin, C.D. Geol. and Ore Deposits of the Randsburg Quadrangle of Calif. Bulletin 95, California State Mining Bureau, 1925. (Ref. cit. pp.22)

1 - Knopf, A. and Kirk, E.E. Geol. Reconnaissance of the Inyo Range and the Eastern Slope of the Sierra Nevada, Calif. U.S.G.S. Prof. Paper 110.

2 - Ball, S.H. A Geologic Reconnaissance of Southwestern Nevada and Eastern California. U.S.G.S. Bulletin 308 (1907)

to the same intensity of action suffered by the rocks of the Rand mountains[3]. Further east, in the Bristol range, sediments of Lower and Middle Cambrian and Carboniferous age are known which are but little altered.[4] Still further east, in the Grand Canyon section, sedimentary strata of Algonkian age are not metamorphosed.[5]

"Since nowhere within this province or in adjacent regions have rocks known to be younger than the Archean in age suffered the same intensity of metamorphism as have the Johannesburg gneiss and Rand schist, these groups must, at least until further evidence is forthcoming, be considered to be Archean in age."

Furthermore, in the Vincent area alone, one must allow for the emplacement of four types of plutónic rocks, uplift and erosion of these bodies, the deposition of the Escondido series and accompanying outpourings of lava and deposition of tuffs, and subsequent upliftaand erosion ~~to the~~ present state. This must have taken a very long time. Pre-Cambrian is none too long ago for this Pelona series to have been deposited.

While Hulin presents valuable data and evidense upon the point, I believe that positive and conclusive proof of the age of this series still remains to be found.

No fossils have ever been discovered in this area.

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3 - Spurr, J.E. Descriptive Geology of Nevada South of the Fortieth Parallel and Adjacent Portions of California. U.S.G.S. Bulletin 208 (1903).
4 - Clark, C.W. Lower and Middle Cambrian Formations of the Mojave Desert. Bulletin Dept.of Geology, University of California, Vol.13, pp.1-7, 1921.
5 - Noble, L.F. The Shinumo Quadrangle, Grand Canyon Dist., Arizona. U.S.G.S. Bulletin 549, 1914.

Igneous Rocks

Plutonic Rocks

Plutonic Rocks

The plutonic rocks of the Vincent area are represented by four well defined intrusives: anorthosite, granodiorite, syenite and granite. The following chapter will deal only with the petrographic descriptions and with the megascopic features that are of aid in field and laboratory determinations of the types. Genetic relationships will be discussed under a separate heading.

Anorthosite: The anorthosite outcrops in four separate divisions in T5N, R12W, Sec.17 and 19. This formation occupies a narrow belt running in a northeasterly direction, approximately N60°E. The belt is of low relief, and it appears as if the anorthosite is exposed because erosion has progressed deeper, and into the older rocks. The anorthosite cuts the complex, oldest series in the area. It shows two closely related phases, both magmatically and mineralogically. The typical rock is coarse, equigranular, bluish-gray to white in color, and is associated with a darker, apparently dioritic phase, that one would hardly suspect to be part of the anorthosite body. These dark dioritic phases occur in bands and stringers throughout the anorthosite in no particularly regular fashion; they often give the rock a distinct gneissic appearance, as if the anorthosite was cutting an older series, and had in part injected it to form a lit-par-lit gneiss. This was the original conception of the anorthosite, and its banded associate. No transition zones, or definite contacts were observed to confirm this, however. In a trip to the region, the writer was accompanied by Dr. W.J. Miller, of U.C.L.A. After seeing the exposure he stated his belief that the banded darker types were facies of the anorthosite, formed during emplacement, from the anorthosite magma. His idea is based upon similar phenomena observed in the large anorthosite body in the San Gabriel mountains to the south. In this large body patches of dark anorthosite occur heterogeneously in the midst of anorthosite of the most homogeneous character[19].

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19 - Personal Communication.

This belief was confirmed to the writer's satisfaction when the petrographic studies of the anorthosite were complete. Slides of both phases showed the same essential constituents in about the same proportions, with less than 5% dark minerals in all but one case, and in that case the field relations showed the rocks to be distinctly part of the anorthosite. The type rock is holocrystalline, Hypidiomorphic, equigranular in texture; and is composed of bytownite, in subhedral grains showing pericline twinning; magnetite; hornblende; apatite; titanite; and alteration minerals kaolinite and sericite. The banded character of some specimens is not revealed in thin section. Magnetite is quite abundant as an accessory, and seems in some cases to be of secondary origin, filling the cleavage and fracture planes in some of the grains of other minerals.

The following table summarizes the mineralogical features of the anorthosite in the slides that were prepared.

Texture	S01	S04	S05	S07	S08
Hypidiomorphic	x	x	x	x	x
Holocrystalline	x	x	x	x	x
Inequigranular	x				
Equigranular			x		
Constituents					
Essential Minerals					
Plagioclase		x	x		
Bytownite				x	
Labradorite	x				x
Accessory Minerals					
Hornblende	x		x	x	x
Biotite		x			
Apatite	x		x		x
Magnetite	x	x	x		x
Titanite	x		x		x
Alteration Minerals					
Epidote	x				x
Kaolinite	x	x		x	
Sericite		x	x		
Red iron oxide	x				

Remark: S01: Possibly greater than 10% Fe-Mg minerals in this case.

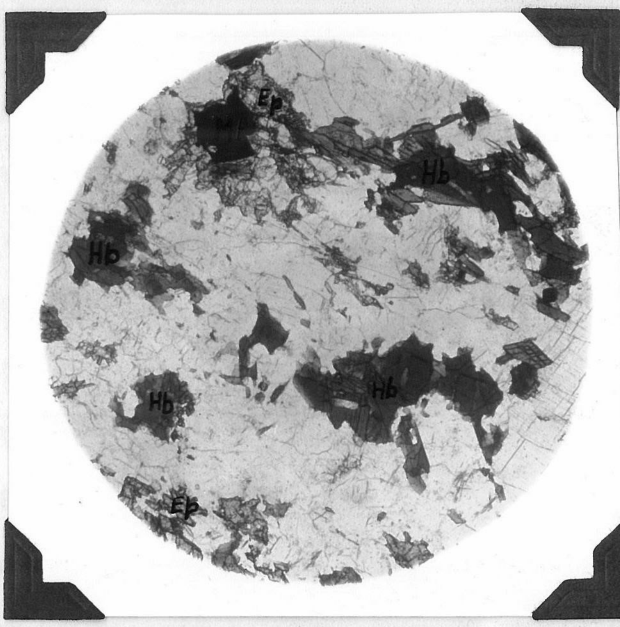

Figure 7 - Photomicrograph of Anorthosite. X27. Nicols Uncrossed. (Hb) Hornblende, (Ep) Epidote, (Mt) Magnetite, (Ap) Apatite.

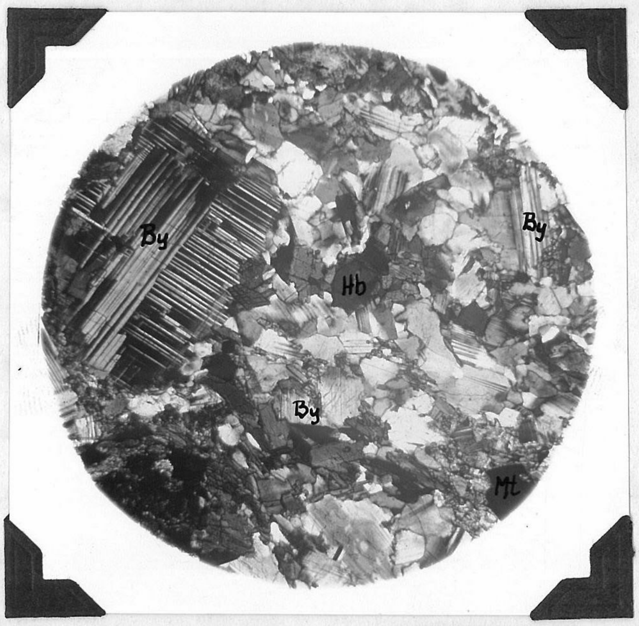

Figure 8 - Photomicrograph of Anorthosite. X27. Crossed Nicols. (By) Bytonite, (Hb) Hornblende, (Mt) Magnetite.

Granodiorite: The granodiorite is the predominating plutonite south of the base of the Pelona ridge extension. It is exposed chiefly in islands in the alluvium, but it occupies one major area east of Soledad pass, and also the large hill west of the pass, underlying the main body of volcanic rocks. The distinctive features which identify this type are its pronounced gneissic structure, which is accentuated by the orientation of the hornblende crystals; and second, the typical subhedral to euhedral boundaries shown by the hornblende. A variation in the granodiorite occurs in contact with the syenite in T5N, R12W, Sec.24, where it develops a higher ferro-magnesian content, and loses the gneissic structure. This variety is of very limited extent. A similar variation is found in a larger body to the south.

The rock is holocrystalline, hypidiomorphic, equigranular; is composed of plagioclase (andesine); quartz, showing strain figures; microline; considerable hornblende of strong pleochroism, Z=blue green, X=yellow green; titanite; apatite, in good euhedral crystals; magnetite; and alteration products, epidote, kaolinite, sericite, and a red iron oxide. A cataclastic texture has developed. The grains are crushed and broken.

Syenite: The syenite body occupies the greatest area of the plutonic series. It comprises the entire western extension of the Sierra Pelona. It is characteristically weathered, and a few good exposures are encountered. Even where the Edison Power Company has built a road across the ridge, exposing the syenite in cuts, the rock is so badly altered that in only one place was a species obtainable from which a section could be made that showed fresh grains.

The body is fairly homogeneous, of a rather dark yellowish brown color (mainly because of alteration) and of medium grain. Locally, quartz-rich

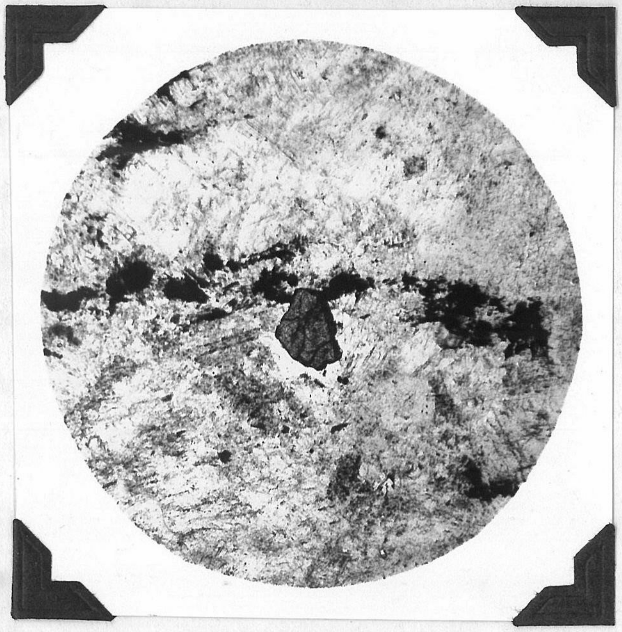

Figure 9 - Photomicrograph of Granodiorite, showing characteristically large titanite crystals. X27. Nicols Uncrossed.

Figure 10 - Photomicrograph of Granodiorite. X27. Nicols Crossed. (M) Microcline, (My) Myrmekite, (Pl) Plagioclase.

variations were noted. These occupy very small areas and grade almost at once into the true syenite body, with no evidence that the quartz-rich facies is a body of different origin. The rock often contains a small amount of quartz, but always less that 10%.

The syenite is holocrystalline, with a hypautomorphic granular texture, similar to that shown by Johannsen[20], as typical for a corundum-syenite from Renfrew County, Ontario. By far the most abundant constituent is microperthite, which is in some cases almost sub-microscopic. This intergrowth makes up at least 90% of the whole. Microcline and fine twinned plagioclase, probably oligoclase; a fibrous amphibole (hornblende), which in most cases is pretty well broken down; subhedral grains of apatite; titanite; zircon and magnetite; and occasional quartz grains comprise the remaining 10%. Alteration products are kaolinite, sericite and red iron oxide.

Locally the syenite shows cataclastic and gneissoid structures. These are best developed in the large shear zone, which adjoins the syenite on the north flank of the Sierra Pelona extension.

The syenite is cut by occasional pegmatic dikes, that may be offshoots of the later granite.

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20 - Johannsen, A. A Descriptive Petrography of the Igneous Rocks. Part I, pp.38, Figure 47.

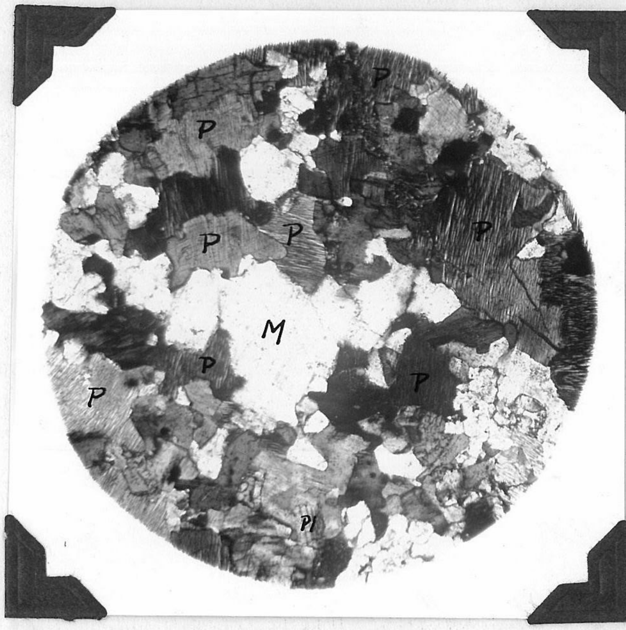

Figure 11.

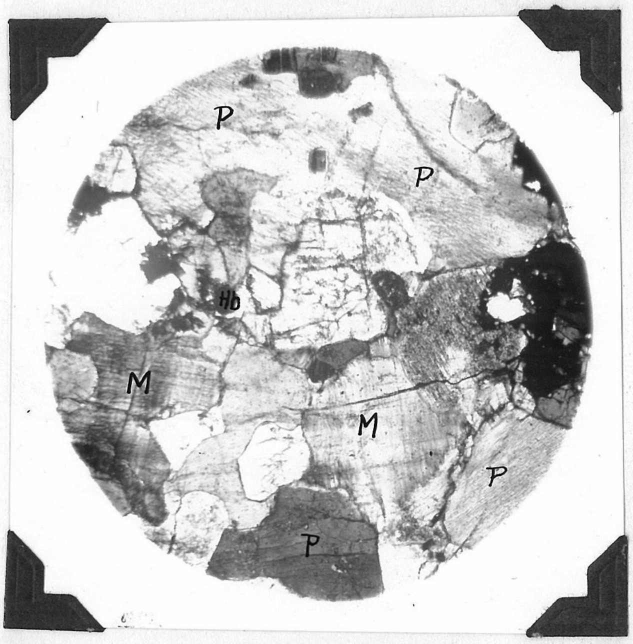

Figure 12.

Photomicrographs of Syenite. X27. Crossed Nicols.
(P) Perthite, (M) Microline.

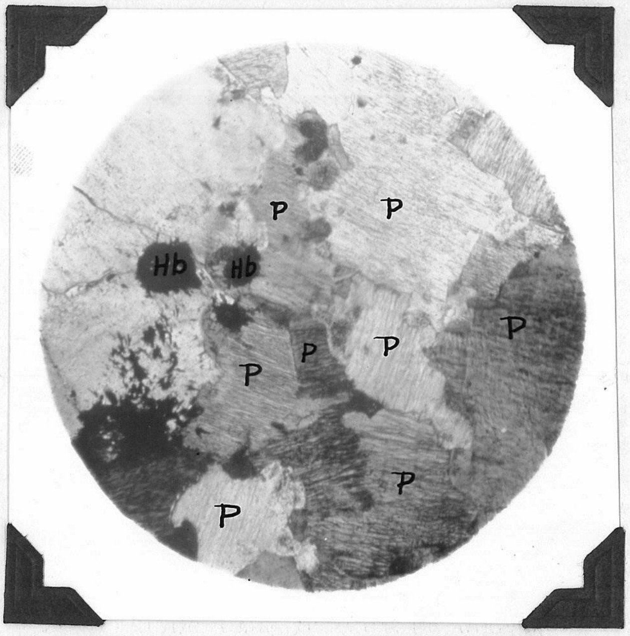

Figure 13 - Photomicrograph of Syenite. X27. Crossed Nicols.
(P) Perthite, (Hb) Hornblende.

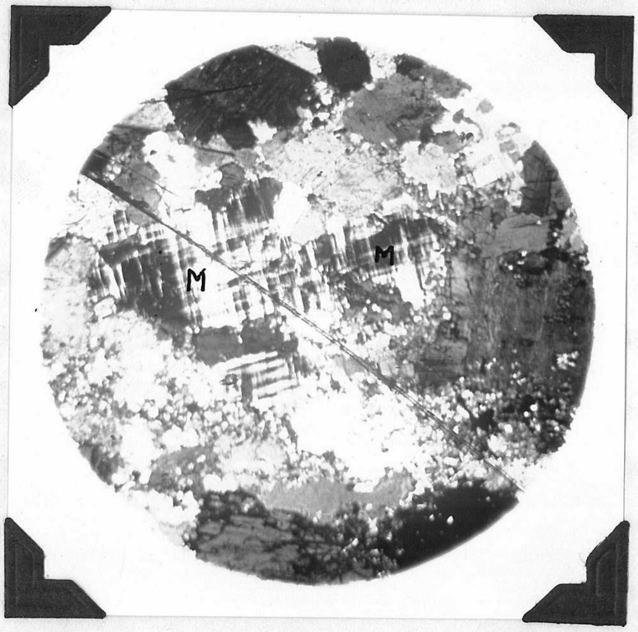

Figure 14 - Photomicrograph of Granite. X27. Crossed Nicols.
(M) Microcline

Resume of the petrography of the syenite body:

Texture	S02	S03	S012	S023	S029(I)	S029(II)	S037	S039
Holocrystalline	x	x	x	x	x	x	x	x
Allotriomorphic			x	x				
Hypidiomorphic				x	x	x	x	x
Equigranular						x		
Inequigranular								
Constituents								
Essential Minerals								
Microperthite	x	x	x	x	x	x	x	x
Microcline	x	x	x	x	x	x	x	x
Accessory Minerals								
Plagioclase	x	x	x	x	x	x	x	x
Oligoclase							x	
Quartz			x		x	x		
Hornblende			x		x	x	x	x
[redacted]				x	x	x	x	x
Pyroxene					x			
Muscovite				x	x			
Magnetite			x	x		x	x	x
Zircon						x	x	
Titanite				x			x	
Chlorite		x			x			
Alteration Minerals								
Sericite			x		x	x		x
Kaolinite	x	x	x		x	x		x
Epidote					x	x		
Red iron oxide				x				x

Remarks: S02: Thick section.
S03: Granite phase, greater than 10% quartz.
S012: Some myrmekitic-like intergrowths.

Granite: The granite is the youngest plutonic rock in the region. It occupies areas east of Soledad pass, and an area to the west, in T5N, R12W, SW¼ Sec.7, and R13W, SW¼ Sec.12. In the first area, the granite intrudes the granodiorite; in the second, the granite intrudes the schist. The rock is typically light-colored and fine-grained, with a very small percentage of dark minerals. Locally the granite shows slight gneissic structures, especially near the schist-granite contact, where assimilation of the schist has taken place.

The granite shows some textural variations, but the mineralogy is remarkably uniform for specimens from widely separated exposures. Quartz is abundant in anhedral grains; microcline is the potash feldspar rather than orthoclase; plagioclase is present in small quantities, generally andesine. Biotite, apatite, and zircon are present as accessories. Aplitic types carry garnet. Occasional myrmekitic-like intergrowths are observed. The rock is holocrystalline, hypidiomorphic, inequigranular.

Summary of petrography of granite member:

Texture	SC6	SC13	SC20	SC34	SC50(1)	SC50(2)
Holocrystalline	x	x	x	x	x	x
Allotriomorphic		x	x		x	x
Hypidiomorphic	x			x		
Equigranular		x			x	x
Inequigranular	x		x	x		
Constituents						
Essential Minerals						
Quartz	x	x	x	x	x	x
Microcline	x		x	x	x	x
Accessory Minerals						
Plagioclase		x			x	x
Andesine	x		x	x		
Microperthite		x				
Magnetite		x		x	x	x
Apatite	x	x		x		
Zircon					x	
Biotite			x	x		x
Titanite					x	
Garnet			x			
Alteration Minerals						
Epidote					x	x
Calcite			x			
Sericite	x	x				
Kaolinite	x	x	x		x	
Chlorite		x	x			x
Red iron oxide						x

Correlation

Correlation of plutonic rocks is difficult, even when detailed petrographic comparisons can be made. To correlate igneous rocks of the type above described, by comparing textural and field relationships in adjacent areas, of which the writer has little first hand knowledge, is doubly difficult. In discussing the above types with Dr. W.J.Miller[21], he places the anorthosite as that of the San Gabriel body proper. He states that he has not found syenite in the plutonic rocks of the San Gabriel range, but that the granodiorite is similar in appearance to the Lowe granodiorite, and is possibly a phase of that body. The granodiorite body is known by the writer to be present in the areas immediately south of the Vincent area.

Age

The age of the plutonic series can be placed only by comparison. Assigning the last great plutonic invasion of the Pacific coast region to Jurassic time, and assuming the latest intrusive to be of that age, the granodiorite falls in the group. As the relations between the other plutonic series are very obscure, only an approximate statement of relative age may be reached. The syenite seems older than the granite, preceded by the granodiorite, and then by the anorthosite. These bodies represent activity from the time of the Pelona schists to the Jurassic granite. Hershey[22] calls the granite rocks of Soledad pass "Mesozoic" granites.

The writer fully realizes the inadequacy of the above statement, but it is the best that can be made with the evidence available in the area.

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21 - Personal Communication
22 - Ref. cit. pp. 1

Hypabyssal Rocks

Hypabyssal Rocks

The hypabyssal rocks comprise only four types that need but brief mention here. Lamprophyric dikes cut the old complex series and the granodiorite. They are coarse grained, equigranular, principally of hornblende. Dioritic dikes cut the schist in two places. They are composed of hornblende, epidote, apatite, and plagioclase. Pegmatites cut the anorthosite, syenite, and schist series. Silexite dikes and quartz veins are present in the schists. Aplites are the youngest hypabyssal rocks and cut the granite and granodiorite.

The dike rocks are not prominent features of the plutonic bodies, and hence it is not deemed important to give detailed description of the types. Slides were made of the dioritic types that cut the schist.

Petrogenesis

Petrogenesis

The field conditions under which the study of the intrusive relations of the plutonic series of the Vincent area were made are such that the definite order of intrusion of the four plutonic rocks has not been satisfactorily determined. In order to construct an approximate time relationship between the series, it has been necessary to make many inferences without a sufficient background of evidence, and to make assumptions (for hypotheses only, and not conclusion) that may at a future date prove dangerous. In regard to this series, it may be stated at the outset that only the most incomplete history can be derived from observation.

A summary of the relationships of the four types as the writer has placed them, proposes the following order from oldest to youngest: crystalline complex, ortho- and para- rocks, cut by an anorthosite intrusive; this followed by general intrusion of granodiorite; the syenite; and the youngest intrusive, the granite. The following paragraphs will discuss the types in relationship to the older rocks, presenting evidence for each, followed by a brief discussion of the origin of the types.

Anorthosite

General: Because of the frequent intrusive association of the anorthosite with the crystalline complex, it has been placed as the oldest plutonic series. Huge tongues of anorthosite cut this group parallel to the regional struture. The anorthosite in turn is cut by pegmatite dikes that may be offshoots of the later granite. The anorthosite has never been found in relation to any of the younger plutonic rocks in the Vincent area.

Origin: The origin of anorthosite is one of petrography's most perplexing problems. Several hypotheses have been presented, two of which have found rather wide tentative acceptance among petrographers.

The most concise summary of the anorthosite hypotheses was presented in a paper by Miller, in 1931. He states as follows[23]: "Two important hypotheses in regard to the Adirondack anorthosite have been advocated and elaborately discussed. One of these is by Bowen, and the other by the writer. Bowen's hypothesis[1] may be very concisely stated as follows: (1) intrusion of a gabbroid magma in the form of a laccolith; (2) development of an upper, chilled, gabbroid border facies; (3) settling of mafic crystals in the magma to form gabbro and peridotite at the bottom; (4) settling of plagioclase crystals to form anorthosite above the gabbro; (5) solidification of residual syenite-granite magma in a position between the anorthosite and the upper chilled border.

"The writer's hypothesis[2] may be very concisely stated as follows: (1) intrusion of a gabbroid magma in the form of a laccolith; (2) development of an upper and outer chilled, gabbroid, border facies; (3) probable settling of mafic crystals to form gabbro and peridotite at the bottom; (4) solidification of the residual plagioclase-rich magma to form a large body of anorthosite between the gabbro and the chilled border."

The above statement was applied to the Adirondack anorthosite. The essentials of the origin of the anorthosite, however, apply to any body.

From slight experience in the Vincent area, and in the area to the southwest, I believe that the hypothesis of Miller more nearly explains the

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23 - Miller, W.J. Anorthosite in Los Angeles County, California. Jour. of Geology, Vol.XXXIX, No.4, May-June, 1931.
1 - Bowen, N.L. Jour. Geol., Vol.XXV, (1917), pp.209-43; 500-512.
2 - Miller, W.J. Am. Jour. Sci., Vol.XVIII, (1929), pp.383-400.

observed field facts. Dikes and apophyses of anorthosite cutting country rock appear to be unrefutable evidence that anorthosite, although a monomineralic rock, can produce the same results that any plutonic body of normal type may accomplish.

Other Types

Granodiorite: The granodiorite presents a unique problem. Its relation to the anorthosite is not known. By studying the areal map accompanying this report, one sees that anorthosite and granodiorite, syenite and granodiorite, and granite and granodiorite are mapped in contact with one another. The exposures are badly weathered, and covered with soil or alluvium. Most careful observation has failed to reveal a clue as to the relationship in the first two cases. The granite may definitely be placed as younger than the granodiorite. Intrusive relations seen in the weathered outcrops along the Edison

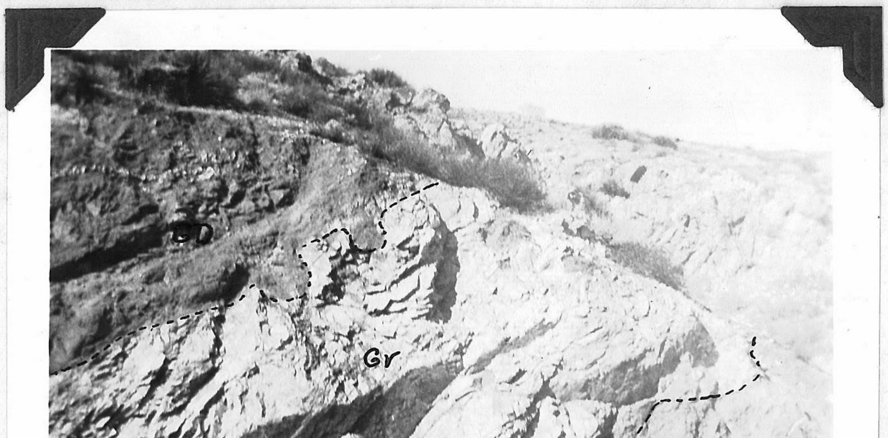

Figure 15 - Granodiorite cut by Granite Dike.
(½ mi. sw. of Vincent, on State Highway)

Power road that passes through the area point to the granodiorite as being older than the syenite; these justify the placing of this type next younger than the anorthosite. Miller[24] informs me that nowhere in the San Gabriel range, where anorthosite and granodiorite are adjacent, has he been able to determine the relationships. Faulting, erosion or alluvium have always interfered. This relationship is one that may, at a future date be worked out, if new exposures in areas yet unknown, are discovered. Miller places the Lowe granodiorite of the San Gabriel, which he tentatively correlates with the Vincent granodiorite, as a younger series than the anorthosite.

Syenite: The syenite is alone in the Vincent area as far as proof of its relations to the other plutonic rocks is concerned. Certain indicatory evidences may be presented, but not definite ones. Along the Edison Power road which crosses Pelona ridge, are deeply weathered exposures of what appears to be granodiorite. These are badly faulted. (In shear zone.) Because the syenite nearly surrounds the apparent granodiorite, it would seem that the granodiorite was cut by the syenite. A second observation in the southwest corner of the area, also is of the same nature. This is, I realize, poor grounds for age relationships, but it is the best that can be presented. The syenite is cut by pegmatic dikes that are probably granitic offshoots.

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24 - Personal Communication.

Granite: The granite cuts the granodiorite and schist in definite dikes and apophyses. If the pegmatite dikes that cut the anothosite and syenite bodies may be considered to definitely represent the granite, it may be stated that the granite cuts all the other plutonites of the area.

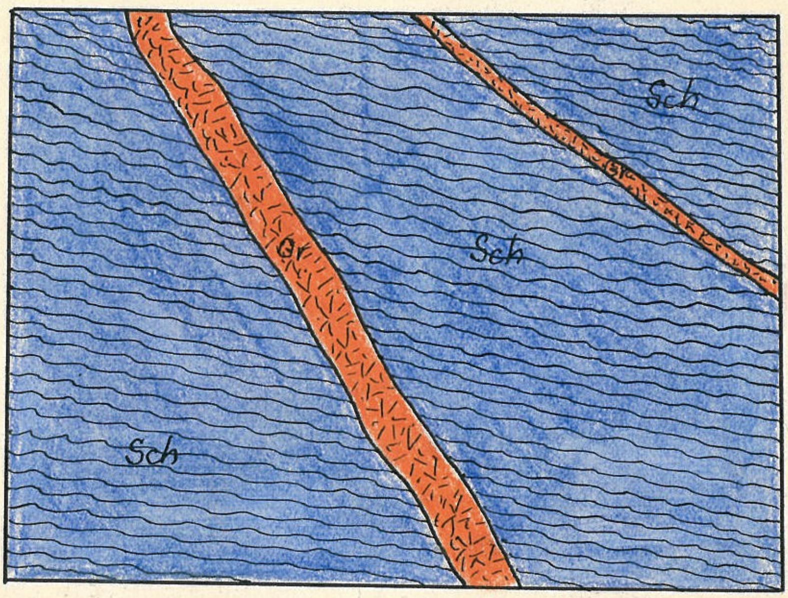

Figure 16 - Diagrammatic Section Showing Granite Cutting Schist.
(2' x 3') (T5N, R12W, Center SW$\frac{1}{4}$, Sec.7)

Dike Rocks: There are three types of dike rocks in the area. Coarse lamprophyric dikes cut the crystalline complex in distinct intrusions at an angle to the gneissic structure. What are apparently the same dikes also cut the granodiorite, and may cut the anorthosite. The pegmatic dikes referred to below cut every type older than the granite. The youngest rock in the area consists of aplitic dikes that cut the granite and granodiorites east of Soledad pass.

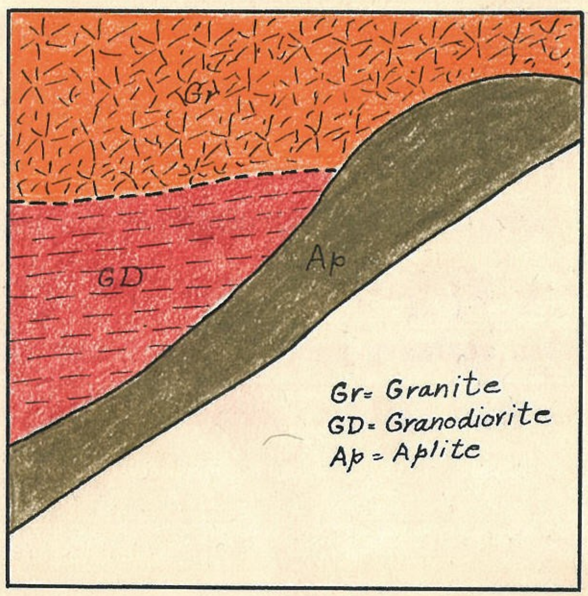

Figure 17 - Aplite Dike Cutting Granite and Granodiorite.
(T5N, R12W, W Center Sec.23)

Origin of the Granitic Plutonites

The granodiorite, syenite, and granite are members of a consanguineous series that was probably derived from a single granitic magma. By reference to the summaries of petrographic studies on pages 30, 37 and 38, one sees at once that microcline and microperthite are the abundant essential minerals in the syenite; microcline is the potash feldspar in the granodiorite, and also in the granite. Microperthite also appears in one slide of the granite. Besides this, the three types contain but a small percentage of dark minerals. Because of the apparent mineralogic relationship between these three types, for them to have originated from a common granitic magma is the most logical and the simplest hypothesis to propose.

Imagine an area, underlain by a granite magma. From this huge chamber, consider that a part of the body begins to force its way upward, and any portion of the magma becomes stagnated and remains in one position for a considerable time. Differentiation would take place, and from the magma would form a segregate of more basic character than a granite, say a granodiorite. The remaining part of the original body would thus be enriched in alkalic constituents and a syenitic body would form. These differentiates would then be emplaced to form the granodiorite and syenite bodies. Subsequently, granite, from the underlying granitic undifferentiated body, intruded the syenite and granodiorite. Aplitic dikes are the final "shots" from the granitic invasion.

Volcanic Rocks

Volcanic Rocks

The volcanic rocks comprise a series that occupies the point of the "wedge" between the San Andreas and Soledad pass faults, immediately west of Soledad pass. Besides this large area of volcanics, there are numerous isolated lava-capped "islands", and also complete "islands" of volcanic rocks.

This group offered the greatest problem when differentiation of types was attempted. The desired amount of detail was not gained because the nature of the series is such that it offers difficulties which cannot be overcome without extensive petrographic work so that correlation within the series itself would be possible. As sufficient time is not available for extensive petrographic studies of the volcanic rocks (which is in reality outside the scope of this problem) only the barest superficial treatment of this group will be attempted. The difficulties in differentiation of types and correlation by field methods became more apparent as field work progressed. First, the varied character of the volcanic rocks themselves; thiswould at first seem advantageous if it were not for the fact that of the many types observed, not one was distinctive enough to be used as a "key" bed. Second, the limited horizontal and vertical extent of the flows and fragmental beds. Third, excessive faulting, which produced jostling and settling of blocks and many lateral displacements. Fourth, the low relief of a great part of the volcanic series, which is covered with deep soils and contains practically no determinable outcrops over large areas.

The volcanic rocks consist of flows, of acid and basic character, and fragmental rocks, tuffs and agglomerates. Many types were observed, some of which will be listed below and more fully discussed. Others will be but briefly mentioned.

Rhyolites and basalts are the two most common flow types. The rhyolite is best developed in the large area in the "wedge", while the basalt occupies all the islands as well as large areas in the "wedge". The types of volcanic rocks present are grayish-red tuffaceous rhyolite, as the commonest representative of the acid group; platy basalt; red and black basalts, some of which show good flow structures and have vesicular cavities; an interesting amygdaloidal basalt, with amygdules of calcite, quartz, and some zeolite, probably pectolite. One flow with obsidian bands was observed.

The fragmental rocks are extensively represented by tuffs, which are widely distributed through the series. They consist of a multitude of small angular fragments from red, purple and gray lavas, varying in size from 1/32 inch to an inch in diameter. These are embedded in a matrix of volcanic ash, of a light yellowish-gray color. The distribution of the tuffs may be determined from the aerial maps. The agglomerate is a minor member of the series, but is generally basaltic in character.

Two types appeared so interesting that slides were made of them. Both were basalts. The first, in hand specimen, a porphyritic brick red basalt, showed in section very abundant phenocrysts of zoned plagioclase, sometimes with as high as eight distinct zones, and good phenocrysts of augite. The phenocrysts are in some cases reabsorbed. The ground mass contained laths of plagioclase, pyroxene, magnetite, glass and abundant red iron oxide, in hyalopilitic texture. This slide was so distinctive that, even though it is a type found only in two places in the area, a photomicrograph was taken of it. (See figure next page.)

A second type was a homogeneous massive basalt. It showed small phenocrysts of augite, plagioclase, and magnetite, with a ground mass of the same minerals, in pilotaxitic intergrowth. Sericite, kaolinite, and red iron oxide are the alteration products.

Sedimentary Rocks

Figure 18 - Photomicrograph of Basalt. X27. Crossed Nicols (Pl) Plagioclase, (Ag) Augite.

Because of the amount of fragmental material and the slight horizontal and vertical extent of the flow of the series, it seems that only eruptions from cones, whereby small flows would alternate with explosive eruptions, can explain this series. No evidence of fissure eruptions is present. The position of the source vents is unknown.

No criteria for age determination is available. These are probably, however, of Miocene age, since this period was one of extensive vulcanism throughout the great basin and the whole United States.

The entire discussion of the volcanic rocks is sketchy and inadequate. The writer had to choose between concentration on the metamorphic and plutonic, or volcanic rocks. Emphasis on the plutonic rocks was selected because of the writer's greater interest in these types and because their history was indispensible in working out the areal problems.

Sedimentary Rocks

The sedimentary rocks comprise four separate beds which outcrop rather close together in the south central part of the area. The surface exposure of the sedimentary series is of small area, but the beds offer an interesting problem because of their unusually coarse character, with intercalated beds of finer material. The beds generally directly overlie the basement rocks, and in some cases seem to be derived in part from them. In describing the sedimentary beds they will be referred to as Tmf_1, Tmf_2, etc., the symbols meaning "Tertiary, Miocene, fanglomerate, first bed", etc.

<u>Tmf_1 Formation:</u> This formation occupies a small area in T5N, R12W, SE$\frac{1}{4}$ Sec.17. Though the surface distribution is small, this bed makes one of the boldest topographic features in the area. The bed forms as sharp east facing cliff over 125 feet high. A gentler slope is formed by the lowest fanglomerate member of the bed; the basal member is a series of thin strata of red coarse arkosic sandstone. The formation lies by unconformity on the granodiorite. The overlying rock is a massive basalt flow, with several beds of intercalated tuff, that interrupt the sequence of the lava flows. One tuff member forms

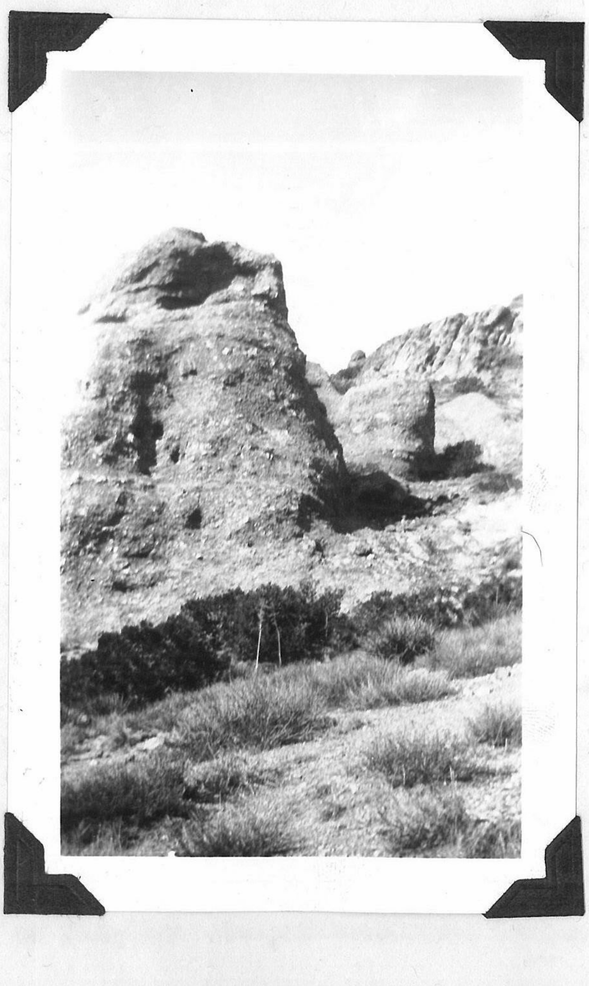

Figure 19 - 125 foot Cliff of Fanglomerate (Tmf_1) (T5N, RleW, SE$\frac{1}{4}$ Sec.17)

as cliff about 40 feet high, immediately above the 125 foot cliff of the fanglomerate.

The formation has a maximim thickness of 400 feet. It dips S75°W at 27°. At least 375 feet of the formation is composed of boulders and slightly rounded fragments, mainly of granodiorite, but also containing granite, schist, quartzite, and occasional lamphrophyric dike material. These have been derived principally from crystalline rocks of the San Gabriel mountains, or nearby areas containing similar rocks. Anorthosite has not been found in this bed. Many huge boulders of granodiorite are found, cut by aplitic dikes that are probably offshoots of the granite magma of the region. (See Figure 20) The boulders vary greatly in size. Measurements of several showed sizes of 3 x 3 x 3 feet, 9 x 3 x ?, 3 x 2 x ?, 6 x 3 x 3. (See Figure 21). These range to pebbles of less than ¼ " in diameter. The fragments are held together by a matrix of quartz grains and red iron oxide. These cementing agents bind the rock so that it resists erosion, but weathering easily decomposes the cement, and leaves only boulders in a red sand upon the surface. This may, at first, give rise to the mistaken idea that the material must be unconsolidated recent alluvium rather than material derived from a well cemented bed. The middle member of the formation shows boulders of the same material as the upper member, but the cement is predominantly a whitish quartz sand. This member is slightly lighter colored. The basal member is a coarse reddish-brown well-bedded sandstone, intercalated with thin layers of fine conglomerate. The grains of the sandstone are sub-angular quartz, with some quartz pebbles, rather well rounded.(See Figure 22)

The structural features of the bed are of two types; first, stratification; and second, fault structures of secondary origin. The finer lenses of fanglomerate and sandstone member are well stratified and they give a clew

Figure 20 - Granodiorite Boulder, Cut by Aplite Dike, in Fanglomerate. (T5N, R12W, SE$\frac{1}{4}$ Sec.17)

Figure 21 - Boulders in Fanglomerate. (T5N, R12W, SE$\frac{1}{4}$ Sec.17)

Figure 22 - Basal Sandstone Member of Tmf_1.
(T5N, R12W, SE¼ Sec.17)

to the general stratification. These lithologic features approximate in

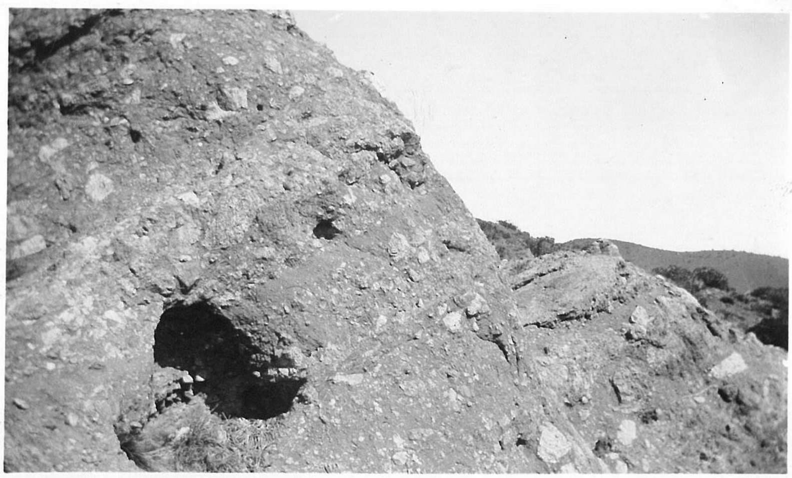

Figure 23 - Crude Stratification in Tmf_1.
(T5N, R12W, Sec.17)

direction the bedding of the sandstone member, and are probably definite stratification planes. The subsequent fault structures have developed rather extensively. The faults are not major in the region itself, but have altered materially the original placement of the formation. On the north border, a movement of 51 feet has displaced the bed. On the south, at approximately the same horizon, an amygdaloidal basalt has been thrown adjacent to the conglomerate. Besides these there are a few small faults with offsets of from one to five or six feet that dismember the bed. (See figures 24, 25, 26)

Figure 24 - Local Displacement (3 feet) in Tmf_1.
(T5N, R12W, SE$\frac{1}{4}$ Sec.17)

Figure 25 - Detail of Faulting Tmf_1.
(T5N, R12W, SE$\frac{1}{4}$, Sec.17)

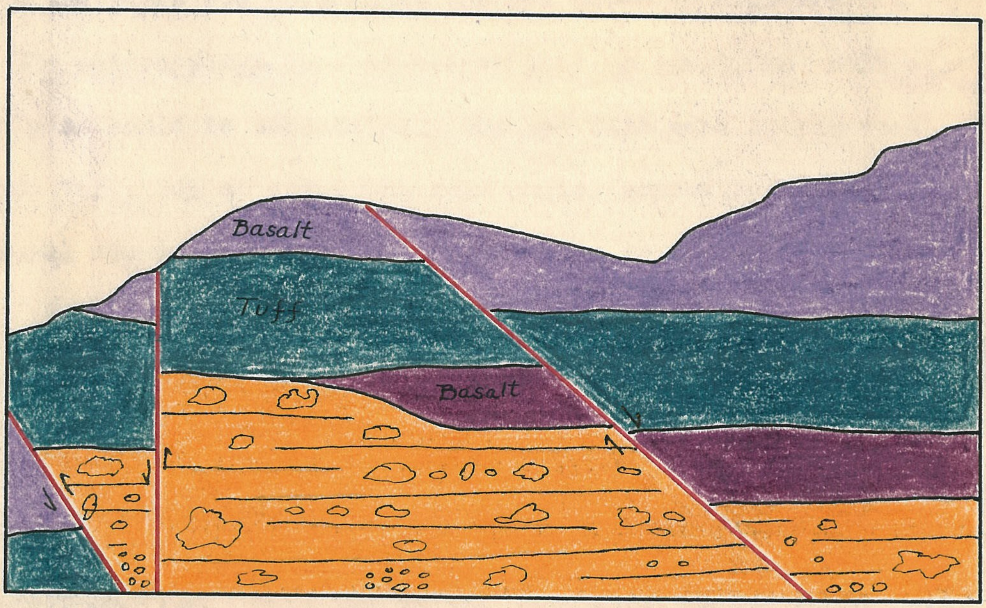

Figure 26 - Diagrammatic Section of Figure 25.

Tmf2 Formation: The second unit of the sedimentary rocks consists of a very uniform fanglomerate, which is essentially like Tmf_1 formation, with the distinction that its homogeneity is marked. Also, there is no basal sandstone member. The formation outcrops in low hills in T5N, R12W, SW¼ Sec.17, SW¼ and NW¼ Sec.20. The bed lies directly on the eroded surface of the complex metamorphic rocks. The formation is composed almost entirely of boulders of a banded granite which, according to Dr. W.J.Miller[25], closely resemble the old banded granites of the San Gabriel mountains. The cementing material is again quartz, and iron oxide.

The chief feature of this bed is its weathered character. Only three definite outcrops of the bed were observed, and these only in the bottom of the largest canyon that is eroded in the bed. Here were outcrops on a dip slope which showed conclusively that the bed was a unit and not merely alluvial or wash material. The surface distribution of the bed was determined by the fiery red color that the bed shows on exposure and decomposition. The outcroppings were so meager that no attitudes could be observed. As nearly as could be ascertained, the bed dips more nearly south of west than does Tmf_1, but at about the same angle, approximately N45°W at 30°. The general dip is indicated on the geologic map.

It is possible that the Tmf_2 formation is the faulted extension of Tmf_1. No confirmation of this could be found, but the fault that breaks the uppper 250 feet of Tmf_1 passes close to the north limit of Tmf_2, as if the two might have been related, or even one, at an earlier stage.

Tmf3 Formation: This bed is the most variable lithologic unit in the area. It laps up on the flank of the syenite body in T5N, R12W, south ½ of Sec.18. At the contact of the formation with the basement rock, the beds

25 - Personal Communication

Stand vertically, but flatten out to about 40° dip, soon after leaving the contact. A diagrammatic section through the bed shows best this relation:

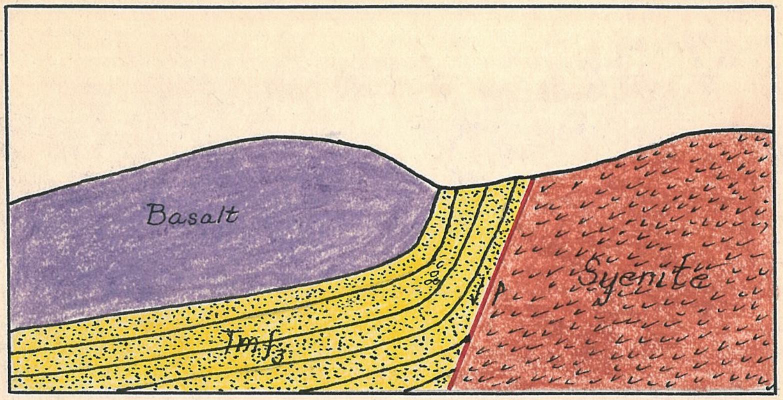

Figure 27 - Diagrammatic Section Across Tmf_3.
(T5N, R12W, SE$\frac{1}{4}$, Sec.18)

The bed is broken by erosion into three parts. The easternmost of these consists of a fine-grained reddish-brown, well-bedded sandstone of not more than 100 feet in thickness, which rapidly diminishes from west to east, however, and has been completely removed by erosion east of its present termination. Away from the unconformity with the underlying syenite, the bed flattens and at once disappears beneath an overlying basalt flow. The sandstone is arkosic in character, being essentially composed of sub-angular grains of quartz and feldspar.

The mid member of the bed is separated by Recent wash from its eastern counterpart. It is distinctly different from the sandstone, being conglomeratic, of medium sized boulders of granite, with a scattering of anorthosite. Because of deep weathering, no consolidated outcrops of this member were observed.

The third and westernmost member is composed almost 90% of anorthosite boulders, which show cleavage surfaces of plagioclase feldspar as large as $1\frac{1}{2}$ x $1\frac{1}{2}$ inches. The boulders are held together by an iron oxide cement. A fault evidently traverses the western member, since a breccia of sub-angular anorthosite fragments, cemented with calcareous material, was collected from the bed.

Tmf$_4$ Formation: Tmf$_4$ formation does not show definite exposures in the area. Its presence is inferred by the observation of some red soil with fairly rounded boulders that are sandwiched in between an underlying basalt flow and a 6 inch bed of siliceous limestone, in T5N, R12W, SW$\frac{1}{4}$ Sec.19. The width of color of the bed indicates one of not over 25 feet in thickness.

Travertine Members: In two localities in T5N, R12W, SE$\frac{1}{4}$ and SW$\frac{1}{4}$ Sec.19 were exposures of travertine. One bed was about 6 inches thick, and the other of undetermined thickness. The limited extent and the association with basalt flows lead one to infer that they are formed by solutions emanating from the lava.

Origin of the Sediments: The coarse character of the fanglomerate beds and the arkosic nature of the sandstones, indicate deposition of these beds under arid conditions. The slightly rounded character of all the constituents, plus the poor sorting in the beds, seems to indicate that the material did not travel a great distance before deposition. Then, these beds must be of essentially the same period, because they invariably overlie the basement rocks, and initiate deposition on the old topography. This is also true in the region to the south of the Vincent area. It seems evident that simultaneous or nearly contemporaneous deposition was going on over all this region but that the materials from which the beds are formed were derived from areas of different and distinct types of rocks. Thus the anorthosite predominates and is confined to a single formation, Tmf$_3$; the banded granite to Tmf$_2$.

In view of these facts, accumulation in a basin or series of connected basins into which material was carried, first from one side of the basin and then from another, would account for such accumulations. If one could imagine the product after consolidating the materials that make up the detrital fans of, for example, the Mojave desert basin of today, I believe a fanglomerate similar to these would result. This would account for massive fanglomerates overlying well sorted sandstones. The sandstones would represent those periods of relative slight rainfall, and thus little but fine material would be deposited, whereas the fanglomerate represents cloudburst-time material. The basal "red beds" inaugurate the cycle of deposition of fanglomerates and volcanics throughout the whole of this and adjacent regions.

Age of Sediments: As one would expect after reading the above description of the formations, no fossils were found. The age of these beds, as nearly as can be determined by comparative evidence, are probably Lower Miocene, or possibly upper Oligocene, the so-called "Sespe". On the basis of wide-spread vulcanism in the lower Miocene, it seems best, since volcanics predominate in these sediments, to label the beds lower Miocene. Also, W.S.W.Kew maps formations[26] in the San Fernando quadrangle, which adjoins the Elizabeth Lake sheet, as of middle Miocene; and the beds here discussed could easily be deposited in lower Miocene time, if my conception of that time is anywhere near the correct order of magnitude.

In reviewing the article of O.A. Hershey[27] to which reference heretofore has been made, as nearly as can be determined the beds herein discussed should be referred to the "Escondido" series, a name proposed by Hershey for a

26 - Kew, W.S.W. U.S.G.S. Bull. 753, 1924.
27 - Hershey, O.A. Ref. cit.pp2.

section of coarse sediments exposed typically in Escondido valley, San Fernando quadrangle. He refers to the presence of a basal breccia overlying the basement rocks throughout the area to the west and southwest of Vincent. He also mentions the localization of wash from certain basement rocks in one bed, and complete absence of that type in another. Hershey believes static water conditions of marine deposition to characterize the Escondido series. No evidence of such marine character is shown by the formation present in the area. The Escondido series is referred to the Tertiary.

TECTONIC GEOLOGY

TECTONIC GEOLOGY

The Vincent area is one in which structural features are conspicuous. If any single geologic process could be said to be the dominating factor in producing the features as they are today, structural processes would rank first.

Faults

Four definite fault structures of major importance and several minor faults traverse the area. These will be discussed under five groups: 1) San Andreas fault zone, 2) Soledad pass fault, 3) Una fault zone, 4) South Face fault, and 5) Minor faults.

San Andreas Fault zone: The San Andreas rift needs little introduction. It is noted as one of the largest fault zones in the United States. It is over 700 miles long, and produces distinct topographic forms all along its trace. The San Andreas rift crosses the State highway one-half mile south of Palmdale. It forms the boundary of the Vincent area on the northern side.

Figure 28 - One of the Faults of the San Andreas Zone, Near Palmdale, Cal. (On State Highway)

The fault zone here is very well marked topographically. On the north side of the zone kernbuts and brecciated hills occur in a line along the fault. These obstruct the drainage to the Mojave basin, and sag ponds are developed along the zone. After a heavy rain water flows along the rift for days, forming a marsh that is impassable. The ranchers inform me that the desert side somehow acts as a dam and stores the water from the Sierra Pelona, constituting an abundant supply for summer use. I believe that the real source of the abundant water in the zone is underground. The water moves toward the surface from the depths along the fault.

The rocks in the faults are very extensively brecciated. The kernbuts contain breccias, which are made up of material of every type, ranging from fragments of schist that appear once to have been transported material, to yellow sandstones. The differentiation of types along the zone was not attempted. That is a problem in itself. Therefore, in mapping, the zone was arbitrarily bounded on the south; an effort was made to include, approximately, the entire brecciated zone. The movement along the San Andreas fault is considered to be mainly horizontal.

Soledad Pass Fault: This fault passes along the east side of the Vincent area. It is the cause of the Soledad pass. This fault intersects the San Andreas somewhere to the northeast of the area. It has been traced for over 20 miles down Soledad canyon to the southwest, to the vicinity of Lang, California, where it ends[28].

Evidence of the presence of the fault in the Vincent area is the pass itself, and brecciated zones in the granite and granodiorite a few hundred yards south of the southern boundary of the Vincent area. Brecciated, slightly recemented lava fragments appear in a roadcut along the trace of

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28 - Ref. cit. pp. 60.

the fault where it leaves the generalized map.

The direction of movement and differentiation of upthrow and downthrow blocks is hard to determine. The profile of the stream courses on the east side of Soledad pass indicates that the last upward movement has been in the east block. The streams occupy hanging valleys in their upper courses, pitch into steep middle courses and then trench their fans in the lower parts. This would indicate recent uplift of the east block.

Una Fault Zone: "Una" is the name applied to the lobate shear zone that joins the San Andreas in the vicinity of Una Lake, and gradually thins and dies away near the granite-syenite contact about three miles westward. The presence of definite fault lines as the map shows is merely for diagrammatic purpose. The south boundary of the shear zone is well-defined.

The evidence for this shear is the extreme brecciation, alteration and mixing of the rocks in the areas of low relief crossed by the shear. In this zone are recognized schists (of the Pelona series), and plutonic rocks of granite and syenite. The main mass of the rock is unrecognizable. Along the southern side of the shear, where it begins to thin, are two or three patches of peridotite. A slide shows the rock to be almost wholly magnetite, with very abundant apatite and some altered amphibole. It was found absolutely impractical to differentiate the types of rocks present in the shear.

South Face Fault: Along part of the south face of the syenite body passes a fault, of small proportions by comparison to the San Andreas and Soledad pass faults, but nevertheless worthy of discussion. This fault passes through the sedimentary bed Tmf_3. The face of Sierra Pelona ridge, close to the trace of the fault, is badly broken, so that sometimes one cannot determine where the syenite ends and the fanglomerate begins. This fault has been extended to connect with those that transect the lavas along the south face. This is done on meager evidence, but the writer believes that this may well be warranted.

Minor Faults: In a region lying in a wedge between two such faults as the San Andreas and Soledad zones, one would expect to find much jostling and settling of blocks along minor faults. This is especially the case in the volcanic series that occupies the point of the wedge. TThe movements in these volcanic rocks have been extensive. Many faults and cross faults have been placed in the area, although in most cases the evidence is only the presence of slickensides, and it is hard to determine whether this means the movement of a foot or several hundred feet. In mapping, the faults in the volcanic rocks, the writer has weighed carefully the little definite evidence available and has then placed faults only where it seems essential for them to appear in order to explain the surface distribution of the volcanic series. In the "wedge" are many slickensided surfaces that lie horizontally, and seem to indicate the possibility of extensive horizontal movements. This problem of minor faults is further complicated by the generally limited horizontal extent of a single flow in the series. This makes correlation by stratigraphic sequence impossible in most cases.

There are many other minor faults in the area. None of them are worth more than passing mention. The contact between the syenite and granite in the western Sierra Pelona is a brecciated zone that has obliterated the intrusive relations. Most of the faults represented by dashed lines have been located by the combined evidence of brecciation, slickensides, and sometimes by the presence of springs that emanate along the supposed fault zones.

Folds

Folds: Faulting has not been the dominating deformational process in the Vincent area. However, in the area of metamorphic rocks in the northwestern part, a structure is developed that seems best interpreted as a large anticline, with steeply dipping limbs, plunging to the southwest. By reference to the maps accompanying this report, it may be seen that there is a regional strike and dip on the northwest side of the valley which is eroded along the axis of the anticline. The regional attitudes are approximately N50°-60° E in strike. They are quite regular on the northwest side. On the southeast side of the valley, a regional attitude is also developed, being a little more east of north than on the northwest limb. The dips in either case are steep, averaging probably 50° or more. As many attitudes as possible were recorded, but at best, as the map shows, large areas were present in which attitudes could not be taken. But from observing approximate attitudes in the process of field work, it seems that an anticlinical structure is the best interpretation.

The possibility of a thrust fault is indicated by the recorded attitudes, as it can be seen that the regional structure on the northwest flank of the supposed anticline is much more regular than on the southeast. Thus a thrust from northwest to southeast might accomplish the same result. This hypothesis has been discarded because little evidence of faulting was observed. A brecciated zone of not over 1½ feet thick, which extends for but a short distance is the only direct evidence of faulting. Such a zone might easily be formed along the crest of a fold where deformation was more intense. This is probably the same in this fold, as shearing of the schists is greater along the axis than on the flanks.

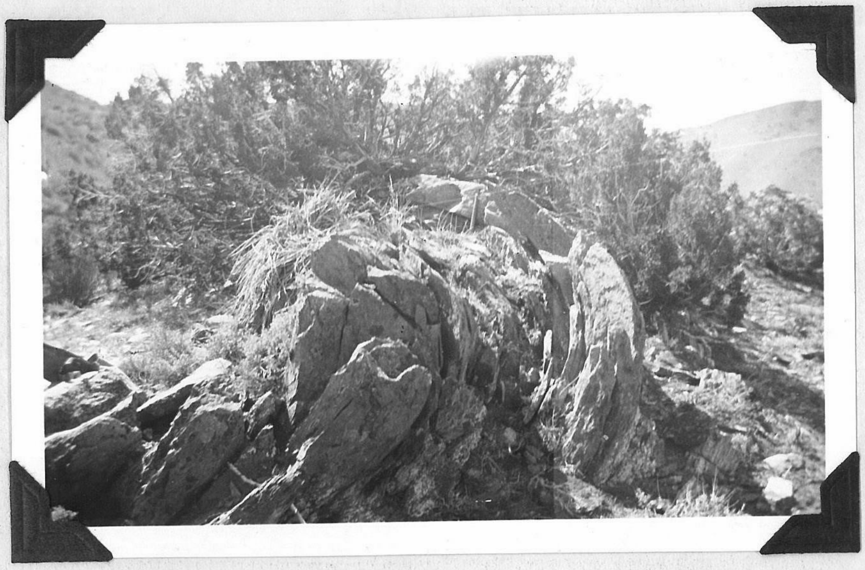
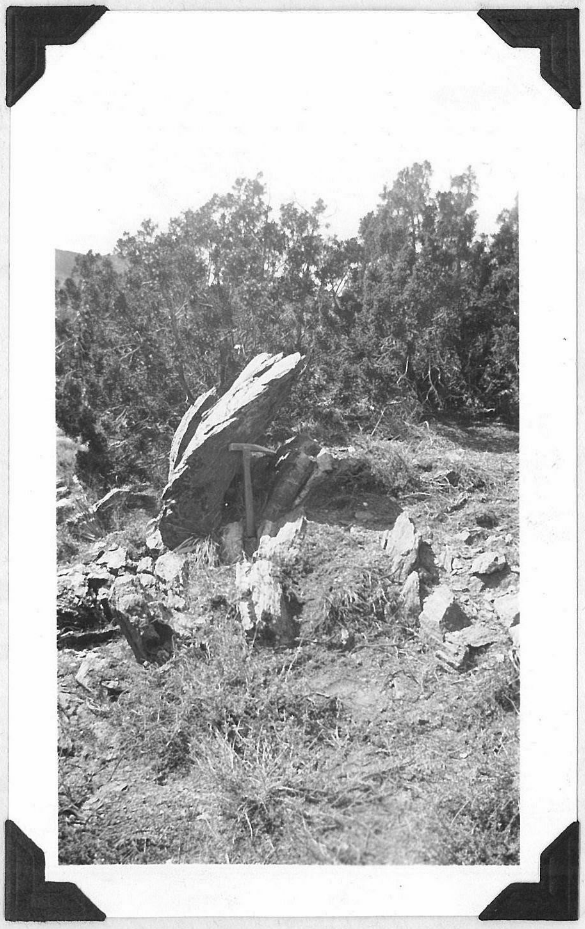


Figure 29 - Overturned Fold in Schist.
(T5N, R12W, center Sec.6)



Deformations locally in the schists are very interesting, and of such character that correlation of individual members in the metamorphic series is impossible. The accompanying pictures are indicative of the deformation of the series, especially on the southeast flank of the anticline. They also show why estimates of the thickness are impractical.

Figure 30 - Minor Crenulation - Typical of Schist.

Joints

All the igneous rocks of the area are highly jointed. Because of the general weathered character of the rocks of all types, but two recorded measurements of jointing were made. In the syenite "island" in the extreme southwest corner of the area, a reading on well developed joints showed two sets, strike W35°W, dip 42°N; and strike S55°W, dip 69°. Thus these are at ? 69° to one another. Whether this is the general system of jointing of the syenite could not be ascertained. A single reading of the joints of both granite and granodiorite east of Soledad pass showed an attitude of N75°E at 58°.

Unconformities

Unconformities: The unconformity between the fanglomerate beds and the basement rocks on which they lie is the only erosional break in the area, prior to the present one. This surface is one of general undulating character, which had a considerable depth of soil over it in some cases. The unconformity may be of early Tertiary age.

Age of Faulting

Age of Faulting: The criteria for the age determination of structure is slight. All faults show evidence of recent activity. Road repairs are continually being made where the San Andreas crosses the state highway in the Vincent area. Along the Soledad fault the same is true. Material falls onto the road at a rate much greater than normal weathering. Of course, movement on the northern part of the San Andreas was recorded in 1906, a maximum of 22 feet horizontally. It seems that the faults on the area have all been very active, up to the present day.

ECONOMIC GEOLOGY

ECONOMIC GEOLOGY

Economically the district offers little opportunity. Many tunnels have been driven throughout the area, chiefly in search of water. In the volcanic rock areas, some material has been taken out for road building and ornamental purposes. There seem to be possibilities for greater development of the water resources. One of the larger sag ponds along the San Andreas fault has been dammed so that the storage area is enlarged, and it acts as an irrigation reservoir for the farms adjacent to Palmdale. This reservoir is known as Harold reservoir, Una Lake, or Palmdale reservoir. Other than the water resources, the region offers no future possibilities.

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