GEOLOGY OF PART OF THE ADELANTO HILLS

BY

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FIELD PARTY

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ABSTRACT

The Adelanto Hills are a low range of folded limestone, situated about five miles northwest of Adelanto, California. The limestone is a dark blue finely crystalline, roughly bedded type, which has been hydrothermally altered in places to a white crystalline limestone, or to a fine grained highly altered brown limestone. The main igneous rock outcrops in the south part of the area and is a light colored, coarse grained granodiorite body that apparently has been faulted into place. A complimentary association of several fine grained, dark colored granodiorite intrusions and numerous pegmatite dikes occurs in the northern part of the area. Several large light colored acidic dikes intrude the limestone and their relationships to the other igneous rocks cannot be determined, with the exception that they are earlier than the pegmatite. The alteration of the blue limestone to the white limestone is due in part to the cutting of the area by the acid dikes. Hydrothermal solutions controlled to some extent by igneous contacts, the bedding of the blue limestone and possibly by faults, are responsible for the rest of the alteration. The area is cut by a large fault trending N65W and by numerous smaller faults trending about N20W. The structure on either side of the main fault is roughly parallel. The mineralization of the area is mainly a contact metamorphic type, the ore minerals being lead, zinc and silver.

Oxidation has resulted in some secondary enrichment, especially of silver. Some scheelite is mined at the present time from a contact zone between porphyry and limestone.

INTRODUCTION

The area covered by this report comprises about forty acres, located across the center of a low range of hills, approximately five miles northwest of Adelanto, San Bernadino County, California.

An outcrop map was prepared by means of a plane table survey, on a scale of fifty feet, to the inch. No topography was included in the map. The work was done in conjunction with the advanced Field Geology course at the California Institute of Technology, by Howard Reynolds, Richard Wasem, and Bernhard Haffner. This report was prepared as a senior thesis.

STRATIGRAPHY

The Adelanto Hills are a low, roughly lenticular, range of folded limestone, intruded by a few moderate sized igneous bodies, and cut by numerous dikes, including pegmatitic, aplitic, and acidic types.

Blue Limestone

The limestone is mainly a dark blue, finely crystalline, roughly banded variety. It is thought that the banding is a remnant of the original bedding of the limestone. These impure bands resist erosion and give the limestone a ribbed appearance on weathered surfaces.

The blue limestone alters to two different types of limestone, each of which will be considered below under a different heading.

White Limestone

The white limestone is a white to light brown variety, usually fine grained, but sometimes quite coarsely crystallized. It is an alteration of the blue limestone, which retains none of the banding or structure of the blue limestone. Although the contact between the white and the blue is often sharp, the contact actually grades into the blue. No constant relation could be found between the white limestone and the faults and intrusions.

Brown Limestone

This variety of limestone is of infrequent occurrence. It occurs mainly in thin stringers and narrow zones, usually localized along faults or shears, or next to intrusives. It is a highly altered fine grained rock and seems to be associated more closely with the white limestone than with the blue. It may be a further alteration of the white limestone rather than a different type of alteration. The brown color is due to iron oxide. If the blue limestone was slightly mineralized, and then altered in the same manner that produces the white limestone; and then was oxidized, the mineralized areas would be brown, due to iron oxides, instead of white. The altering solutions themselves may have locally carried iron solutions to produce the brown limestone instead of the leached white limestone.

Breccia

The breccia is a limestone fault breccia locallized along the western part of a well defined fault trending N65. The limestone has been well fractured and broken into small angular particles. The breccia has been solidly cemented by silica. Both white and blue limestone fragments make up the breccia, with a predominance of white fragments opposite the white limestone, and vice versa.

Dark Granodiorite

In the northwestern part of the section are several large intrusive outcrops. This rock is a fine grained holocrystalline, dark bluish hypabyssal intrusive. The contact between the granodiorite and the limestone seems to be of an intrusive nature. The nature of the contact is somewhat complicated by the presence of unaltered zones along the contact adjacent to altered limestone along the same contact.

Light Granodiorite

This is a distinctly different type of rock and its outcrop is confined to the extreme southwestern part of the area. The rock is granitic in appearance, medium coarse grained, and rather light colored, as it contains much fewer dark minerals than the dark granodiorite. It seems almost certain that the contact between this light granodiorite and the limestone is a fault contact. This conclusion is based mainly on the fact that there is no alteration of the limestone along the contact. This rock is the main type of igneous rock in the hills, although it outcrops only in a small part of the mapped area.

Pegmatite

The pegmatite is granitic in type, and only moderately coarse grained. Locally it becomes almost aplitic in character. The pegmatite occurs mainly as thin dikes averaging five feet or less in width, in irregular patches, and in a large outcrop mass. The pegmatite, along with the dark granodiorite intrusive, is largely confined to the northern part of the area. The dark granodiorite is criss-crossed by numerous pegmatite dikes. No pegmatite is near the light granodiorite rock, with the exception of one small outcrop in the limestone near the northern contact of the light granodiorite.

Acid Dikes

Numerous rather large and fairly continuous silicic, fine grained to cryptocrystalline dikes cut through the area. There seems to be at least four or five slightly differing rock types, although some may be only slightly different facies of the same rock. The dikes are confined to the limestone and in no place cut either granodiorite body. Their relations could not be determined. About 150 feet southeast of point E, a pegmatite dike appears to cut through an acid dike, showing the pegmatite to be later.

STRUCTURE

The limestone in the area is very tightly folded. The main axial trend seems to be northwesterly with some local variation. Dips range from 65° to vertical and are, in general, directed in either a southerly or a westerly direction.

The dark granodiorite in the area is probably post folding in age. The nature of the outcrop outline and the fine grained crystalline nature of the dark granodioritic rock suggest that it was intruded at rather shallow depths, rather than being faulted into its present place.

The pegmatite dikes throughout the area were intruded shortly after the emplacement of the dark granodiorite and probably represent and end phase of the dark granodiorite intrusion. This is borne out by the fact that the pegmatites are restricted to the near vicinity or cut through the dark granodiorite intrusion.

Neither the pegmatite nor the dark granodiorite seem to have altered the limestone into which they were intruded. The sporadic occurrence of the white limestone along the dark granodiorite contacts is probably due to hydrothermal solutions, rising along the limestone-granodiorite contact.

The acid dikes are nearly always surrounded by a zone of white limestone, showing that at least part of the hydrothermal alteration of the blue limestone to white is connected to the cutting of the area by these numerous acid dikes.

It was suggested by Dr. H. J. Frazer[1], that some of the white limestone may be an original sedimentary facies, in view of the fact that the white beds in general are practically parallel to the bedding in the blue limestone. The discontinuity of the white limestone bands makes this rather improbable. Also, the similar nature of all the white limestone in the area indicated a common origin. It is more likely that the path of the rising hydrothermal solutions was to a certain extent controlled by the bedding of the blue limestone, and the blue limestone was altered to white along definite planes.

In view of the large size and coarse grained nature of the light granodiorite body it should have altered the limestone along the contact if it had been intruded into its present place. Unaltered blue limestone is in sharp contact with the light granodiorite and this would indicate a fault contact.

The area is roughly divided into two parts by a fault zone that trends N65W, and is marked along its western extension by a fairly thick band of fault breccia, which was described in a previous paragraph. The fault is traceable

1- Oral communication.

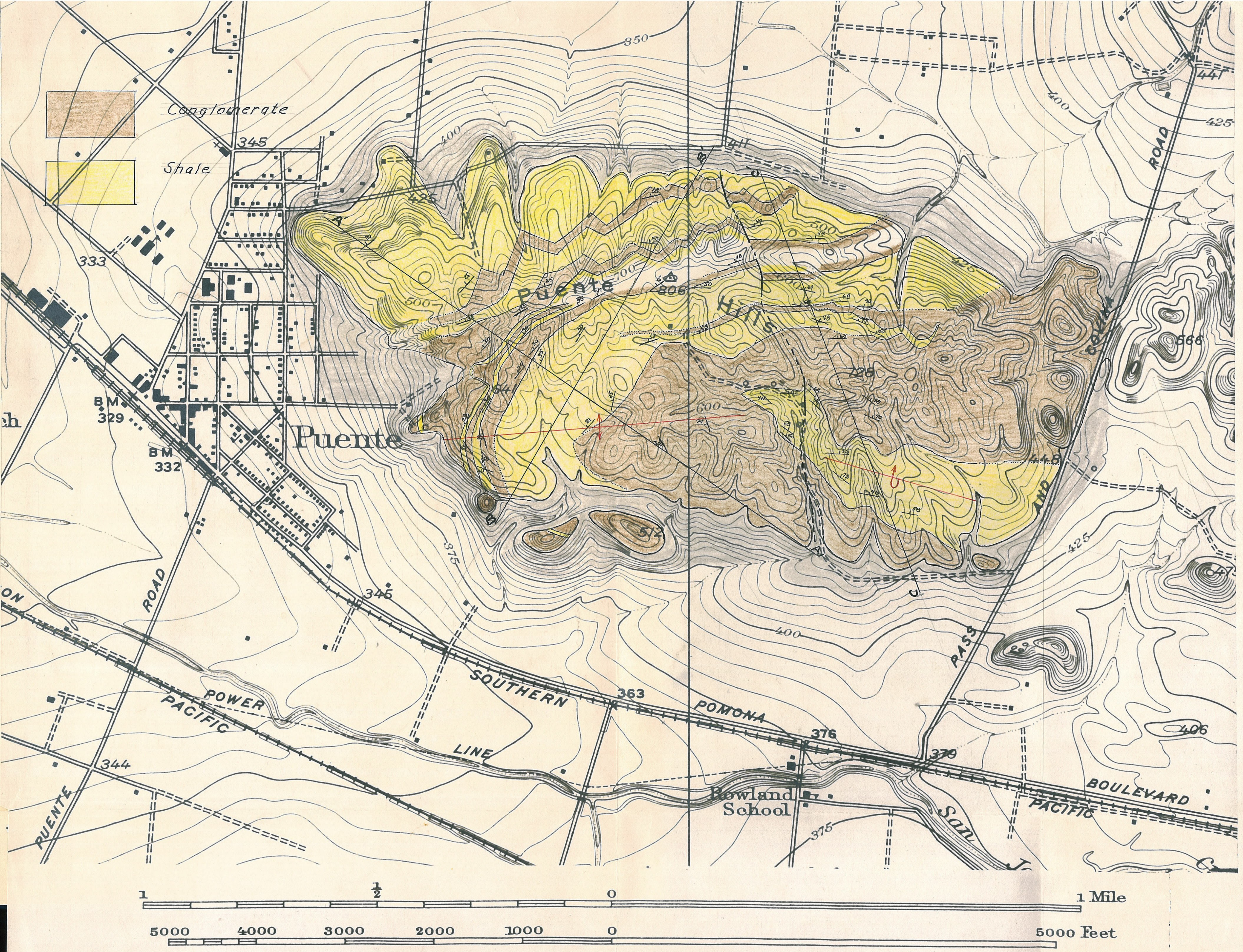
for several hundred feet in an easterly direction from the breccia zone and then is lost beneath the drift. However, farther to the east, particularly in the area outside of that mapped, evidence of further shearing lines up well with a continuation of the fault zone.

In the extreme northwestern portion of the area another well defined fault was mapped. Along the fault is a narrow zone of brecciation averaging about a foot wide and characterized by a distinct jaspar cement. The trend of the fault is about N20W. Several small subsidary faults or fractures on the south side of the main N65W striking fault, also have a trend of N20W. The small faults are cut off by the main fault.

ECONOMIC CONSIDERATIONS

The mineralization of this area is definitely that of a contact metamorphic type. The Adelanto Hills have been pretty well prospected for a number of years, and there has been some small production. The primary mineralization is mostly galena, sphalerite and silver in limestone contact metamorphic zones. The mineralized areas are often localized along shear zones, which show an alteration characterized by the occurrence of garnet, epidote, pyrite, and other minerals. There has been some hydrothermal mineralization along shears, which are said to show good gold values. Alteration has modified the lead-zinc localities, leaving secondarily enriched ore and forming, in places, secondary deposits of hydrozincite which as yet have not been proved to be commercial. Galena is very scarce in most of the ore and no secondary deposits of galena have been found, although there is a little calamine in places. Primary galena has been mined however, from the deep shafts near point E.

The latest development work in the area has exposed some scheelite. The scheelite occurs in disseminated grains in both the limestone and a porphyry along the contact. The ore occurs, apparently, in a small upfaulted block which has brought to the surface the contact between limestone and an altered porphyry. The porphyry has not been found to outcrop elsewhere in the area.



Contour interval 5 feet and 25 feet (see diagram)

Datum is mean sea level

REPORT ON THE GEOLOGY OF THE PUENTE HILLS

INTRODUCTION

The area mapped consists of one and two thirds square miles known as the Puente Hills. The Hills are located directly east of the town of Puente and are about fifteen miles south-east of Pasadena.

The purpose of the mapping was to give a student geologist some experience in mapping and interpreting a structure of folded sediments.

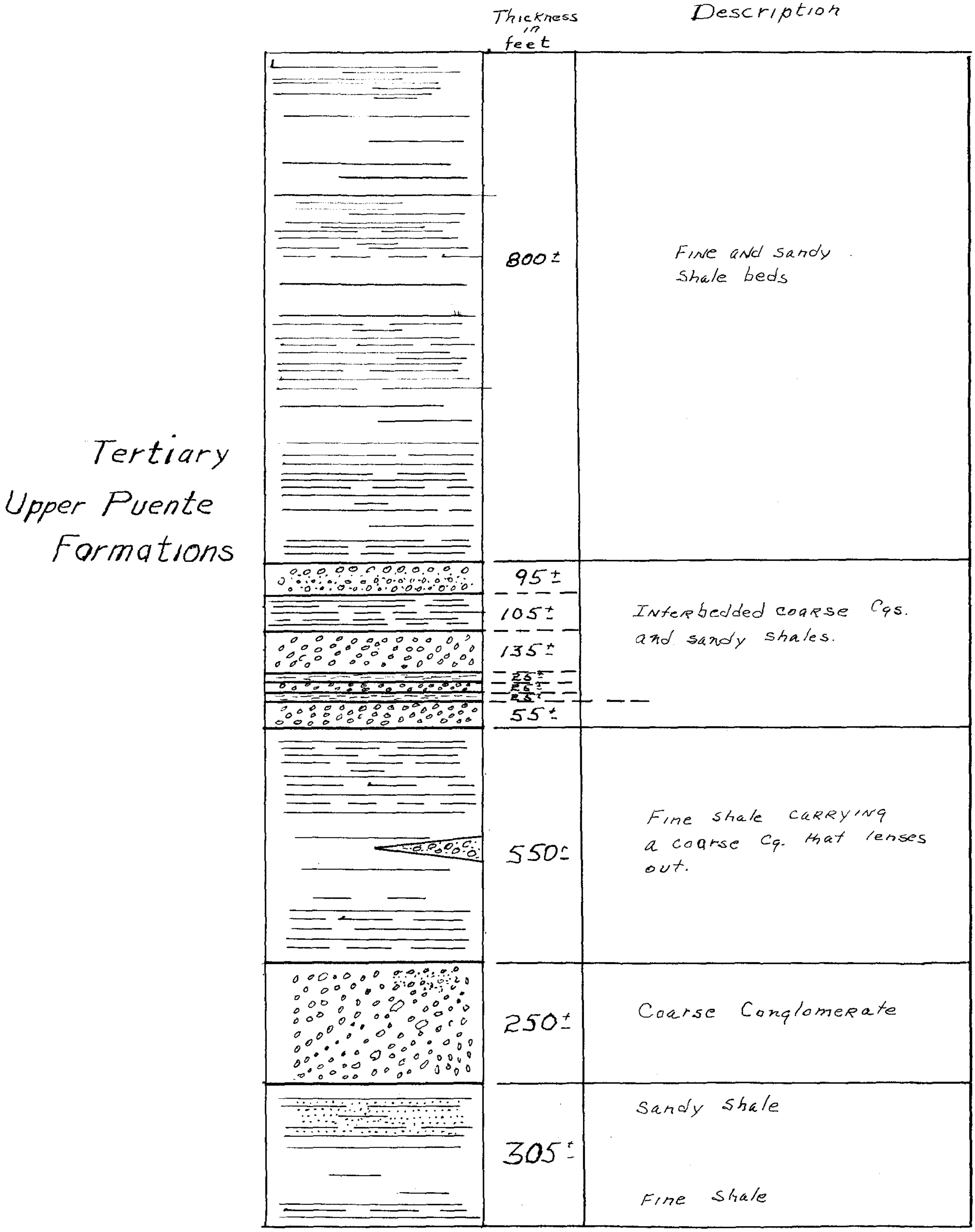
Approximately ten days was spent in the field completing the mapping.

The method used was a Brunton Compass traverse with a U. S. G. S. topographic map.

STRATIGRAPHY

The area consists of folded beds of conglomerates, sandy shales, and fine shales. The individual beds are fairly constant in thickness throughout the entire area.

The oldest beds exposed in the area are a shale series of approximately 300 feet thickness. The lower half of the series is a fine shale that weathers to a whitish grey. The upper half is a very coarse shale, almost a fine sand stone that weathers to a brown color.



Thickness in feet
Description
Tertiary
Upper Puente
Formations
800±
Fine and sandy shale beds
95±
105±
135±
25±
26±
25±
55±
Interbedded coarse Cgs. and sandy shales.
550±
Fine shale carrying a coarse Cg. that lenses out.
250±
Coarse Conglomerate
305±
Sandy Shale
Fine Shale

Conformably above this lies a conglomerate bed that contains a number of one to two foot beds of sandstone. The conglomerate is distinguished by the red lava boulders that it carries. The minimum thickness is about 250 feet.

Lying conformably above the conglomerate is another fine shale that weathers to a whitish grey. This shale carries a conglomerate bed that seems to lens out. The conglomerate bed is distinguished by its large white boulders. The minimum thickness ofthis shale bed is in the neighborhood of 550 feet.

Conformably above this shale is a small conglomerate bed of about 55 feet in thickness. This conglomerate bed carries a hard cemented layer that enables one to trace the bed very easily over a considerable length of its exposure.

Lying conformably above the conglomerate bed are three beds, shale, conglomerate, shale, that average about 25 feet in thickness. The shales are the typical sandy shales of the area and weather to a brownish color. The conglomerate is a coarse conglomerate also weathering to a brownish color.

Lying conformably above these three small beds are three other beds of similar character, two conglomerates and a shale. These three beds are slightly thicker. The conglomerates carry no large boulders and weather to a brownish color.

The entire sequence of these alternating conglomerates and shales lying between the two large shale members total about 365 feet in thickness.

The youngest beds exposed in the area are a series of sandy shales that outcrop over the north-west part of the area. These shales weather to a brownish color and decompose to a brown gumbo soil. The minimum thickness is about 800 feet and may be considerably more.

STRUCTURE

The main structural feature of the area is an anticline that plunges slightly south of west. The structure is complicated by a north-south fault near the middle of the area and by the overturning of the part of the anticline that lies to the east of the fault.

Referring to structure section B-B' it seems that the north limb of the anticline dips more steeply than the south limb. This would tend to more the crest of the structure to the south at depth. It is unlikely that the beds in this north limb continue to dip as steeply as indicated, however, there were no dips available to show that the beds flatten out to any extent in the north end of the area.

That the fold is asymmetrical is born out by the sharp bending of the large shale bed in the south-central part of the area. However, the evidence is very obscure in this section of the area and not much can be proved.

The overturned portion of the anticline is shown in section C-C'. Most of the south limb is not exposed in the area and no dips are available in the conglomerate of the south limb to aid in the accurate determination of the amount of overturning. The fold appears to be nearly isocline with the high of the structure moving notth at depth.

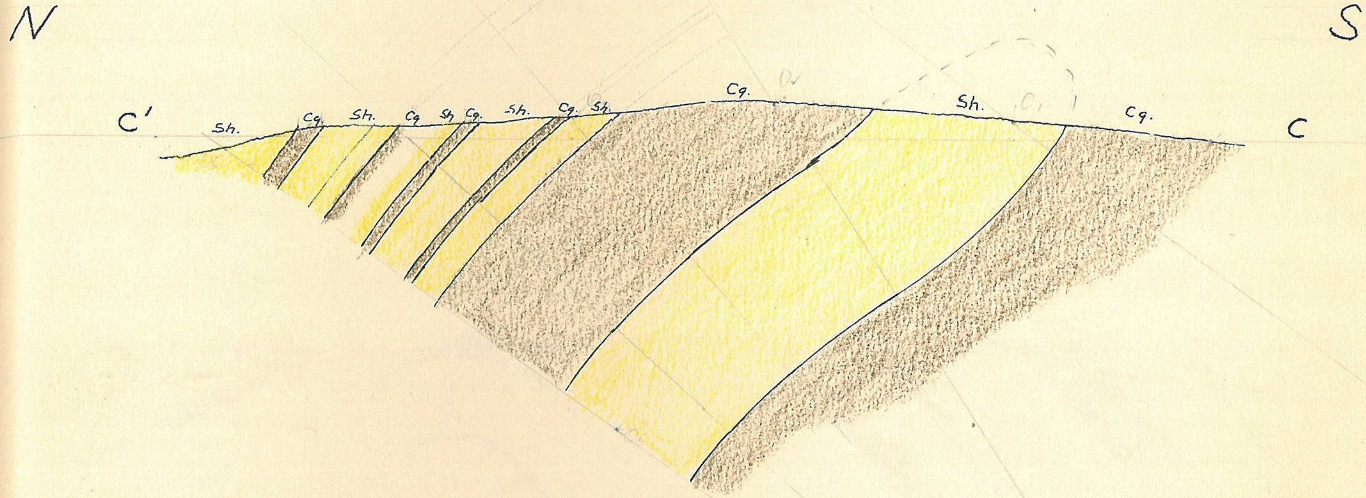
The north-south fault can be mapped by offsets in beds in three localities. In the remainder of the area the outcrops are too obscure to determine any offset relationships. The offsets are found on the beds of shallower dip and it may be that the movement was mainly vertical with the east side going up relative to the west side. The total movement was probably not more than a very few tens of feet.

OIL POSSIBILITIES

The igneous rocks of the region outcrop at the extreme eastern end of the San Jose Hills. Five miles to the west along the main anticlinal axis a well encountered igneous rocks at 4000 feet. Sixteen miles to the west the basement is calculated to be at about 16,000 feet. Assuming that the basin dips uniformly to the west the igneous rocks would lie under the Puente Hills at a depth of nine to ten thousand feet. This is at sufficient depth not to cut out any oil-bearing formations.

The sections show that there is closure on the north, south, and west sides of the area west of the fault. The fault may have had sufficient movement to trap any oil present in the area west of the fault. A test well should be drilled south of the main anticlinal axis shown on the map since here the high of the structure moves south at depth.

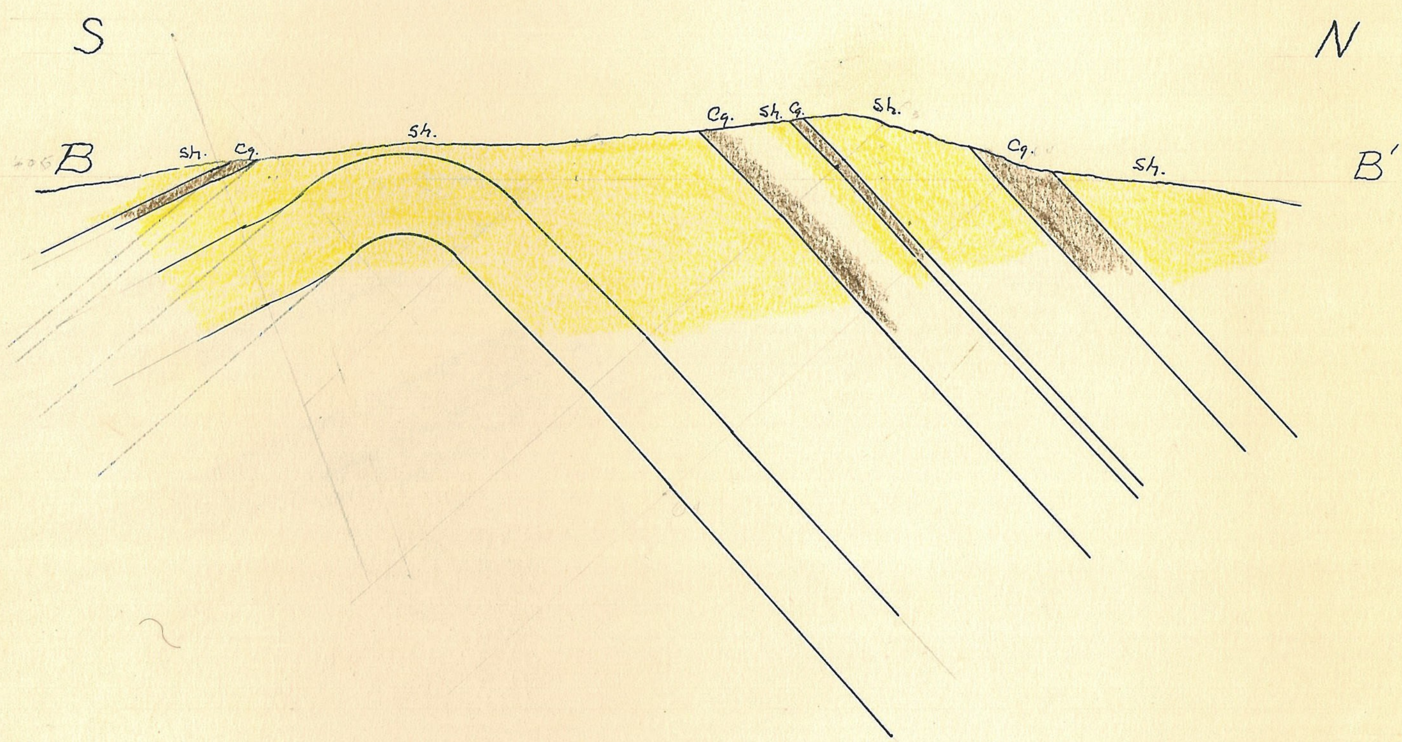
Puente Hills
Section C-C'



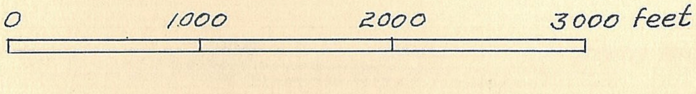
Vertical Scale = Horizontal Scale

1000 feet = 1 inch

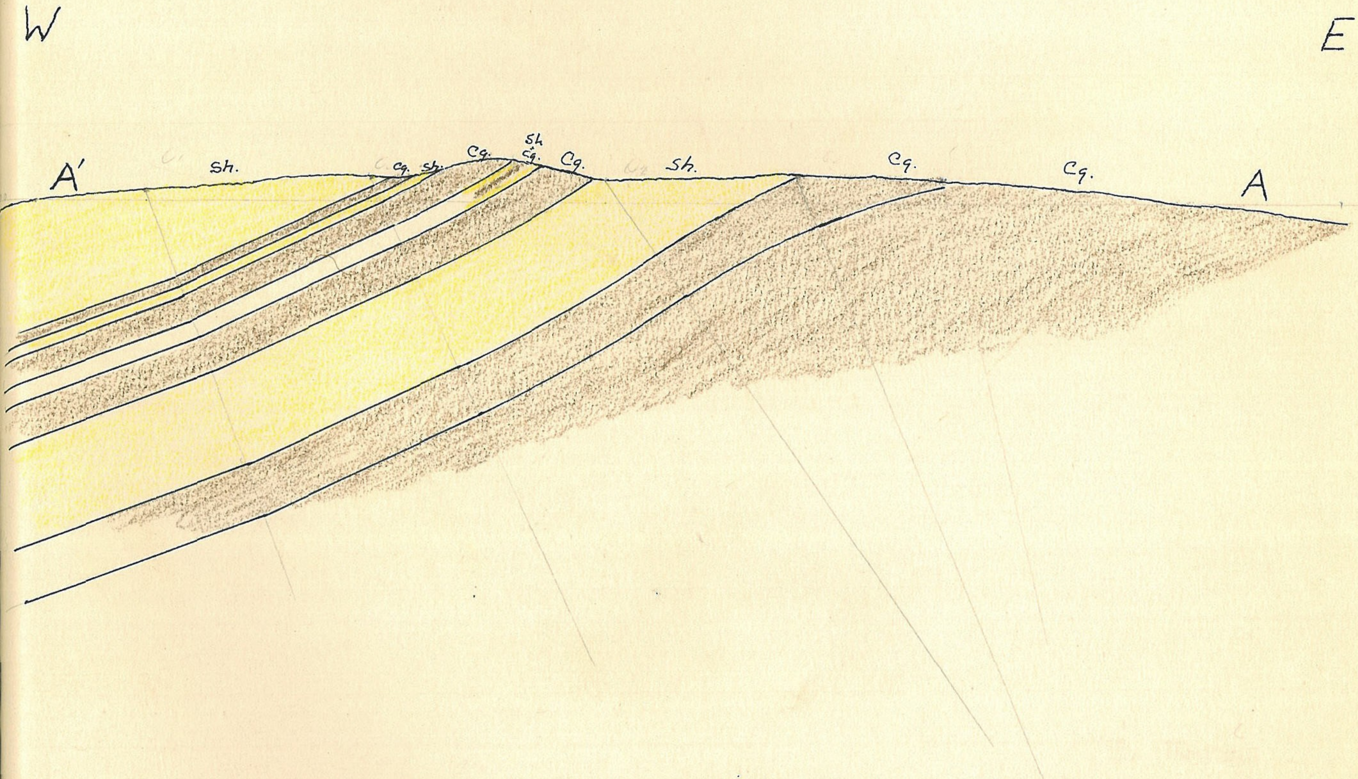
Puente Hills
Section B-B'



Vertical Scale = Horizontal Scale
1000 feet = 1 inch

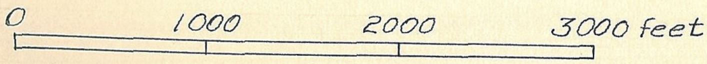


Puente Hills
Section A-A′



Vertical Scale = Horizontal Scale

1000 feet = 1 inch



GEOLOGY OF A PORTION

OF THE

ADELANTO HILLS

R. Wasem

ABSTRACT

The Adelanto Hills are a low range of folded limestone hills, situated about five miles northwest of Adelanto, California. The limestone is a dark blue finely crystalline banded type, which has been hydrothermally altered in places to a white crystalline limestone, or to a fine grained highly altered brown limestone. The alteration is indistinctly associated with faulting and minor intrusions in the area. The main igneous body in the area is a large granodiorite body that has apparently been faulted into place. A complementary association of a fine-grained dark granodiorite and numerous pegmatite dikes occursin the northern part of the area. Several large, light colored, acidic dikes intrude the limestone, and their relationships to the other intrusions cannot be determined. The area is cut by a large fault trending N 65° W and by numerous smaller faults trending about N 20° W. The structure on either side of the main fault is roughly parallel. Mineralization of the area is mainly a contact metamorphic type, containing lead, zinc, and silver. Considerable oxidation has occurred in the area, resulting in some supergene enrichment, especially of silver. Some scheelite is mined at the present time from a contact zone between porphyry and limestone.

INTRODUCTION

The area covered by this report comprises about forty acres, located across the center of a low range of hills, approcimately five miles northwest of Adelanto, San Bernardino County, California.

An outcrop map was prepared by means of a plane table survey, on a scale of fifty feet to the inch. No topography was included on the map. The work was done in conjunction with the Advanced Field Geology course at the California Institute of Technology, by Howard Reynolds, Bernhard Haffner, and Richard Wasem. This report was prepared as a senior thesis.

STRATIGRAPHY

The Adelanto Hills are a low, roughly lenticular, range of folded limestone hills, intruded by a few moderate sized igneous bodies of hypabyssal character and cut by numerous dikes, including pegmatitic, aplitic, and acidic types.

Limestone

The limestone is mainly a dark blue, finely crystalline, roughly banded variety. It is thought that the banding is a remnant of the original bedding of the limestone and contains a greater percentage of carbonaceous material than area between the bands.

Two main types of alteration of the blue limestone occur, each of which will be considered under a different heading.

White Limestone

The white limestone is a white to light brown variety, usually fine grained, but sometimes quite coarsely crystallized. It is an alteration of the blue limestone which retains none of the banding or structure of the blue limestone. Although the contact between the white and the blue is often sharp, the contact actually grades into the blue in many places. In many places the contact is indeterminable because of the interfingering of white and blue bands. No clear relation could be found between the white limestone and the faults and intrusions.

Brown Limestone.

This variety of limestone is of infrequent occurrence. It occurs mainly in thin stringers and narrow zones, usually localized along faults or shears, or next to intrusives. It is a highly altered fine grained rock and seems to be associated more closely with the white limestone than with the blue. It may be a further alteration of the white limestone rather than a different type of alteration.

Breccia

The breccia is a limestone fault breccia locallized along a well defined fault trending N 65° W in the western part of the area. The limestone has been well fractured and broken into small angular particles. The breccia has been solidly cemented by silica. Both white and blue limestone fragmens make up the breccia, with a predominance of white opposite the white limestone, and vice versa.

Fine-grained Granodiorite

In the northeastern and eastern part of the area are several large intrusive outcrops. This rock is a fine-grained, holocrystalline, dark, hypabyssal intrusive. The contact between the granodiorite and the limestone seems o be of an intrusive nature. The nature of contact is somewhat complicated by the presence of altered zones in the limestone along the contact in some places and the lack of this alteration in other places. This is especially well illustrated along the boundaries of the large outcrop of this granodiorite in the extreme northern part of the area.

Coarse-grained Granodiorite

This is a distinctly different type of intrusive and its outcrop is confined to the extreme southwestern part of the area. The rock is granitic in appearance, medium coarse grain, rather light colored, and is probably a granodiorite. It seems almost certain that the contact between this granodiorite and the limestone is a fault contact. This conclusion is based mainly on the fact that there is no alteration of the limestone along the contact. This rock is the main igneous rock of the area.

Pegmatite

The pegmatite is granitic in type, and only moderately coarse grained. It occurs mainly as thin dikes averaging five feet in width, in larger irregular patches, and in a large outcrop mass. The pegmatite is largely confined to the northern part of the area. In this part of the area it cuts extensively the fine-grained granodiorite. The pegmatites were probably very closely associated with the intrusion of this fine-grained granodiorite.

Acid Dikes

Numerous rather large and fairly continuous silicic, fine-grained to cryptocrystalline dikes cut through the area. There seem to be at least four or five slightly differing rock types, although some may be only slightly different facies of the same rock type. The dikes are confined to the limestone and in no place cut the fine-grained granodiorite. Their relations with the larger intrusive bodies could not be determined.

STRUCTURE

The limestone in the area is very tightly folded. The main axial trend seems to be northwesterly with some local variations. Dips range from 65° to vertical and are, in general, directed in a southerly or westerly direction.

The dark granodiorite in the area is probably post-folding in age. The nature of the outcrop outline and the fine-grained texture of the rock suggests that it was a close-to-the-surface intrusion and was intruded into its present position rather than being faulted into place.

The pegmatite dikes throughout the area were intruded shortly after the emplacement of the fine-grained granodiorite and probably represent an end phase of this intrusion. This is borne out by the fact that the pegmatites are located around this fine-grained granodiorite or cut through it.

There is no clearly defined connection between the alteration of the blue limestone to white limestone and intrusion or faulting. It was observed that, in general, white limestone always occurs in close association with the dikes; on the other hand, however, white limestone also occurs where no dikes are to be found. It is certainly probable that the hydrothermal alteration of the blue limestone to white limestone is connected, at least in part, to the cutting of the area by these numerous acid dikes. The areas not immediately adjacent to dikes may have been altered by these same dike solutions which came up along fracture planes in the limestone.

The probable fault relationship of the coarse-grained granodiorite to the blue limestone has already been mentioned in a previous paragraph. The absolute lack of alteration of the blue limestone around such a coarse grained igneous body is an almost conclusive argument against an intrusive relationship.

The area is roughly divided into two parts by a fault zone that trends N 65° W. The westerly portion of this fault zone is well marked by a zone of intense brecciation that has been discussed in a previous paragraph. Towards the east the zone of faulting is lost beneath the drift. However, farther to the east, particularly in an area outside that mapped, evidence of further shearing lines up well with a continuation of the zone of brecciation.

In the extreme northwestern portion of the area another well defined fault was mapped. Along this fault is a narrow zone of brecciation averaging about a foot in width and characterized by a distinct jasper cement. The trend of the fault is about N 20° W. This is the same as that of several small subsidary faults or fractures on the south side of the main fault. The small faults are cut off by the main fault.

ECONOMIC CONSIDERATIONS

The mineralization of this area is definitely that of a contact metamorphic type. The Adelanto Hills have been pretty well prospected for a number of years and there has been some small production. The primary mineralization is mostly, galena, sphalerite and silver in limestone contact zones. Some mineralized areas are located along shear zones which show an alteration characterized by garnet and epidote. There has been some hydrothermal mineralization along shears, which are said to show good gold values. Alteration has modified the lead-zinc localities, leaving secondarily enriched ore and forming, in places, secondary deposits of hydrozincite which as yet have not been proved to be commercial. Galena is scarce in the ore and no secondary deposits of galena have been found, although there is a little calamine in places.

The latest development work in the area has exposed some scheelite. The scheelite occurs, apparently, in a small upfaulted block, which has brought to the surface the contact between limestone and an altered porphyry. The scheelite occurs in disseminated grains in both the limestone and the porphyry along the contact. The porphyry does not outcrop elsewhere in the area.