THE GEOLOGY OF THE EL TIRO HILLS, WEST SILVER
BELL MOUNTAINS, PIMA COUNTY, ARIZONA

by

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STATEMENT BY AUTHOR

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ABSTRACT

The El Tiro Hills contain a partially undeformed stratigraphic section that includes rocks ranging in age from the Permian Scherrer Formation to the Cretaceous and (or) Tertiary Claflin Ranch Formation, all cut by younger intrusive rocks.

Of interest is the thick section of Rainvalley. Its contact with the overlying Cretaceous Amole-type (largely epidotized) clastics is probably a disconformity. These Cretaceous rocks are in turn overlain by clastics and volcanics of the Claflin Ranch Formation. The nature of this contact is an angular unconformity.

A considerable portion of the Amole-type Cretaceous has been shattered, brecciated, and hydrothermally altered. This alteration is continuous into part of the Claflin Ranch. This portion of the Amole-type Cretaceous has been designated as the Andesite Complex because
of the seeming association with andesite porphyry intrusions.

Stocklike intrusives of quartz monzonite porphyry cut all but the Permian rocks, and porphyritic granite intrudes the Permian in the western portion of the area. Irregular andesite porphyry dikes and pods are widespread, and quartz latite porphyry dikes intrude the Cretaceous. Quartz latite porphyry tuffs of uncertain age are found in the southeastern portion of the area.

Two strong northwest faults occur in the area and probably represent a major shear direction. Faults other than a possible north-south group are minor and probably result from tensional forces.

Small showings of oxide copper and minor pyrite occur locally.
CHAPTER 1
INTRODUCTION

The Problem

There are large areas in the vicinity of Tucson that contain Cretaceous and (or) Tertiary rocks, which have not received the geologic attention that areas of Paleozoic rocks have had in the past. The objective of this thesis was to map such an area and hopefully to contribute knowledge regarding the upper Paleozoic to Mesozoic, or Cretaceous, and possibly Tertiary sections.

The area chosen includes a small separate group of hills that lies to the south but is geographically part of the main mass of the West Silver Bell Mountains. Since these hills are not named, the area has been herein called the El Tiro Hills, at Dr. Lacy's suggestion, and certain topographic features within the area have also been named by the author.

The El Tiro Hills are bounded on the south side by the Papago Indian Reservation and cover all or part of secs. 25-28 and 33-36, T. 11 S., R. 7 E. The area is approximately 45 miles northwest of Tucson and can be reached via graded county roads leading west from
the town of Silver Bell or south from Red Rock on Route 84. (See figs. 1 and 2).

**Procedure**

The area was mapped using an enlargement to 1:12,000 of the desired area as found on the Vaca Hills quadrangle. Brunton compass, tape, and triangulation were the methods employed for the location of features.

Difficulty was encountered in projecting geological features due to areas of cover and talus covered hill and ridge slopes. A general area of outcrop has been shown on the geologic map, but there are some fair-sized areas within that designated as outcrop that are covered or, at best, have poor outcrops. For this reason contacts are generally inferred.

Through microscopic inspection of rock in thin sections, much valuable knowledge regarding rock types was gained. Some of the opinions expressed in this regard were confirmed by Dr. DuBois.

**Previous Work**

The two works most directly related to this thesis problem are those by McClymonds (1957) and Watson (1964) on the Waterman Mountains and Silver Bell Mountains, respectively.
FIGURE 1. MAP SHOWING LOCATION OF THE EL TIRO HILLS
CHAPTER 2
PERMIAN ROCKS

General

The oldest rocks exposed in the El Tiro Hills are of Permian age. These consist of much of the Scherrer Formation, the Concha Formation, and the Rainvalley Formation. The composite thickness of the three units exceeds 1,200 feet. The latter two units are readily seen from the access road along the powerline in the southern part of the area. They form a conspicuous gray ridge in the northwest corner of sec. 34 with prominent bedding planes dipping moderately to steeply northeast (fig. 3). The Scherrer Formation lies to the southwest near the base of the ridge and is thus not seen from a distance. These various Permian units compare quite favorably with their counterparts in the nearby Waterman Mountains, as described by McClymonds (1957), and elsewhere in southeastern Arizona, as described by Bryant (1955). The one exception is that there appears to be more of the Rainvalley Formation present here than has been described elsewhere.

Due to the time element involved and the scale used in mapping, Permian formations have not been subdivided in detail, and no measured section was made. Therefore, the following discussion
FIGURE 3

View looking northwest at Permian limestone and Contact Ridge.
is of a general nature. It is suggested that further work on a detailed basis might prove advantageous to those interested in correlating this with other known Permian formations, particularly since this is one of the most westerly unaltered exposures known.

Scherrer Formation

The Scherrer Formation is the oldest known rock unit found in the thesis area. The lower portion of the Scherrer is hidden under Recent alluvium to the southwest, but three and possibly four subdivisions of the Scherrer can be identified—two quartzite and two limestone. In the El Tiro Hills a maximum of approximately 300 feet of the Scherrer is exposed as the southwest slope of a low ridge. It generally strikes north-northwest to northwest; dips ranging from $53^\circ$ to $75^\circ$ NE. were recorded.

The lowest unit exposed, but by no means the oldest of the Scherrer, is a light-gray, fine-grained, locally feldspathic quartzite with a quartzo-feldspathic cement. There are some specks of iron oxide present. The rock is generally well fractured and broken. Less than 100 feet is exposed.

Overlying this unit is a generally thinly bedded, buff to tan, finely crystalline, dolomitic limestone with medium- to fine-grained clots of white crystalline calcium carbonate. It weathers to a tan to
buff, is well fractured, and broken with sharp edges rounded by weathering.

This unit is overlain by more than 100 feet of gray quartzite, which is well fractured and broken, irregularly stained by dark iron oxide, and consists of fine-grained glassy quartz with a siliceous cement. Chlorite occurs as individual specks and narrow seamlets. This unit is the most easily seen and traced. In at least two locations this unit has small showings of green copper carbonate and silicate, which have led individuals to use these spots for digging location or prospect pits.

Directly overlying the upper Scherrer quartzite is a 12-foot-thick bed of massive light-gray dolomitic and argillaceous (?) limestone that weathers to a tan-colored rough surface. This is probably equivalent to the 18-foot-thick bed of "silty and limy dolomite . . . and . . . sandy limestone" described by McClymonds (1957, p. 48). On this basis, the unit has been placed in the Scherrer Formation following the lead of McClymonds (1957) and Bryant (1955), who prefer to retain "the term 'Concha' for the unbroken series of limestones overlying the clastics of the Scherrer" (McClymonds, 1957, p. 48).

North of Red Hill enclosed in the porphyritic granite is a large block of poorly cemented (possibly leached) fine-grained quartzite that has tentatively been assigned to the Scherrer. The beds strike northeast and dip steeply southeast. This does not conform with adjacent
beds, and the block may have been "rafted" by the granite.

In the main outcrop of Scherrer the units are offset along northeast faults and cut by andesite porphyry dikes up to 20 feet thick that intrude along faults.

Concha Formation

The Concha Formation, as estimated from construction of the section, is approximately 420 feet thick. This compares with 510 feet of Concha found in the Waterman Mountains by McClymonds (1957, p. 49). The formation conformably overlies the Scherrer; it begins above the highest clastic unit of the Scherrer and extends through the thicker bedded blue-gray limestones.

The Concha is somewhat resistant to erosion and thus forms higher ridges and slopes than the underlying Scherrer. It consists of thickly bedded to massive, finely crystalline, with lesser amounts of coarsely crystalline, limestones. These rocks are mostly dark gray with a central lighter gray less resistant unit. The formation as a whole contains rare to moderate amounts of light-tan to brown chert as clots and very irregular knots. Irregular blebs of white calcite up to a few inches in size are common. As a whole the units have a roughly weathered "elephant's hide" texture.

These limestones are also weakly offset, apparently by some of the same faults and andesite porphyry dikes that cut the Scherrer.
Rainvalley Formation

The Rainvalley Formation is similar to the Concha. It is exposed in the northwest corner of sec. 34 and appears to be in a continuous conformable relationship with the Concha. It is a good ridge-forming unit and for the most part stands topographically higher than the Concha.

McClymonds (1957, p. 52-55) describes a 321-foot thickness of Rainvalley in the Waterman Mountains but notes that it may be much thicker if overlying alluvium covers higher beds.

In the El Tiro Hills the author found approximately 550 feet of Rainvalley. At first glance this is somewhat of an anomalous condition. The classic idea is that Paleozoic formations thin toward the western part of the State. This can be shown to be the case with some of the other Paleozoic units but cannot be assumed in the case of the Rainvalley, since we are dealing with an incomplete, eroded, or faulted surface at the "top" of the Paleozoic. The Rainvalley was of unknown thickness and may have either thinned or thickened to the west. Another possibility for this seemingly anomalous thickness was put forth by Dr. D. L. Bryant when he visited the thesis area with the author in August of 1963. He suggested the possibility of imbricate thrusting to thicken the section and thus give a repetition of beds. This was not apparent
during the course of field investigation but might possibly be resolved by a section measured in detail.

The lower + 430 feet of the Rainvalley compares quite favorably lithologically and in fossil content to the lower 250 feet in the Mustang Mountains, as discussed by Bryant (1955, p. 50-51), and to the lower 205 feet in the Waterman Mountains, as discussed by McClymonds (1957, p. 52-54). As seen in the thesis area, the Rainvalley consists of dark-gray to light-gray fine granular limestones. It is usually more thinly bedded than the underlying Concha and does not present as rough a weathered surface. Chert nodules, which are generally dark brown, are less abundant here than in the Concha. Some blebs of white crystalline calcite are present, but these are generally small. Fossils are not uncommon, and **Composita**, crinoid parts, **Dictyoclostus**, and a bellerophontid gastropod were noted. Thin beds, generally less than 2 feet thick, of finely layered sandstone can be found in the Rainvalley. These weather out faster than the limestone and thus form boulder-covered depressions. These sandstone units consist of fine granular quartz with a calcite cement and some granular calcite. Small blebs of hematite and irregular hematite staining impart a pinkish-gray color to the rock. These sandstones are generally brown iron oxide stained on weathered surfaces.

The upper +120 feet of the Rainvalley Formation overlies a well-altered, brecciated, and sheared fault zone. The relative
movement on the fault is left lateral, as indicated by drag, and the fault is nearly parallel to the strike of the beds. (See detailed discussion under "Structure.") Thus, the fault may not cause much addition or loss from the overall thickness of the section.

The +120 feet above the fault lithologically compares, in part, with the upper 150 feet discussed by Bryant (1955, p. 51):

The upper 150 feet of the Rainvalley formation is composed of light gray and grayish brown, generally coarse grained limestone, in places dolomitic. Chert is prominent in the lower part but decreases toward the top. Fossils are very scarce but calcite knots and geodes that simulate shell shapes make up as much as 20 percent of the rock in some zones.

The +120 feet above the fault also lithologically compares, in part, with the upper 116 feet discussed by McClymonds (1957, p. 54-55):

"The upper 116 feet of the Rainvalley formation is interbedded limestone and dolomite, usually forming a gentle slope . . . A few chert nodules . . . The only fossils recognized were in the 3.7 foot thick bed, 44 feet from the base of the unit . . ." It is felt by the author that the differences can be logically explained.

This upper +120 feet of the Rainvalley Formation consists of interbedded, irregular lensy, and laterally gradational limestone and argillite. This unit can be found on the southwest slope of Contact Ridge. It is a slope former with the limestone weathering out much more rapidly than the argillite. The slope is covered by much talus from the overlying Cretaceous rocks, and outcrops are at best spotty
and difficult to follow. To the southeast along Contact Ridge the section is faulted to the north, and the ridge top consists of Rainvalley.

The limestones of the unit are a thick, white to tan to gray, medium to coarsely recrystallized limestone. They contain variable amounts of brown siliceous cherty masses, which are more abundant in the lower part. The limestone is leached and weathers to a loose granular texture. No fossils could be found.

Argillaceous clastics are irregularly interbedded, lensy, and also form an almost continuous 7- to 8-foot band above the top of the crystalline limestone. These argillites are very dense, hard, and resistant to erosion. They are blocky, fractured, and weather to a tan to brown iron-stained rock. The fresh rock is very light gray to pinkish gray and fine to very fine grained. It appears to be composed of very fine grained to fine-grained quartz with some fine-grained calcium-silicates and minute yellowish specks of argillaceous material. There are a few specks of limonite and some fine hematite. The rock breaks with a smooth subconchoidal fracture.

The uppermost limestone is quite continuous along strike. It is only a few feet thick and may be eroded in the southeast portion of the outcrop area. It is a blocky roughly weathered rock and is tan to brown due to limonite staining in outcrop. On a fresh surface the limestone is massive and gray with many irregular seamlets and bleb occurrences of hematite and limonite. Locally, it has clots and seams
of medium- to fine-grained calcite. It has a rough irregular to sub-
conchoidal fracture. Although contacts are partially masked by talus,
this limestone unit appears to be overlain by a thin argillaceous unit
similar to that underlying the limestone. The contact between the Pa­
leozoic and the coarse-grained basal conglomerate of the Cretaceous is
only a few feet above the top of this limestone unit.

Northwest of the main outcrop of Permian units are some low
hills in the central and east-central part of sec. 28. In these hills sim­
ilar limestones and argillaceous beds are found with the Cretaceous
overlying them. In this area, however, alteration and metamorphism
have been stronger, and the area is complicated by intrusion and pos­
sibly by faulting. Much of the limestone is either a crumbly, light-
colored, coarsely recrystallized limestone or a very resistant, rough,
dark-brown, iron-stained weathered rock. On fresh surface this latter
rock is a light-gray-green color with massive light-yellowish-green
garnet, white fibrous to bladed wollastonite, and irregular clots of
gray to blue-gray anhedral to crystalline quartz. Locally, some dis­
seminated pyrite and iron oxide and dark copper oxide, which replace
the sulfide, occur in the sediments.

The Cretaceous-Paleozoic contact is exposed in an outcrop in
the south-central portion of sec. 28. This appears to be offset to the
south from other contact exposures. The presence of the intrusive
granite porphyry may complicate this area, but too little information is
available to draw any definite conclusions as to its effects.

It has been stated that the limestone-argillite section above the aforementioned fault zone is probably Paleozoic Rainvalley and, in part, is lithologically similar to the uppermost Rainvalley found in the Waterman Mountains and the Mustang Mountains. The major lithologic dissimilarity is that no argillaceous beds, such as occur in the El Tiro Hills, are found in the aforementioned mountains. Since during the Paleozoic the central part of Arizona had a positive area, Mazatzal Land (Stoyanow, 1936, p. 462), the presence of argillaceous clastics does not present a problem. It may be that in this westerly area interbedded and lensy fine-grained clastics were being deposited with the Mazatzal Land as the source area but that the more easterly regions were too far away to receive this fine sedimentation. Fine-grained clastics having a widespread distribution are found in other parts of the Rainvalley. Another possibility is that less post-depositional erosion took place in this particular area, thus allowing more of the Rainvalley to be left than has been found elsewhere. Even assuming an overall thinning to the west it is possible to say this may be a facies change. Further justification for not placing this limestone-argillite unit in the Cretaceous is the presence of a very coarse grained conglomerate directly overlying the limestone-argillite. This is interpreted by the author and others who have seen it to be the basal conglomerate of the Cretaceous. It is the only very coarse grained conglomerate found underlying
typical Cretaceous arkoses, shales, and argillites in this area.

The relationship between strikes and dips in the Paleozoic and in the overlying Cretaceous is, for the most part, that of similarity. Both Paleozoic and Cretaceous rocks have northwest to north-northwest strikes. The difference between dips is minor, possibly the Cretaceous being slightly steeper than the Paleozoic.

It was often difficult to obtain reliable strikes and dips immediately adjacent to the contact of the Paleozoic and Cretaceous rocks. Their relationship is probably a disconformity surface.
Rocks of the Amole-type and of probable Cretaceous age occur over more than half the area mapped. Significantly, more difficulty was experienced in mapping a continuous section of Cretaceous rocks than in mapping Permian rocks. Outcrops of Cretaceous rocks are not continuous or connected and are often separated by wide expanses of cover or areas of poor exposure. As is evident from the geologic map, many of the ridges, which are made up in part or wholly or Cretaceous rocks, are parallel to strike and are flanked by much talus; therefore, only a minimum of different rock types can be seen. No attempt was made to make a comparison of rock units and thicknesses here to Cretaceous units elsewhere in Arizona. It is almost impossible to correlate units over long distances and occasionally even over a few tens of feet. The important fact is that in this area there is a sequence of rocks that lithologically, in their alteration, and in their associations, closely resembles other Cretaceous rocks found in Arizona.

It is estimated that an undisturbed section of Cretaceous in this area would exceed 5,000 feet in stratigraphic thickness. This
section has been disturbed and reaches a thickness of approximately 7,000 feet:

In general, these rocks, which include the Cretaceous rocks in secs. 27 and 34, strike north-northwest and dip steeply to the east or may be overturned to the west. In the far western area beds strike more northwesterly and dip moderately to steeply northeast. Eastward through the Andesite Complex area the strikes and dips remain about the same, but dips show a tendency to flatten toward the Eastern Undisturbed area.

**Western Undisturbed Area**

This area includes that of the Cretaceous outcrops that occur from the Paleozoic-Cretaceous contact east to a north-south zone passing between the large quartz latite porphyry dike and the large andesite porphyry dike. There is a small area of disturbed Cretaceous in the east-central part of sec. 34, which is excluded from this discussion.

By undisturbed it is not to be construed that there has been no diastrophism or intrusive activity. It is a relative term used to distinguish this and the Eastern Undisturbed area from the central brecciated, broken, intruded, and metamorphosed area.

In outcrop the basal unit, lying on a disconformity, is a massive arkosic conglomerate that is blocky and irregularly fractured and
broken. It is hard, somewhat resistant to erosion, and forms a good cap over the more easily eroded upper part of the Rainvalley. The weathered surface is brown and is stained by a moderate amount of dark-brown iron oxide. On a fresh surface the color varies from green to gray to light cream gray. It consists of gray, subangular to rounded, fine-grained, glassy quartz and lesser light-gray feldspar, generally less than 2 mm in size. Larger fragments, generally of gray, medium- to fine-grained, rounded quartzitic cobbles, occur up to several inches in diameter. These quartzite cobbles make up less than 50 percent of the rock by volume. The cementing matrix is variably light to darker colored and is probably siliceous to argillaceous in composition. Locally, the matrix has been converted to light-green epidote and sometimes to smaller amounts of reddish-brown garnet. Some specimens show irregular bleblike occurrences of secondary granular epidote. Finely disseminated specularite is pervasive to absent. This unit of the Cretaceous is several feet thick; the remainder is generally more thinly bedded.

In the following paragraphs a selected group of Cretaceous rocks has been picked as representative of the Western Undisturbed area. The descriptions accompanying these rocks are often an accumulation of descriptions from a number of similar specimens. Therefore, it is not expected that in all cases one would find in a single specimen all the characteristics noted for that particular rock. A
generalized section through this area of the El Tiro Hills is categorized as being thinly bedded, striking north-northwest, and dipping steeply eastward to vertical or steeply overturned to the west. It is improbable that the ridges of Cretaceous rocks are limbs of steep tight folds. No field evidence was found to support folding. Most of the sediments show some degree of epidotization and dissemination of specularite.

Arkoses and arkosic conglomerates are usually blocky and irregularly fractured and are stained tan to brown by iron oxide in outcrop. The thickness of individual beds varies. On fresh surface the conglomerates usually are dark colored, browns and reds. They contain subrounded to angular or rounded to subangular fragments of quartz and feldspar, which are generally less than 3 mm and often less than 1 mm in diameter, and contain variable amounts of lithic material that often exceed the quartz and feldspar in size. Almost invariably the matrix is of very fine grained siliceous material that has a fair amount of epidote grains or aggregates and finely disseminated specularite and (or) hematite staining. Occasionally, small amounts of chlorite are present.

Argillites and hornfels are both common in this area and may be physically similar. The former is moderately stained in outcrop by dark iron oxide, is blocky, has a smooth fracture, and breaks well across beds that are commonly less than 1 mm in thickness. Often shallow solutional pits are present. The fresh rock is very dense,
tough, and hard; colors vary from light tan to green. The rocks are very fine grained and generally have fair to moderate amounts of small clots and blebs of epidote and lesser amounts of very fine grained white specks of possible feldspar. The hornfels are also dark iron stained in outcrop and have an irregular to subconchoidal fracture. Fresh surfaces are light colored, dense, massive, and very fine grained. Roundish blebs to a few millimeters in diameter of light-yellowish calcium silicate are not uncommon in a siliceous matrix. These blebs often have a fine-grained epidote center and a very narrow halo of dark-green chloritic (?) material.

Red ferruginous and black shales are interbedded with the aforementioned rocks, but not in any great quantity. Perhaps one reason for not seeing more of these shales is that they tend to weather back more rapidly than the other clastics due to their fissile broken nature, and consequently they are often covered by talus from upslope.

In three locations a bed (or beds) of probable volcanic tuff was found. These are located (1) approximately half way between the northeast and southeast corners of sec. 34, (2) to the north of (1) about 2,500 feet along the strike of the beds, and (3) a few hundred feet west of the north end of the large quartz latite porphyry dike. By repositioning faulted blocks, these outcrops are almost on the same projected strike and thus are probably the same bed. The tuff has a rough weathered surface, is thinly bedded, and is irregularly stained by iron and
manganese oxides. It is generally a light-gray to white color. A fresh surface is light gray to cream and very fine grained. The rock is weakly epidotized and contains some quartz and feldspar fragments and what appear in thin section to be devitrified glass shards. The matrix is extremely fine grained and siliceous.

The contact between the Western Undisturbed area and the Andesite Complex area is very indefinite. This is not only due to the contact being partially covered but also to the fact that the zone of disturbed sediments gradually becomes more pronounced on the east side of the large quartz latite porphyry dike. In the southern part of the contact area relationships are even less apparent.

Andesite Complex Area

Although the rocks of the Andesite Complex area are Cretaceous in age, the agent or agents responsible for their brecciation, shattering, and alteration may be significantly younger than Cretaceous. Because of this, and the fact that the unit has a distinctly different physical appearance, it will be discussed later as a separate unit and has been mapped as such.

Eastern Undisturbed Area

This area is on the boundary between secs. 35 and 36 and is elongated in a northwest direction. The maximum exposed thickness
of section is 1,200 feet. The beds strike north-northwest and dip moderately to the northeast. The lower contact of this unit with the Andesite Complex is generally more definable than the contact of the western unit and the Andesite Complex. The one exception is in the east-west contact in the southwestern part of sec. 36, which occurs on a topographically irregular and higher surface and may be complicated by erosion.

With only minor variations, this area has the same assemblage of lithologic types as the western area, except that no coarse conglomerate was found here, and a narrow limestone unit could be traced discontinuously over a short distance in the very northwestern portion. The typically epidotized arkose, argillite, hornfels, and red and black shales were all found. The limestone is a maximum of 25 to 30 feet thick and is probably thinner and overturned to the west; no good bedding was seen. It is gray to white, medium crystalline, and has very little chert; it contains a small amount of hematite in the upper portion. No fossils were found. It appears that, in part, this limestone is at the erosional unconformity, which truncates the aforementioned Cretaceous units.

Angular Unconformity

The eastern area of Cretaceous rocks is overlain by clastics of the Claflin Ranch type, and the relationship is that of an angular
unconformity. From the northwesternmost portion of the eastern area to the southeast for about half the contact length between the eastern area of Cretaceous rocks and the Claflin Ranch clastics (approximately 3,000 feet), this relationship is very evident. No faulting was found to account for the angular unconformity. Within a few feet of the contact and on either side of it, one can measure strikes that differ by as much as 60° in two lithologically distinct rock units; the dips are comparable. This is the first marked irregularity found in the Cretaceous. There is also a marked change across the contact from very fine to very coarse grained sediments.

It is also in this area that one of the lower coarse-grained conglomerates of the Claflin Ranch Formation contains boulders of the bedded argillite found directly under the unconformity, thus indicating an erosional hiatus. Along the remainder of the contact between the eastern area Cretaceous and the Claflin Ranch Formation this relationship is less evident. This is, in part, due to the lack of good exposures and, in part, is due to north-south faulting that is evidenced by the offsets in a traceable andesite porphyry sill (or flow) in the Claflin Ranch sequence. Faulting appears to cause the southward swing of the unconformity. Similar offsetting also may be true in the area of the contact south of the northeast corner of sec. 35. Thus, it becomes evident by reconstruction that on the pre-Claflin Ranch erosion surface the Cretaceous beds had a northeast strike and dipped to the southeast.
No conclusions are drawn regarding the pre-Claflin topographic surface.
CHAPTER 4
CLAFLIN RANCH FORMATION

General

The term "Claflin Ranch Formation" was first used by Richard and Courtright (1960, p. 1) to refer to a thick series of clastic rocks found in the Silver Bell Mountains. Later used by Watson (1964, p. 111), the term was extended to include "any coarse clastic of 'Laramide' aspect." As used in this thesis, it also includes the tuffaceous pyroclastic rocks interbedded with these coarse Laramide clastics.

Since this unit is stratigraphically the highest mapped in the thesis area, the age is uncertain. In the Silver Bell Mountains, Watson (1964, p. 122) determined from structural evidence that it is of Late Cretaceous age. However, the Claflin Ranch Formation, as mapped in the El Tiro Hills, overlies an angular unconformity. The author would like to suggest, based on the evidence presented in previous pages, that possibly this hiatus in the deposition of Amole-type sediments and the deposition of the much differing Claflin Ranch type may represent the Cretaceous-Tertiary boundary. It is possible, of course, that this unconformity is a local feature and reflects local upheaval related to Laramide deformation.
The Lower Contact of the Claflin Ranch

The portion of the lower contact of the Claflin Ranch Formation not overlying the Amole-type clastics overlies the Andesite Complex. This part of the Claflin Ranch Formation includes the contact in the southeastern part of the area mapped and that portion of the contact that runs northwest from the section line between secs. 26 and 35. The exact nature of this contact is uncertain, since exposures in the contact area are good only on the southern and western flanks of Gato Peak. Even there, the relationship between the rock units is not clear due to the apparent alteration transgressing the contact. Much of the remainder of the contact area is under cover, and exposures are poor and scattered.

For the entire length of the contact, excepting the southeastern end, different strikes were recorded in the Claflin Ranch Formation than in the underlying Amole-type Cretaceous; this shows up as an angular unconformity. However, where the Claflin Ranch Formation is near the Andesite Complex, the bedding becomes much less apparent; whereas, farther away from the contact the bedding is very evident. In the vicinity of the contact, the Claflin Ranch also assumes the gross overall physical aspects of the underlying Andesite Complex. These include a massive, poorly bedded, and rubbly weathered appearance. The colors in both grade from green to purplish and have variable amounts of dark iron oxide. Not at all uncommon along this contact are small
pods to dikes of andesite porphyry. Thin-section analysis shows that the Claflin Ranch arkosic clastic in this contact zone on the southern flank of Gato Peak has an exceptional amount of crystalline plagioclase and epidote. This, taken with the other aforementioned factors, has led the author to conclude that there is a strong possibility that where the Claflin Ranch Formation is in contact with the Andesite Complex it has been hydrothermally altered by the same agents that were responsible for the Andesite Complex.

A few hundred feet southwest of the northeast corner of sec. 27, the Claflin Ranch Formation can be seen in outcrops separated from the main area of outcrop. The bedding in these separated outcrops strikes in a more westerly direction than it does in the rest of the exposures of this formation. At the apparent base(?) of this particular section is an interbedded limestone and limestone conglomerate sequence. This unit is a maximum of 60 feet thick and is discontinuous along a strike length of ±600 feet. Strikes vary slightly from east-west, and dips are steep to moderate to the north. The weathered surface of the limestone has a smooth to rough "elephant's hide" texture and locally has deep pot holes. For the most part, it is thinly bedded, massive, finely granular, and gray to deeply hematite stained (often following bedding). Limestone conglomerate beds are not as abundant as the limestones and consist of fine- to coarse-grained, subangular to rounded, lithic fragments, mostly limestones, in a limy matrix. These
conglomerates are also hematite stained. Some brown iron oxide-stained chert and irregular blebs and seams of white calcite were found. Very small amounts of granular (detrital?) quartz and feldspar, chlorite, and secondary epidote also were found.

This sequence has been placed in the Claflin Ranch Formation, since the overlying rocks are in all probability Claflin Ranch and are conformable with the sequence. A second reason for placing it in the Claflin Ranch Formation is that fine-grained Amole-type clastics striking at right angles and dipping approximately vertically can be seen almost in contact with the sequence. This contact probably again represents the angular unconformity between the Claflin Ranch Formation and the Cretaceous Amole-type clastics.

**Rock Types**

Generally the rock units of the Claflin Ranch Formation are brown, tan to cream colored, medium- to coarse-grained clastics and tuffs. Bedding is usually readily distinguishable. This type of clastic grades laterally rapidly, and rock types in the basal part are a function of source material and topography on which they were being deposited. Thus, correlation of individual units over long distances would be impossible. A general discussion of more prominent rock types should suffice to show the similarities between the Claflin Ranch Formation of this area and the Claflin Ranch Formation of other areas.
The Claflin Ranch Formation is noted on the geologic map (fig. 6) as the thick sequence on the north and east sides of the mapped area. The strike of these clastics is very consistently northwest, with dips averaging 50° to 55° NE. The clastics are fairly resistant and stand out as ridges and hills, which are collectively the highest group of the area (fig. 4). These ridges are locally dissected, but faulting is suspected in these areas.

It should be noted that the base of the Claflin Ranch Formation varies in its lithology along the unconformity. This introduces no problem if one assumes that the pre-Claflin surface was not perfectly flat but was topographically irregular and had depressions that had to be filled before any continuous layers could be deposited. One of the lower arkosic conglomerates, overlying the Cretaceous in the Eastern Undisturbed Cretaceous area, is an irregularly broken rock stained by dark iron oxide. Fractures break across grains. It consists of sub-rounded to subangular medium- to fine-grained fragments of quartz and feldspar generally less than 2 mm in size. There are also numerous coarse-grained, subangular to angular, lithic fragments that are mostly argillites, like those found bedded directly below the unconformity. The matrix consists of very fine grained siliceous and calcareous material with much fine-grained epidote and some finely disseminated hematite.

Descriptions of a representative group of Claflin Ranch Formation rocks follow.
FIGURE 4

View looking east at base of Gato Peak, showing well-bedded clastics of the Claflin Ranch Formation.
Tuff: It is light tan in color, thinly bedded, and irregularly fractured in outcrop, tending to break parallel to bedding. The rock is light tan on fresh surfaces and appears to be a dense compact mass of quartzo-feldspathic material with much fine-grained white feldspar(?). Some crystalline feldspar and granular quartz, as well as a small amount of bleached very fine grained micaceous material, are present.

Arkose weathers to a reddish-brown color and has an irregular uneven fracture. It consists of many medium-grained, angular to subangular, white feldspar fragments, lesser amounts of light-green altered feldspar, and subrounded to subangular glassy quartz. Also noted were some medium- to coarse-grained varied types of lithic fragments, clots of micaceous material, and specks of disseminated hematite in a siliceous matrix. The rock has much hematite staining.

Tuff occurs as irregularly fractured beds, brown in color, with some dark iron oxide staining. This rock is composed of fine-grained elongate to roundish feldspar and wisps to clots of dark micaceous material in a dirty very fine grained matrix. This rock may be of a laharic origin.

Arkose is blocky and irregularly fractured and stained by dark iron oxide. The rock is moderately epidotized and appears to be composed of fine-grained angular to subrounded feldspar and red siltstone fragments. Some specks of specularite are present. This specimen is from fairly close to the Claflin Ranch Formation-Andesite Complex contact.
Lithic tuff is tan and hematite stained; it is very rubbly to blocky in outcrop. The rock is composed of fine- to coarse-grained, angular to subrounded, lithic fragments of mostly white to pink (hematite-stained) volcanic porphyry and clots of altered micaceous material in a dense aphanitic groundmass. This unit is thick and massive.

Crystal and lithic tuff is blocky and broken in outcrop; it is stained by dark-brown iron oxide on weathered surfaces. The chief constituents of the rock are white subhedral feldspar generally less than 1 mm in diameter, some glassy quartz phenocrysts (eyes), clots of chlorite, and volcanic fragments. The matrix is dense, siliceous, and aphanitic. The rock shows fair to moderate epidotization near the Claflin Ranch Formation-Andesite Complex contact.

Andesite porphyry is blue gray in color and consists of white anhedral to subhedral feldspar phenocrysts to 4 mm in length, but generally less than 1 mm, in an aphanitic groundmass. This rock is conformable with bedding and is either a flow or a sill. It reaches +30 feet in thickness and is offset by faulting several times. It is a good marker unit in this area.

Generally the sequence of pyroclastics and clastic rocks noted above is nonuniform with beds ranging from a few inches to several feet in thickness. Beds thicker than a few feet are uncommon with the exception of a massive lithic tuff near the upper portion of the Claflin Ranch Formation as it is found in the El Tiro Hills.
CHAPTER 5
ANDESITE COMPLEX

General

The term "Andesite Complex" herein applies to highly disturbed—intruded, metamorphosed, and brecciated—Cretaceous rocks. The area encompassed by the Andesite Complex is roughly two-thirds of sec. 35, extending north into sec. 26, and a small prong extending east into sec. 36. A separated outcrop is also found in the eastern part of sec. 34. The maximum thickness is about 4,000 feet.

Lithology

In describing this unit, a group of physical features and structural relations of the whole unit must be borne in mind—the picture obtained by one outcrop or facet would not be complete. The designation "andesite" in the name should not be construed to mean this is a breccia-type feature with an andesitic matrix. It was chosen because of the spatial relationship between the Andesite Complex and dikes, sills, and irregular pods and masses of andesite porphyry, particularly along and adjacent to contact areas.
In outcrop the rock is iron stained and weathered mainly to a greenish to purplish color and, less frequently, to a brown and gray color. The hills in the area of outcrop are low and rounded, with a surface covered with rounded rubbly rock material. Of all the rock units noted in the area, it is topographically the least prominent. The gross aspects of this unit are that of a gigantic breccia mass in which decreasingly smaller breccia fragments are found. The brecciation is confined, for the most part, to the Cretaceous Amole-type clastics and lies between the Paleozoic and Claflin Ranch Formations. Thus, it is similar to the dacite porphyry, which contains much foreign material (xenolithic), as found in the Silver Bell Mountains and as described by Watson (1964, p. 26-29). The alteration in the Andesite Complex has not been confined to Amole-type clastics alone.

It should be noted that in the area mapped as Andesite complex there are numerous strikes and dips shown. These actually represent areas in which the Cretaceous Amole-type beds have not been completely destroyed or shattered. The strikes and dips are generally the same as found in the Western and Eastern Undisturbed areas.

The contacts of the Andesite Complex with the underlying and overlying Amole-type Cretaceous rocks and the Claflin Ranch Formation are not sharp. The latter contact appears to be gradational due to masking by hydrothermal alteration. The lower contact between the Amole-type Cretaceous and the Andesite Complex is very erratic and
transitional, and, for this reason, no contact line has been used on the geologic map. About 200 feet east of the large quartz latite porphyry dike (fig. 6) the Andesite Complex is more prevalent than the unshattered, unbrecciated, Amole-type Cretaceous rocks. There is euhedral plagioclase in some rocks of the contact zone, which may possibly be of secondary origin (Dr. DuBois, personal communication), abundant specularite and epidote, and well-altered groundmasses (very cloudy in thin section), and a very subtle relic flow texture (Dr. DuBois, personal communication). These features seem to suggest hydrothermal activity possibly related to the formation of the Andesite Complex. The eastern contact is similar to the western contact but is much more definable, and for this reason a contact line has been shown on the geologic map.

In the very southeastern portion of the El Tiro Hills the Andesite Complex is in contact with quartz latite porphyry of a volcanic origin. Fragments of the quartz latite porphyry occur in the Andesite Complex adjacent to the contact. This indicates that the formation of the complex was post-porphyry. Near this contact fragments of coarse, biotite-rich, granitic rock (very similar to the "Precambrian" granite found elsewhere in the general area surrounding the thesis area) and schistose rock (much like the Pinal Schist) are found as part of the complex. In a hill slightly to the north of this contact and located in the Eastern Undisturbed Cretaceous, fragments of red shale, generally rounded gray limestone fragments with only a very thin recrystallized
halo, and andesite porphyry fragments are found in a pluglike mass of Andesite Complex. These facts suggest a possible intrusive origin for at least a part of the complex.

In the east-central part of sec. 34 and extending southeast into sec. 35, a gray, fine-grained, massively bedded limestone was found. It has a discontinuous strike length of approximately 3,500 feet, appears to dip moderately to the southwest, and has an outcrop thickness of a maximum of 50 feet. The strike is not conformable with strikes in the adjacent rocks. This limestone shows erratic strong alteration to massive light-green garnet, specularite, and some remnant magnetite. In some locations oxide copper is found associated with this alteration. In the southeastern part of this outcrop the large northeast-trending quartz latite porphyry dike stops abruptly at the limestone; faulting is strongly suspected, but no supporting evidence for this was found.

In the area near the northeast-trending quartz latite porphyry dike, the limestone is apparently surrounded by the complex. In the northwestern portion of outcrop of this limestone, the Amole-type Cretaceous is on the north side of the limestone, and the complex is on the south side. During field investigation the author was unable to determine the age (no fossils were found) or a reasonable explanation for this limestone unit; therefore, it has been arbitrarily placed in the Cretaceous. It may be, however, that the unit is Paleozoic in age and that unfound structures have brought about the relationships noted.
Other areas of the complex include a disarray of small pods, dikes, and irregular bodies of andesite porphyry (especially in contact areas), unbrecciated Amole-type clastics in blocks of various thicknesses and lengths, and well-altered, broken, and unshattered sections of Amole-type Cretaceous rocks with a matrix of finer breccia, usually much epidote, specularite, feldspar, and quartz, and carbonate that may or may not be of hydrothermal origin.

Conclusions

From the above discussions of varied lithologies and conditions found within the Andesite Complex, the apparent metamorphic effects of this unit upon the Claflin Ranch Formation, and the possible intrusive breccia-type relationships noted locally, it is concluded by the author that this unit is the result of igneous and hydrothermal activity that post-dates the Claflin Ranch Formation, as it is known in the El Tiro Hills, and is itself post-dated by a number of the intrusives in the area. The close association of intrusive andesite porphyries, the pervasive epidote-specularite alteration, and the shattering and brecciation all seem to be related to the formation of this complex unit.
CHAPTER 6
INTRUSIVE ROCKS

General

There are five general types of intrusive igneous rocks in the El Tiro Hills. Each type may show some petrographic and mineralogic differences within itself, but for the sake of clarity these have been grouped. Three of these are stocklike bodies, and two are dikelike. The latter two may be sill-like, but not enough structural information could be obtained.

They are in all probability Laramide in age, but few interrelational features could be found for determining relative ages among these rocks. The one exception is that some of the andesite dikes cut quartz monzonite porphyry and quartz latite porphyry.

Quartz Monzonite Porphyry

Five stocklike bodies of quartz monzonite porphyry were mapped. These range from a few hundred feet to a few thousand feet in length. The contacts seem to follow no regular outline or orientation. Structural control was not evident. In outcrop these intrusives vary from a conspicuous reddish, to dark iron-stained, to relatively
unoxidized, irregularly fractured rocks. In general they have a fine-grained groundmass of potash feldspar and quartz with plagioclase phenocrysts. Dark minerals are usually present and may include biotite, short stubby hornblende, and chloritized biotite. Hydrothermal alteration is weak. Most of these quartz monzonite porphyries can be seen to post-date the Claflin Ranch Formation and the Andesite Complex.

**Granite Porphyry**

Red Hill, in the central part of sec. 28, was named for the very conspicuous red to pinkish granite porphyry of which it is composed. The outcrop is not confined to the hill but has an irregular configuration in the nearby hills. A very small outcrop of this rock was also found in the Claflin Ranch Formation near its contact with the Eastern Undisturbed Amole-type Cretaceous. In outcrop, it is irregularly blocky to coarse and rubbly. The rock is composed of medium-to fine-grained, pale-colored to red, iron-stained plagioclase phenocrysts in a groundmass of finer grained subhedral orthoclase and anhedral quartz. Irregular clots of dark mafics(?) altering to hematite are prominent throughout the rock. This intrusive is apparently responsible for the garnetization, silication, and recrystallization in the nearby limestones.
Porphyritic Andesite

In the area along the boundary between the Papago Indian Reservation and sec. 36, an irregular body of dark porphyritic andesite intrudes the quartz latite porphyry tuffs. Locally, this rock is weathered to a crumbly mass and is generally iron stained. It appears to be composed mostly of plagioclase laths and much pyroxene, possibly diopside. Some of the plagioclase crystals are significantly larger, thus giving the rock a porphyritic texture.

Quartz Latite Porphyry Dikes

Standing out conspicuously as roughly north-south ridges in the area of the southeast corner of sec. 26 is a fairly thick quartz latite porphyry dike (the term "dike" is preferred over sill because subsurface relationships are not known). This dike is offset by faulting in at least three places. The dike averages approximately 100 feet in thickness. Other similar, but narrower, northeast-trending dikes of this type can be found in the southeast corner of sec. 35. In outcrop these dikes are white to cream and are moderately stained by dark iron oxide. On a fresh surface they are light colored, very dense and hard, with varying amounts of glassy quartz eyes, biotite, and subangular to rounded xenolithic fragments of fine-grained clastics and aphanitic porphyries. Some irregular epidote alteration and red hematite
staining are also present. The possibility that the larger dike may have been the source of the quartz latite porphyry tuffs and flow breccia has been considered. The dike, in this instance, would have to be pre-Andesite Complex in age—this cannot be established. Metamorphism adjacent to the dikes is negligible. Even the xenoliths within the dikes appear "fresh."

**Andesite Porphyry Dikes and Pods**

Numerous purplish to brown andesite porphyry dikes and small, irregular, podlike intrusions are found. These vary greatly in size and somewhat in texture. However, the trends of the dikes are almost always north to northeast. Locally, these dikes may have intruded along faults. The pods are commonly found along or very near the contacts of the Andesite Complex and other rocks. The majority of the remainder of the pods is within the complex. Metamorphism adjacent to these dikes is almost nonexistent. Some of the narrow dikes and many of the small pods could not be represented due to the scale used in mapping.
CHAPTER 7
VOLCANIC ROCKS

General

In the southeastern corner of the area mapped there is a moderate thickness of volcanic rocks intruded on the south side by the porphyritic andesite and in contact with the Andesite Complex to the north. An isolated outcrop is located to the northwest near the southeast corner of sec. 35. This outcrop shows some very tight folding, probably flowage folding.

These rocks consist of very thinly bedded quartz latite tuffs and massive quartz latite flow(?) breccia. Because of their location and limited lateral extent, these volcanic rocks present somewhat of a problem. For this reason they are noted as a distinct unit.

Lithology

The very thinly bedded tuffs are white to light gray in color, are iron stained on weathered surfaces, and have an angular blocky fracture with parting along bedding planes being common. The tuff is very dense and hard, has a few glassy quartz eyes and light feldspar phenocrysts, and a very fine grained matrix. The flow(?) breccia is
similar, with randomly oriented angular to roundish fragments (to +1 foot in diameter) of the thinly bedded tuffs embedded in a similar rock matrix.

**Age and Stratigraphic Position**

These rocks are found only in the southeastern area and are similar in composition to the quartz latite porphyry dikes. The strike varies from north to roughly east, and the dip is steep to vertical to steeply overturned. The stratigraphic top appears to lie generally toward the north side. The flow breccia thus overlies the bedded tuffs. Since the Andesite Complex has fragments of the tuff in it, the tuff must be pre-Andesite Complex. The tuff lacks conformity with the Claflin Ranch Formation, and, although it is not found in the Claflin Ranch sediments, it is apparently pre-Claflin Ranch Formation and post-Amole-type Cretaceous. The author feels that the thinly bedded tuffs had a source to the south or east and were deposited on an irregularly eroded surface, possibly dipping to the north or west. After tuff deposition a flow of quartz latite composition occurred—flowing out over the tuffs, it brecciated them and incorporated the fragments into the flow. Evidence for flowage exists in the isolated outcrop in sec. 35. The Claflin Ranch Formation was then deposited, later tilted, and the Andesite Complex formed.
The age of these rocks with respect to the quartz latite porphyry dikes is speculative. The tuffs and flow breccia may be related to the nearly north-south dike if it also pre-dates the Andesite Complex. The other northeast quartz latite porphyry dikes post-date the Andesite Complex.
CHAPTER 8
STRUCTURE

General

Three stages of uplift and (or) tilting and erosion are likely:
(1) probable uplift and erosion of the Paleozoic with little to no apparent
tilting; (2) tilting and erosion of the Amole-type Cretaceous, and (3)
tilting and erosion of the entire sequence found in the El Tiro Hills.
The latter two may have been a related process with a short hiatus
during Laramide time. No evidence for folding was found in this area
except for flowage folds in the quartz latite porphyry tuffs. Faulting is
present in varying degrees of intensity, and the faults have been clas­
sified, for the purposes of discussion, into four groups.

Northwest Faults

These, and possibly the north-south faults(?), are probably
the strongest of the faults found. Reference has already been made to
the northwest fault, which is located in the Rainvalley Formation.
The fault zone is several feet wide and consists of highly sheared broken
limestone with much specularite, fair to moderate amounts of brown
iron oxide staining, and some green garnet (fig. 5). The fault is found in the top of the saddle southwest from Contact Ridge. A general strike is N. 50° W. (nearly parallel to the strike of the limestone beds). No dip could be measured, but it appears to be steep. Drag folding in the fault zone indicates left-lateral movement. An attempt to follow the fault to the northwest and the projection of the fault to the southeast was futile because of talus cover.

Another strong northwest fault, possibly having as much as a 1,000-foot strike-slip component, was found by noting the offset of the quartz latite porphyry dike near the southwest corner of sec. 26. The indicated movement is right lateral. No actual fault zone was found during mapping, but a good lineation was observed when the author flew the area with Dr. Spencer Titley. It appears to strike approximately N. 25° W. Collectively, these faults may represent a major shear direction.

**Northeast Faults**

Northeast faults are the most abundant. These cause minor offsets in the Paleozoic and Cretaceous and also in the quartz latite porphyry dike located a few hundred feet south of the southeast corner of sec. 26.
Fault in Rainvalley Limestone.
Often these faults are occupied by narrow andesite porphyry dikes, which may possibly indicate that these faults are of a tensional nature.

**East Faults**

The east faults are few in number but show up as offsets, as much as 300 feet, of the quartz latite porphyry and andesite porphyry dikes in the west-central part of sec. 26. The relative movement is left lateral.

**Possible North Faults**

A series of roughly north faults is indicated in the Claflin Ranch Formation by the apparent offset of a sill (or flow) of andesite porphyry. The same sill (or flow) can be found in several of the ridges and appears to be offset by a steplike series of right-lateral faults. None of these were actually found.
Occasional minor quantities of copper oxide and pyrite occur in the uppermost quartzite unit in the Scherrer Formation; a small amount of pyrite and dark copper oxide is found in the upper part of the Rainvalley Formation; copper oxide is found in the tactite areas of the anomalous limestone discussed in Chapter 5; and small amounts of pyrite occur in the intrusives. Two shafts in limestone in the southern part of the area are known to have encountered copper oxide; however, no information on production was obtained. Aside from scattered occurrences, there are occasional narrow veins containing quartz, calcite, hematite, and a trace of copper oxide, which trend in a northeast direction.

The contact metamorphic zones are nearly void of mineralization of economic significance, and the intrusives show little hydrothermal alteration. The area, therefore, does not warrant an extensive expenditure of money unless more favorable geologic or geophysical information becomes known.
SELECTED BIBLIOGRAPHY


GEOLOGIC MAP OF THE EL TIRO HILLS, WEST SILVER BELL MOUNTAINS, PIMA COUNTY, ARIZONA

LEGEND

- **RECENT**
  - ALLUVIUM

- **CRETACEOUS AND/OR TERTIARY**
  - CLAFLIN RANCH FORMATION
  - CRETACEOUS - UNDIFFERENTIATED
  - RAINVALLEY FORMATION
  - CONCHA FORMATION
  - SCHERRER FORMATION

- **PALEOZOIC - PERMIAN**
  - PALEOZOIC - PERMIAN
  - ANDESITE PORPHYRY AND PORPHYRITIC ANDESITE
  - QUARTZ MONZONITE PORPHYRY
  - QUARTZ LATITE PORPHYRY - DIKES, TUFFS, AND FLOW BRECCIA
  - GRANITE PORPHYRY
  - ANDESITE COMPLEX

- **LARAMIDE**
  - LARAMIDE QUARTZ LATITE PORPHYRY - DIKES, TUFFS, AND FLOW BRECCIA

DEFINITE CONTACT
INFERRED CONTACT
STRIKE AND DIP OF BEDS
DEFINITE FAULT
INFERRED FAULT

APPROXIMATE SCALE: 1:12000
APPROXIMATE MEAN DECLINATION, 1964

GEOLOGY BY C.W. CLARKE
GEOLOGIC SECTION OF THE EL TIRO HILLS, WEST SILVER BELL MOUNTAINS, PIMA COUNTY, ARIZONA

CONTACT RIDGE

VERTICAL EXAGGERATION - X2.5

SEE PLATE I FOR EXPLANATION AND LOCATION OF SECTION

GEOLOGY BY C.W. CLARKE
TOPOGRAPHIC MAP OF THE EL TIRO HILLS, WEST SILVER BELL MOUNTAINS, PIMA COUNTY, ARIZONA

CONTOUR INTERVAL 40 FEET

APPROXIMATE SCALE 1:12000

APPED BY U.S. GEOLOGICAL SURVEY

APPROXIMATE MEAN DECLINATION, 1964

RED HILL

CONTACT ROCC

PAPAGO

INDIAN

WASH

RESERVATION

T11S

T12S