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GEOLOGY OF THE RUIN BASIN AREA

GILA COUNTY, ARIZONA

by

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This study has not had the advantage of critical review by the U. S. Geological Survey staff, thus all statements represent solely the views of the author. However, the release of the report in its present form as a thesis has been authorized by the Director of the U. S. Geological Survey.

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CHAPTER I INTRODUCTION

Acknowledgements

The field work in the Ruin Basin area was done while the writer was in the employ of the U. S. Geological Survey, Department of Interior. The Geological Survey has kindly permitted the use of material collected while in its employ in this thesis, submitted as partial fulfillment for the degree of Doctor of Philosophy.

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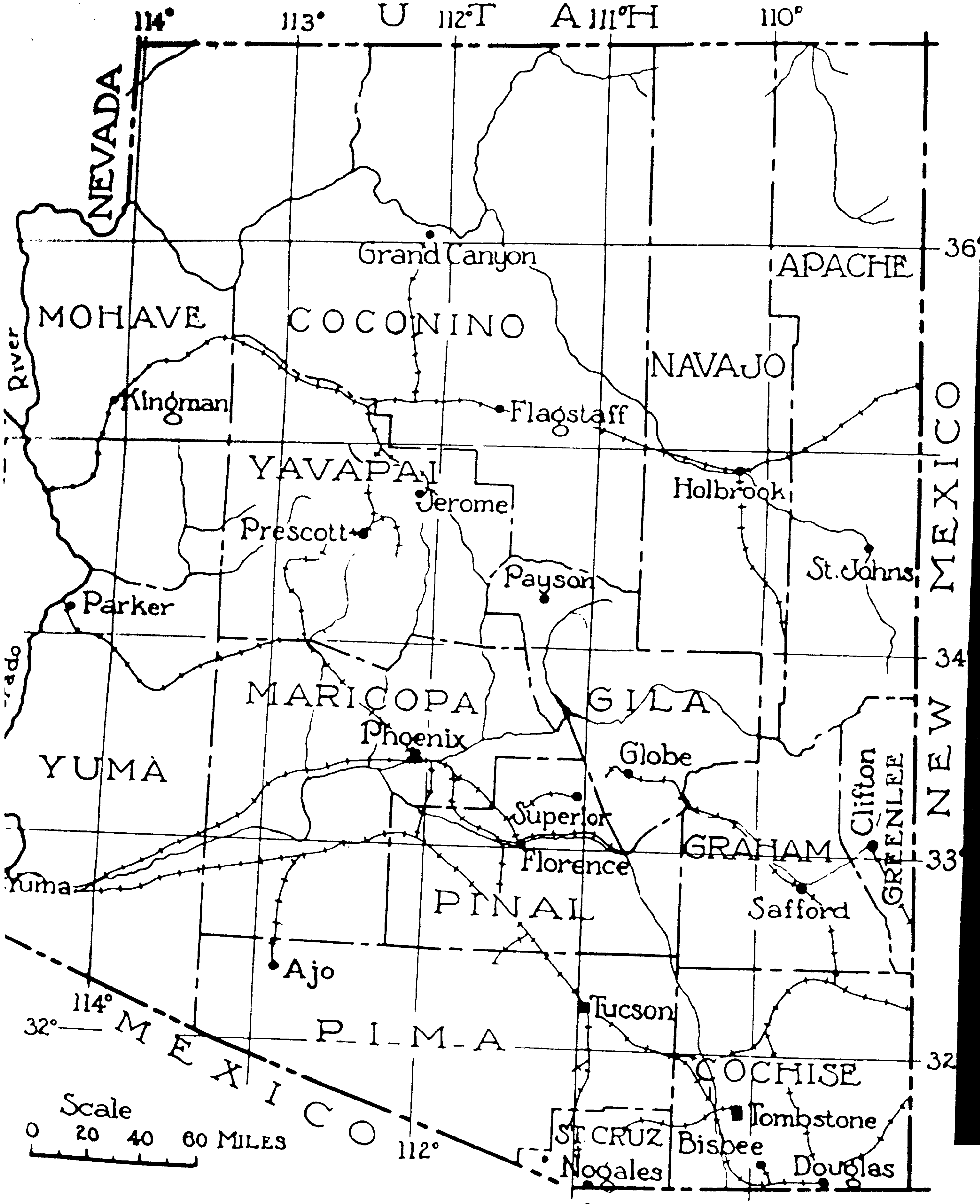
Location

Ruin Basin is in Gila County, Arizona, about 15 miles northwest of Globe. The area mapped is rectangular and covers about 7 square miles. The boundaries are as follows: on the north latitude 33°-30', on the east meridian 110°-52'-30", on the south latitude 33°-27'-30", and on the west meridian 110°-55' (Pl. 1).

The position of Ruin Basin in relation to the State of Arizona is indicated in Figure I. The Basin lies one and a half miles west



1.—Index map of Arizona. *Location of Ruin Basin Area.*

of the Apache Trail on the Gerald Wash Road that can be traveled by automobile.

Physiography

The Ruin Basin area is in the "Basin-Range" province, or the "Mountain Region" of Ransome (1903, p. 10) which is typified by block-faulted mountains. On a small scale, this area displays some of the typical features of Basin-Range topography.

Ruin Basin was once a horst of fast-weathering granite. It was surrounded by blocks of more resistant sedimentary formations. After much weathering the topographic relations were reversed; the former horst is now the trough which forms the largest physiographic feature in the area. It is two and three-quarters long and one mile wide, and has a north-westerly trend (Pl. 1).

Northeast and southwest of Ruin Basin are rugged mountains composed primarily of pre-Cambrian sediments, Devonian limestones, and intruded diabase. Rocks of these two localities are stratigraphically higher than those of Ruin Basin, for they were downthrown relative to the horst during the major block faulting.

Along the west side of Ruin Basin, but separated from it for most of its length by older formations, is a small graben, 8000 feet long and 1000 feet wide, filled with Gila conglomerate (Pl. 1). The northern third of this graben has little topographic expression, but the southern two thirds shows a distinct trough. Southeast of Ruin Basin is a large area of intruded diabase that has moderately rugged relief.

The main drainage is through Gerald Wash which runs easterly across the central part of the area, and thence into Pinal Creek, a mile-and-a-half beyond the boundary of this area. Tributaries of Gerald Wash extend northwest along Ruin Basin, south toward Sleeping Beauty Peak, and southwest toward Flatop Mountain (Pl. 3).

Climate

The Ruin Basin area is semi-arid with a mean annual temperature of about 63° F. and a range from 1°F to 120° F. The mean annual rainfall is about 11 inches. Most of the precipitation comes in the form of violent thunderstorms in June, July, and August, and in rains of November and December. Important climatic factors in rock weathering may be mechanical disintegration due to extreme and rapid change in temperature between day and night, and during rains; and the rapid abrasion by fractured or disintegrated rocks during times of heavy cloudbursts. Chemical disintegration, mainly due to hydration, is also important. Longwell, Knopf, and Flint (1945, p. 23) disregard rapid changes of temperature as a factor in weathering in an arid region. They base their conclusion on results of laboratory experiments. The present writer does not believe the experiments properly simulated the conditions in nature and therefore retains the older theory that rapid changes in temperature are a factor in weathering in an arid region.

Indian Ruins

Indian ruins in the basin area are responsible for the name "Ruin Basin". These ruins represent cultures of many centuries ago when primitive Indians roamed the region. Location of Indian ruins is shown on (Plate 3).

History of Mining[1]

The mining history of the Globe region is colorful and intimately connected with the activities of the fierce Apache Indian tribe that dominated the area before the coming of the white man. The isolation of the mountains and the predatory Apaches who lived in the region kept even the hardy prospectors out of the Globe region until 1874.

The United States Army temporarily subjugated the Indians in 1874, and opened the way to a party of prospectors that crossed the Pinal Mountains from the west and located the Globe claim (now known as the Old Dominion). On their return to Florence, members of the same party located the Silver King Mine[2] which became the first large silver producer in the district.

Other camps that soon after sprang into existence were Ramboz,

1 Principal source of data is Ransome (1901).

2 Silver King mine is actually outside the Globe quadrangle, but it was a great influence in encouraging prospecting around Globe.

Cottonwood Springs, Richmond Basin, Watsonville, and McMillanville. These camps all produced high-grade silver ore. During 1878 and 1879, raids of the Apaches under Geronimo and Victorio kept the miners in a state of constant anxiety, but the settlement at Globe was never actually attacked.

Globe remained a silver camp until 1883 when silver ore production began to decline. At that time, there were 12 mills in the vicinity treating silver and gold ores, but by 1887 these ores were exhausted.

First notice of commercial copper ore was in 1878, and by 1884 continuous copper production was achieved by the Old Dominion mine at Globe. The copper ore bodies at Miami were first worked about 1901, although steady production of copper was not reached until 1906 when the Inspiration Mining Company became well established. In 1907 the Miami Copper Company was formed and began operation.

In 1922 the Globe-Miami district produced 25 percent of Arizona's copper, 10 percent of the copper production in the United States, and 6 percent of the world's total production (Calkin, 1922, p. 11). At that time it ranked fourth in the world, being surpassed only by Butte, Lake Superior, and Bingham. The Old Dominion mine at Globe ceased production in 1930, but the mines at Miami are still large producers.

Previous Investigation[1]

1. Calkins, F. E. (1922). The Globe-Miami district, past, present,

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1. In U. S. Geological Survey Professional Paper 115 by Ransome (1919, pp. 22-25) is an annotated bibliography of 66 papers which are related to the Ray-Miami region, but are not pertinent to the study of the Ruin Basin area.

and future. Arizona Min. Jour, vol. 5, no. 23, p. 11.

A brief discussion of the Globe-Miami district as it compares in production with other copper camps.

2. Copper Resources of the World (1935), 16th Int. Geol. Congress, vol. 1.

A brief description of the ore deposits.

3. Darton, N. H. (1925) A resume of Arizona geology. Univ. of Ariz. Bull. 119, pp. 240-242.

Condensed sketch of Globe Hills area.

4. Davis, W. M. (1925) The Basin-Range problem. Nat. Acad. Sci. Proc. vol. 11

A general discussion of structure and physiography.

5. General geology and summary of ore deposits of the southwest. (1932) 16th Int. Geol. Congress Guidebook 14.

Describes the geologic features related to the occurrence of copper deposits in the Southwest.

6. Gilbert, G. K. (1875). U. S. geographical and geological survey west of 100th meridian.

Physiographic descriptions and Gila conglomerate named.

7. Gilbert, G. K. (1928). Studies of Basin- Range structures, U. S. Geol. Surv. Prof. Paper 153.

Structural interpretation of the Basin Ranges.

8. Knechtel, M. M. Geologic relations of the Gila conglomerate in southeastern Arizona. (1936). Am. Jour. Sci. 5th Ser. vol. 31.

A discussion of the Gila conglomerate.

9. Lee, W. T. (1905) Underground waters of the Salt River Valley, Arizona. U. S. Geol. Surv. W. S.P. 136.

Description of area near Phoenix, does not extend to Ruin Basin area.

10. Ransome, F. L. (1903) Geology of the Globe copper district, Arizona. U. S. Geol. Surv. Prof. Paper 12.

Excellent original description of rocks in the area, and first mapping of the Ruin Basin area on scale $\frac{1}{62,500}$. Contains a few errors in rock correlation.

11. ------------ (1904) Description of the Globe quadrangle, Arizona. U. S. Geol. Surv. Folio 111.

Excellent maps, some of which are not found in Professional Paper 12.

12. ------------ (1910) Geology at Globe, Arizona. Min. Sci. Press. vol. 100, pp. 256-257.

Brief description of geologic setting at Globe.

13. ------------ (1911) Geology of the Globe district, Arizona, Min. Sci. Press. vol. 102, pp. 747-748.

Brief additional material to article in 1910.

14. ------------(1919) The copper district of Ray and Miami, Arizona. U. S. Geol. Surv. Prof. Paper 115.

Corrects several errors of Professional Paper 12; but does not cover the Ruin Basin area with new larger scale map. Also general stratigraphy and correlation between Miami and Ray, Arizona.

CHAPTER 2 GENERAL GEOLOGY

In the following sections of this paper, the sedimentary formations and igneous bodies are described. The Gila conglomerate is given special consideration because of a controversy over its correlation. Regional and local structures are discussed with emphasis on the relationship between diabase and faulting. Erosion, ground water, and mineral deposits are briefly discussed.

Sedimentary rocks

Pre-Cambrian Apache group sedimentary rocks form the bulk of sedimentary formations in the Ruin Basin area. From oldest to youngest this group includes Scanlan conglomerate, Pioneer shale, Barnes conglomerate, Dripping Spring quartzite, and Mescal limestone.

Other sedimentary formations present are Devonian Martin limestone, Mississippian Escabrosa limestone, Tertiary (?) Gila conglomerate, and Quaternary alluvium. The columnar section (Pl. 4) and the correlation chart (Pl. 5) are in the pocket. A measured section of each formation appears at the end of this division of the report (pages 48-62).

Scanlan conglomerate

The Scanlan conglomerate is the oldest member of the Apache group and overlies the Ruin granite in the Ruin Basin area. It ranges from

1 to 5 feet in thickness and forms a cliff or ledge wherever it outcrops. In places its presence is obscured by talus from the Pioneer shale above.

The writer believes the Scanlan conglomerate was deposited on a peneplained surface of Ruin granite which was mantled by a residual regolith developed by subaerial weathering. The regolith, which is composed of unstratified weathered granite, remained on the peneplain where not removed by the agents that deposited the Scanlan conglomerate. A regolith similar to the one in Ruin Basin is the ep-Archean regolith in the Grand Canyon (Sharp 1940).

The weathered granite below the Scanlan conglomerate is considered part of the Ruin granite for it has decomposed in place. For additional detail about the Ruin granite-Scanlan contact refer to section on Ruin granite (page 63).

In some places the Scanlan conglomerate is difficult to distinguish from the weathered granite because they both contain many of the same minerals; namely, large feldspar crystals and quartz grains. The general color of both the weathered granite and the Scanlan conglomerate is moderate reddish orange. The main difference between them is that the stratified Scanlan is quartzitic and contains large, poorly rounded fragments of white, gray and black quartzite, vein quartz, and schist; whereas, the weathered granite lacks these features. Some layers in the conglomerate have a fine-grained, black matrix of silica, but in general, the matrix is coarse-grained and arkosic.

The Scanlan conglomerate is interpreted as having been formed in a large shallow basin of short duration, for the following reasons.

It is found over a large area in southeastern Arizona, and it is neither cross-bedded nor of great thickness.

The Scanlan depositing waters did little transporting, for they only concentrated the coarse material picked up on the peneplained surface. The mineral composition of the conglomerate always reflects the composition of the underlying rock. In Ruin Basin, the Scanlan conglomerate overlies granite, hence the matrix is arkosic. Outside Ruin Basin where the conglomerate overlies schist, the matrix is composed primarily of fine-grained schist (Ransome, 1919, p. 39).

The Scanlan conglomerate apparently grades upward into the Pioneer shale, for the basal beds of the Pioneer contain many of the same mineral constituents as the conglomerate, but the Pioneer shale differs from the Scanlan conglomerate in that the shale is finer grained and darker colored. Because of its thinness, the Scanlan conglomerate is included with the Pioneer shale on the geologic map.

Good exposures of Scanlan conglomerate are few in the Ruin Basin area. A small outcrop occurs in the east central area about 1000 feet north of bench mark 3539 near the road (Pl. 1). A similar outcrop is 3300 feet south of this bench mark. Within a quarter-mile north of the central margin of the area mapped is an excellent outcrop (Pls. 6 and 7). Another excellent outcrop occurs on an isolated peak one-half mile south of the southwest corner of this area. These two occurrences outside Ruin Basin are discussed in the section on Ruin granite, and measured sections of the Scanlan appear at the end of the division on sedimentary rocks.

Pioneer shale

The Pioneer shale is composed of beds that are various shades of red, and it attains a thickness of about 160 feet. The name shale is a misnomer, as applied to the mapped area, for much of this formation consists of arkose, quartzite, and siltstone. The Pioneer is relatively less resistant to weathering than the conglomerate, and thick-bedded quartzites of the Apache group, so it weathers to a slope in most places. The most diagnostic characteristics of the Pioneer shale is the presence of elliptical light buff to green spots (Pl. 8, A). Many beds also contain tiny particles of shiny mica.

Most of the Pioneer shale is believed to be marine in origin, but distinctive cross-bedding was observed in the lower arkose bed of the section measured southwest of the Ruin Basin area. Also, several occurrences of beds with rain and hail impressions were found in the Pioneer shale (Pl. 8, B). Apparently, at least some of the Pioneer shale is not marine.

The uppermost 60 feet of the Pioneer shale is composed of maroon, thin-bedded shale. The formation is conformably overlain by the Barnes conglomerate which makes a striking contrast in appearance owing to the greater resistance to weathering and the coarse texture of the conglomerate. A measured section of Pioneer shale appears at the end of the section on sedimentary rocks (pages 48-52).

Most of the Pioneer shale in the Ruin Basin area crops out in the northeastern quarter. It occurs together with the Dripping Spring quartzite in fault blocks that have been jostled and tilted during intrusion of diabase. Due to extensive erosion since the diabase intrusion, the present appearance of these formations is that of blocks floating in a sea of diabase (Pls. 1 and 2).

Two large outcrops of Pioneer shale occur near the southern limit of exposed granite. Apparently the diabase was intruded along the top of the granite and generally lifted the Pioneer away from its contact with the granite. Locally, however, diabase is absent between the Pioneer shale and the granite.

Barnes conglomerate

The Barnes conglomerate is light brown, massive, and ranges from 5 to 35 feet in thickness. It is composed mainly of well-rounded quartzite pebbles which are white, red-brown, brown, gray, pink and red and sparse jasper. These gravels range from pebble to cobble size. The matrix is light brown, arkosic and ranges in texture from sandstone to quartzite. The cement is firm and siliceous, and the formation weathers to form a cliff.

The Barnes conglomerate is the best marker horizon in Ruin Basin. Where the conglomerate is cut by faults, some of the pebbles are sheared, and in many of these, the halves are later cemented together askew (Pl. 9).

The Barnes conglomerate apparently overlies the Pioneer shale conformably. This apparent conformity may represent a non-apparent disconformity, for the conditions of deposition of the Pioneer shale must have been considerably different from those of the Barnes conglomerate. A considerable thickness of the upper part of the Pioneer shale is composed of the same type of rock, so many feet of shale could have been eroded off without noticeable effect. Also the fact that the conglomerate ranges in thickness from 5 to 35 feet in a horizontal distance of 2000 feet suggests that it was deposited on an undulating surface. Based on the evidence given above, the writer concludes that some Pioneer shale was eroded off before the Barnes conglomerate was deposited.

The upper contact of the Barnes conglomerate is gradational with the Dripping Spring quartzite, for there is a gradation of types upward. Beds in the uppermost part of the Barnes conglomerate alternate with beds of quartzitic arkose which are identical to the lowest beds in the Dripping Spring quartzite. The boundary between these formations has arbitrarily been selected as the top of the uppermost conglomerate bed.

Outcrops of Barnes conglomerate are abundant in the eastern half of the Ruin Basin area. A spectacular cliff of this rock occurs near the eastern border of the area on the north side of Gerald Wash Road. It forms a 35 foot vertical cliff that extends for several hundred feet; it is 100 feet above the road and much faulted, but the texture of the conglomerate is easily recognizable even from a distance. A measured section of Barnes conglomerate appears at the end of the section on sedimentary rocks (page 53).

Dripping Spring quartzite

The Dripping Spring quartzite is divided into an upper and lower part on the basis of different lithologic characteristics. The lower part is composed of grayish orange, coarse-grained, moderately thick-bedded arkosic quartzite with cross-bedding, and ripple marks; it weathers to a resistant cliff (Pl. 10). A whitish gray, massive quartzite, 40 feet thick marks the top of the lower part which has a thickness of 200 feet.

The upper Dripping Spring quartzite is composed of a light gray to yellow gray and red, fine-grained, thin-to thick-bedded, argillaceous quartzite which weathers to a slope (Pl. 11). Many of the thicker gray beds have thin hematite-red layers of quartzite (Pl. 12, B). In a few places, the upper Dripping Spring forms a cliff; these unusual occurrences may be due to local compressional metamorphism, or perhaps local cementation. The thickness of this upper part is 470 feet.

In the lower part of the Dripping Spring quartzite, the diagnostic features are cross-bedding, and, in places, ripple marks, whereas the upper part is characterized by thin, red beds and red talus slopes.

Dripping Spring quartzite crops out around the periphery of the area, but it is most extensively represented in the northeast quarter. Together with the other members of the Apache group, this formation is broken into fault blocks which have been intruded by diabase (Pls. 1 and 2). Measured sections of Dripping Spring quartzite appear at the end of the section on sedimentary rocks (pages 53-57).

Mescal limestone

The Mescal limestone is the youngest formation of the Apache group, and it lies conformably on the Dripping Spring quartzite. The limestone is medium to light gray, and fine-grained. The bedding is thin, and the formation attains a thickness of about 160 feet in the Ruin Basin area. Where the Mescal has been intruded by diabase, it is considerably serpentinized; in other places, the limestone is silicified (Pl. 12, A). The weathered surface is light gray, moderately rough, and forms resistant cliffs (Pl. 11). At the base of the Mescal limestone are two thin beds of aphanitic black silica each about 0.1 foot thick and separated by one-and-a-half feet of silicified limestone. The black beds contain numerous spherical concretions or amygdules 2-5 mm. in diameter with calcite around the periphery and quartz in the center (Pl. 13). These thin beds cover an area of at least one square mile. The relationship of the black beds to the strata above and below is somewhat obscured in the field because the silica outcrops in all places form slopes. In so far as can be determined, the silica appears to have a conformable relationship.

Two modes of origin are suggested for the black silica beds, but neither is free from serious objection. The beds might have originated as sills of vesicular basalt which was intruded between the Dripping Spring quartzite and the Mescal limestone. Later, descending solutions carrying calcium carbonate from the limestone partly filled the vesicles with calcite. When the mescal limestone later was silicified, solutions also silicified the basalt and completed filling the vesicles.

The main difficulty with this explanation is the implausibility of very thin igneous intrusions covering so large an area.

A second explanation of the formation of the black silica beds is that chert layers were laid down on the Dripping Spring quartzite and above the basal one-and-one-half feet of Mescal limestone. By some process, possibly by the decomposition of organic matter, gases seeped into the silica gel as it accumulated. Because of the density of the silica the gas bubbles were entrapped. This process is similar to that of sludge produced by well-drilling which, when canned and allowed to set, may result in a sediment filled with vesicles.

After the vesicles were formed in the chert, some quartz crystallized in them. Later, solutions charged with calcium carbonate descended from the limestones and completed the filling of vesicles. The objections to this explanation are that chert with amygdules is rare; that a source of gas must be accounted for; and that the calcite usually forms the periphery of the amygdule so it was probably deposited before the quartz core.

Many of the Mescal limestone beds are very thin, ranging from 3 to 40 millimeters and have considerable lithologic variation. A measured section of Mescal limestone appears at the end of the section on sedimentary rocks (pages 54-57).

The Mescal limestone is a favored horizon for the intrusion of diabase sills, many of which, in the western part of the area, extend for more than 1000 feet (Pls. 1 and 2). In nearly all places, limestone above the intruded diabase is highly serpentinized. The whole rock is not altered but bands of serpentine one or more inches thick are formed between beds of relatively unaltered limestone (Pl. 14, A). Where metamorphism or alteration is very intense, chrysolite, the asbestos form of serpentine, occurs. Asbestos prospects are present (Pl. 3), but none are deposits of commercial grade. The seams of asbestos are, in most places, less than one inch thick, and, are not continuous (Pl. 14, B).

A detailed discussion of the alteration of the Mescal limestone appears in the section on diabase; also a discussion of the asbestos deposits appears in the section on mineral deposits.

Martin limestone

The Martin limestone of Upper Devonian age rests unconformably on various members of the Apache group in the Ruin Basin area. In the western part of this area a thick sill of diabase intruded below the Martin limestone gives Devonian outcrops an isolated aspect on the geologic map (Pl. 1). The Martin formation is composed of two parts, the upper which is limestone, and the lower a series of alternating conglomerate, quartzite, and limestone beds.

The basal unit of the lower part of the Martin limestone is composed of a red, coarse, thick-bedded, arkosic conglomerate. Layering in this unit is expressed by slight change in color and by pebbles lying with their flat side in the bedding plane. Above this unit are limestone conglomerates, limestones and thin-bedded, brown quartzite. The limestones and conglomerates are of various shades of red, and are mainly thick-bedded. Together they compose most of the 116 foot thickness of the lower member of the Martin limestone (Pls. 15 and 16, A).

Stoyanow (1948, p. 314) reports on paleontological evidence that lower parts of Devonian strata, in at least two southeastern Arizona localities, are equivalents of the Cedar Valley limestone and Independence shale of Iowa. The implication is that these lower parts of the Devonian strata are older than the Martin limestone, and should not be included in it. In the Ruin Basin area no diagnostic fossils have been found in the lower part of the Devonian strata so they are not separated from the Martin formation.

Limestone beds of the upper part of the Martin limestone in Ruin Basin have various shades of gray and are moderately fossiliferous. The fossils are mainly brachiopods, cup and colonial corals, and crinoids (Pl. 17). The total thickness of the upper member of the Martin limestone is about 100 feet.

The limestones of this upper part are thin-to thick-bedded, fine-to coarse-grained and moderately resistant to weathering. Near the top of the Martin formation is a persistent, light brown, fissile shale bed which ranges from 1 to 30 feet in thickness and is the best marker horizon in the Paleozoic section of this area. Measured sections of Martin formation appear at the end of the division on sedimentary rocks (pages 58-62).

At the base of the Devonian section, in most places, beds are considerably brecciated (Pl. 16, B). The brecciation appears to have resulted from bedding plane movements, and diabase has been intruded along this plane in many places (Pl. 18).

The forces that caused the bedding plane movements may have been compressive Laramide stresses, or possibly stresses caused by forceful intrusion of diabase into the area. A more detailed discussion of orogenies in this area appears in the sections on regional and local structure. The bedding plane movements took place before the diabase magma reached the Devonian strata, because the diabase is unbrecciated in most places. The light brown, fissile shale near the top of the Devonian formation also shows results of considerable bedding movement. It is sheared and crumpled, and in many places it changes rapidly in thickness due to squeezing.

In the southeastern part of the Ruin Basin area the lower part of the Martin limestone is missing and the upper part rests on Dripping Spring quartzite. The Martin limestone has been partly removed by erosion in this locality. A few erosional outliers have been left beyond the main outcrops of Devonian strata (Pl. 1). This removed position coupled with the breccia at their bases gives these outliers the appearance of klippen. Actually, they are not considered klippen, for the movements along their bases were not of thrust proportions.

In the southeastern corner of the Ruin Basin area are several outcrops of Devonian strata. These have been considerably faulted in this locality. Two of the outcrops outline the most conspicuous anticline in this area (Pls. 1 and 3).

Localities where Martin limestone occurs south and southwest of the Gila graben, including the small outcrops south of Gerald Wash Road, contain both upper and lower parts of the Martin limestone. All these outcrops are underlain by sills or irregular masses of diabase, and most of the basal beds are considerably brecciated. These outcrops of Martin limestone are cut in many places by faults. The major ones which strike northwesterly are shown on the geologic map (Pl. 1), but many minor faults cannot be shown because of the small scale.

North of the Gerald Wash Road are several outcrops of Devonian strata both east and west of the Gila graben. These outcrops are composed only of the upper member of the Martin limestone, and they lie on thick sills of diabase. East of the Gila graben, outcrops of Martin limestone are faulted on two sides with the result that Gila conglomerate lies on the west side, and Ruin granite on the east of these outcrops.

Escabrosa limestone

The Lower Mississippian Escabrosa limestone overlies the Martin limestone conformably. The Escabrosa is olive gray to whitish gray, and is fine-grained with a sugary texture. Much of the limestone weathers to a characteristic yellow gray surface with large sharp-edged pits and forms cliffs (Pl. 19). Some of the beds contain chert nodules as much as 10 inches in length which weather out in relief forming a very rough surface. The thickness of the Escabrosa limestone is estimated at 200 feet but no complete section exists in the Ruin Basin area (pages 60-62).

The Escabrosa limestone in the Ruin Basin area is sparsely fossiliferous, the fossils being mainly corals and brachiopods. Few Mississippian fossils were found in situ. Most of the Escabrosa outcrops in this area are erosional remnants (Pl. 1).

The largest outcrop of Mississippian strata in the Ruin Basin area is in the southeastern corner. Here the Escabrosa limestone overlies Martin limestone in some places, and diabase in other places. Judging by the outcrop shown on the geologic map, the thickness of the Escabrosa appears to be over 300 feet in this locality, but actually it is less. This is because the area is extremely broken up by repetition faults of small throw and the section is partially repeated many times.

In the south-central part of the Ruin Basin area, Escabrosa limestone is faulted against dacite. The fault probably represents recurrent movement along an old plane, for the northwest extension is filled with a diorite porphyry dike considered pre-dacite in age. On the geologic map (Pl. 1) this fault looks like a possible extension of the fault forming the west side of the Gila graben. This extension is not probable, for the west side is down-thrown in the Escabrosa limestone locality, whereas the east side is downthrown in the graben. Near its southeastern edge, the Escabrosa limestone outcrop is covered by a small remnant of dacite. As no Pennsylvanian strata are found beneath this dacite remnant, the beds of Pennsylvanian age must have been eroded off before the eruption of the dacite. A normal north-south fault in the dacite exposes Escabrosa limestone below the dacite with no Pennsylvanian strata present.

Several small occurrences of Escabrosa limestone, conformably overlying the Martin limestone, are present in the southwestern quarter of the area. In two localities the Escabrosa limestone borders the Gila graben on the east. The more southerly of these two outcrops is long and narrow, and is faulted against Ruin granite on its east side (Pl. 1).

Gila conglomerate

The Gila conglomerate in the Ruin Basin area occupies a north-south trending trough formed by a graben which is 8000 feet long and averages about 1000 feet in width (Pls. 1 and 2). The attitude of the beds varies widely, but the rather steep dip tends to be into the north-south axis.

The Gila conglomerate ranges in color from tan to whitish gray. It is mainly thick-bedded, but weathers to a uniform slope. The matrix is tan to brown and ranges from sand to clay in grain size. The calcareous cement is weak to moderately firm. The moderately rounded gravel is composed of rocks from all older formations, but with a predominance of rocks from the formations outcropping in the immediate vicinity. The gravel ranges from pebble to cobble size. The maximum estimated thickness of the Gila conglomerate in the Ruin Basin area is about 400 feet (Pl. 20).

<u>Local correlation with original Gila conglomerate</u>: Some object to calling the conglomerate in the Globe area the Gila conglomerate. To help clarify this situation, the following discussion is presented.

G. K. Gilbert (1875, pp. 540-41) described and named the Gila conglomerate. His description is as follows:

"A system of valley beds, of which a conglomerate is the characteristic member, are exhibited in section along the gorges of the upper Gila and its tributaries. The boulders are of local origin, and their derivation from particular mountain flanks is often indicated by the slopes of the beds. Its cement is calcareous. Interbedded with it are layers of slightly coherent sand, and of trass, consolidated decomposed cinders, and sheets of basalt.... one thousand feet of beds are frequently exposed, and the maximum exposure on the Prieto is probably 1500 feet ... Beginning at the mouth of the Bonito, below which their distinctive character is lost, they follow the Gila for more than 100 miles toward its source, being last seen a little above the mouth of Gilita. On the San Francisco they extend 80 miles ... Where the Gila intersects, the troughs of the basin range, as it does north of Ralston, the conglomerate is continuous with the gravels which occupy the troughs and floor the desert plains. Below the Bonita it merges insensibly with the detritus of the Pueblo Viejo Desert (San Simon Valley). It is indeed one of the Quaternary gravels of the desert interior and is distinguished only by the fact that the water courses which cross it are sinking themselves into it, and destroying it instead of adding to its depth."

The next use of the term Gila conglomerate was by Ransome (1903, p. 48) in his report on the Globe Copper District. He describes the formation as "identical in character and origin and in part directly continuous with those noted by Gilbert." The Gila deposits surround Globe and occupy the trough between the Pinal Mountains to the south and west, and the Apache Mountains to the north and east. Ruin Basin is located on the southwest flank of this trough (Pl. 20, A).

The extension of the Gila conglomerate by Ransome seems valid in light of the definition of a stratigraphic unit by the "Committee on Stratigraphic Nomenclature" (1933, p. 422) which states: "On the principle that similar lithologic constitution shall be the essential character in extension of a name away from its type area, and that difference in age from place to place is permissible, the same name may be applied for cartographic purposes to a lithologic unit which elsewhere than at the type locality, includes a greater or smaller stratigraphic interval."

<u>Occurrence of Gila conglomerate</u>: In the Ruin Basin area are three separate occurrences of Gila conglomerate. The smallest of these is a veneer of gravel in a saddle along the eastern margin of the area (Pl. 1). This veneer is believed to represent a remnant of a former more extensive deposit, largely removed by erosion.

A large body of Gila conglomerate is located along the western margin of the Ruin Basin area (Pl. 1 and cross-section A-A' Pl. 2). Here the conglomerate overlies both dacite tuff and diabase. This situation is interpreted as the result of a basin eroded in the soft diabase into which tuff and dacite were deposited. Erosion later stripped off most of the dacite, and exposed the diabase. However, a few boulders of dacite and part of the underlying tuff were not removed. During this erosional period, a second trough was formed in this locality. Later orogenic movements gave rise to the cycle during which the Gila conglomerate was deposited in the trough over the diabase and remnant of tuff. At the close of the period of deposition, the area and thickness of the Gila were probably greater than now. The present thickness of the conglomerate in this locality is about 100 feet.

The largest occurrence of Gila conglomerate in the Ruin Basin area is in a long narrow trough located in the southwestern quarter of the area (Pls. 1 and 2, cross-sections A-A' and B-B'). In the recent past, this formation extended over a much greater area than it does today, for the trough represents a graben which is down-faulted at least 300 feet, an estimate based on the present vertical exposure of Gila in the down-faulted block. There is a difference in elevation of over 300 feet between the central part and the northern end of the trough, and a difference in elevation of 275 feet between the central part and the southern end. The attitude of the beds is somewhat inconsistent, but the trend of the dip in most places is into the north-south axis of the trough. This general dip may be partly due to drag along faults that form the graben.

Two possible modes of origin are suggested for the Gila graben. It may have been faulted after the deposition of the Gila conglomerate or the trough (graben) may have been subsiding during the deposition of the conglomerate.

The relatively straight line contacts between the Gila conglomerate and the surrounding rocks suggest that the conglomerate was faulted against them. In the past, Gila conglomerate probably extended over a considerably greater area than it does now. Erosion has had enough time to almost completely clear away Gila conglomerate deposits where they were not protected in down-faulted blocks.

Had the conglomerate been deposited in a stable trough, the dip of the beds toward the center would not exceed 35° (maximum angle of deposition for gravel), as it does on the east side in the southern half of the graben where dips of 55° and 70° are recorded (Pl. 1). These faulting of the conglomerate during or after deposition. Bordering the west side of the graben near the southern end, a small body of Gila conglomerate horizontally overlies the Martin limestone (Pl. 1). The contact between this body and the graben is faulted and the beds in the graben dip 35° eastward very near this contact. This small Gila body is interpreted as a remnant of a wider-spread Gila deposit that existed before the graben was faulted, or beyond the limit of the sinking trough.

<u>Pebble count study:</u> Pebble counts were made at two places within the Gila trough. The first was on a low ridge in the central part of the graben just north of the Gerald Wash Road near the 3751 bench mark. The second count was made on a bench above a cliff at the southern end of the trough, 100 feet east of the creek bottom. A compilation of the data obtained through this study appears in Table 1.

At the mid-graben locality, pebbles in the Gila conglomerate appear to have been derived from nearby outcrops. About 600 feet east of where the count was taken are diabase, Dripping Spring quartzite, Pioneer shale, and Barnes conglomerate, and rocks from these formations comprise most of the pebbles counted (Pl. 1 and Table 1).

Disks were the most abundant pebble shape represented in the counts of both large and small gravels. The other three shapes followed a different sequence of relative abundance in each group. According to Twenhofel (1939, p. 271), the shape of a pebble depends largely on the initial shape of the parent rock as it left the outcrop. Among [illegible] pebbles are many of diabase which weathers to a more spherical shape than do the sediments, therefore, the number of spheres in the small pebble count is greater than in the large pebble count where no diabase was included. Evidently, weathering of the diabase in this locality results in small fragments only. This conclusion is confirmed on the diabase outcrop 600 feet east of where the count was made.

The average sphericity in the count of large and small gravels was .74 and .71 respectively. This means that the 3 axes normal to each other in the pebble are not greatly different in average length (Krumbien, 1924, p. 67). Sphericity is determined as follows: the longest axis in the pebble is (a); the intermediate one is (b); and the shortest axis is (c).

TABLE 1. Compilation of Gila Conglomerate Pebble Count [1]

Locality: Mid graben north of road.

Number of count: 100

Length range of pebbles: 28-134 mm (large pebbles)

Formations represented: p6ds45, p6p23, Tdl1, P6m9, Dm5, Misc. 7

Shapes: spheres 24, rods 27, disks 34, blades 15

Average sphericity: .74

Average roundness: .41

(Table 1 continued on page 28)

1 Techniques employed follow Krumbein (1942). Tabulated data from which these totals were computed occur in Table at the end of the section on Gila conglomerate (page 31).

Locality: Mid graben north of road.

Number of count: 200

Length range of pebbles: 8-28 mm (small pebbles)

Formations represented: p€ds96, db35, p€p29, p€ml2, Td11, p€b.cgl.18, Dm5, misc. 4

Shapes: spheres 73, rods 20, disks 85, blades 22,
36.5% 10% 42.5% 11%

Average sphericity: .71

Average roundness: .35

Locality: Southern end of graben

Number of count: 100

Length range of pebbles: 28-134 mm (large pebbles)

Formations represented: Dm.ls.40, Dm.ss.15, Td36, Ce8, p€dsl.

Shapes: spheres 10, rods 12, disks 49, blades 29

Average sphericity: .65

Average roundness: .39

Locality: Southern end of graben

Number of count: 200

Length range of pebbles: 8-28 mm (small pebbles)

Formations represented: Td.88, Dm.ls 64, Dm.ss34, Ce14.

Shapes: spheres 32, rods 34, disks 94, blades 40
16% 17% 47% 20%

Average sphericity: .65

Average roundness: .35

[illegible]tios b/a and c/b are determined and from a chart which compares these two ratios graphically, sphericity is read directly (Krumbien, 1942, figure 5).

Average roundness is not necessarily related to average sphericity. In this case the average roundness is .41 and .35 for the count on the large and small gravels respectively. This low degree of roundness strongly suggests that the distance of transport was short (Krumbein, 1942, p. 68). Roundness is determined by visually comparing the broadest profile of the pebble with a chart showing 10 sets of standard images of known roundness (Krumbein 1942, Plate 1).

At the southern end of the graben pebbles in the Gila conglomerate very closely reflect in composition rocks of the nearest outcropping formations. A count made in moderately consolidated conglomerate and gravels showed Martin limestone, Escabrosa limestone, and dacite. The latter probably overlaid the Martin near the trough at the time the Gila conglomerate was deposited, but since then the dacite has been eroded back to about 700 feet south of the place the count was made (Pl. 1 and Table 1).

Percentages of relative abundance of the four shapes represented by the pebbles follow in identical sequence in the counts of both large and small gravels. Disks are most numerous, then blades, rods and spheres. This condition leads to the suggestion that the original shapes of the fragments were little modified by transportation or other factors after the rocks left the outcrop, or if considerable abrasion did occur, it was more or less uniform on all three axes of both groups (Twenhofel, 1939, p. 271).

The average sphericity of .65 in both counts again reflects the similarity of appearance between the large and small pebbles. It is surprising to find limestones and dacite with a lower average sphericity than the quartzites of the mid-graben locality. In reality the pebbles of the southern locality look more spherical, so their statistical average more nearly represents their true shape than is true for the quartzites.

The average roundness of .39 and .35 for the counts of large and small gravels respectively is very similar to the average roundnesses in the quartzite pebbles which is .41 and .35. This might represent a similar amount of transportation for the two localities. The greater roundness for the large pebbles in each locality strongly suggests that under similar conditions of transportation the larger pebbles are rounded somewhat faster than the smaller pebbles.

No general conclusions about the Gila formation can be determined from so limited a study; however, the fact is clear that, at least in the Ruin Basin area, the pebbles that form the conglomerate have a very local source, and that at least moderate faulting has occurred since the Gila conglomerate was deposited.

GILA CONGLOMERATE PEBBLE COUNT
(techniques employed follow Krumbein (1942))

Locality: Mid-graben north of Gerald Wash road near benc
mark 3751
Number of count: 100
Length range of pebbles: 28-134 millimeters (large pebbl
Formations represented: pCds 45, pCp 23, Td 11, pCm 9,
Dm 5, misc. 7
Shapes: spheres 24, rods 27, disc 34, blades 15
Average sphericity: .74
Average roundness: .41

Pebble Number	Rock	Sperioity	Shape	Visual Roundness
1	pCds	.76	sphere	.3
2	Td	.65	disc	.6
3	pCds	.69	sphere	.4
4	Dm-ss	.48	bladed	.3
5	pCds	.69	rod	.4
6	pCp	.58	rod	.4
7	pCds	.79	sphere	.4
8	pCp	.69	rod	.5
9	pCm	.77	sphere	.4
10	Dm-ss	.73	disc	.4
11	pCp	.72	rod	.3
12	pCds	.69	rod	.4
13	pCm	.72	disc	.3
14	pCm	.65	disc	.4
15	pCp	.73	sphere	.4
16	pCp	.60	rod	.4
17	pCp	.48	bladed	.5
18	Td	.67	disc	.5
19	pCds	.79	disc	.5
20	pCp	.72	disc	.6
21	Dm-ss	.59	rod	.4
22	pCds	.70	sphere	.5
23	pCds	.72	sphere	.4
24	Dm-ss	.68	disc	.3
25	Td	.71	sphere	.6
26	pCm-chert	.78	disc	.5
27	pCds	.75	sphere	.4
28	pCds	.51	bladed	.3
29	pCds	.59	bladed	.5
30	pCds	.47	bladed	.3
31	pCm	.69	disc	.3
32	pCds	.76	disc	.5
33	Td	.71	disc	.6
34	pCds	.79	sphere	.4
35	pCp	.68	disc	.2
36	pCds	.54	rod	.2

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
37	pЄds	.62	bladed	.4
38	pЄds	.57	disc	.3
39	pЄds	.68	rod	.4
40	pЄp	.66	bladed	.3
41	pЄds	.78	disc	.4
42	pЄp	.60	rod	.3
43	pЄds	.73	disc	.3
44	pЄp	.60	rod	.3
45	Td	.80	disc	.5
46	pЄp	.84	sphere	.5
47	pЄds	.65	disc	.3
48	Dm-ss	.68	disc	.5
49	pЄds	.69	rod	.5
50	pЄds	.66	rod	.4
51	pЄp	.57	rod	.2
52	pЄp	.57	disc	.4
53	pЄds	.74	rod	.5
54	?	.65	bladed	.6
55	db	.81	sphere	.5
56	pЄds	.58	rod	.2
57	pЄds	.84	sphere	.4
58	pЄds	.74	disc	.4
59	pЄbcgl	.78	sphere	.5
60	pЄds	.69	rod	.4
61	pЄp	.61	bladed	.3
62	pЄbcgl	.56	rod	.5
63	pЄp	.68	rod	.3
64	pЄm	.59	disc	.6
65	Td	.63	bladed	.7
66	pЄp	.51	bladed	.3
67	pЄds	.75	disc	.4
68	pЄp	.74	sphere	.4
69	pЄds	.45	bladed	.2
70	pЄp	.53	disc	.4
71	pЄds	.72	disc	.4
72	pЄm	.63	bladed	.4
73	pЄds	.69	rod	.4
74	pЄm	.59	bladed	.5
75	Td	.64	rod	.4
76	pЄm	.85	sphere	.4
77	pЄds	.69	disc	.4
78	pЄds	.83	disc	.4
79	pЄp	.88	sphere	.6
80	pЄds	.66	rod	.3
81	pЄp	.71	sphere	.3
82	Dm-ls	.58	rod	.5
83	Td	.72	rod	.4
84	pЄds	.72	disc	.4
85	Td	.69	rod	.4

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
86	pЄds	.63	disc	.4
87	pЄds	.68	disc	.5
88	pЄds	.64	disc	.4
89	pЄds	.82	sphere	.5
90	Td	.72	sphere	.5
91	Td	.87	sphere	.6
92	pЄds	.77	sphere	.4
93	pЄp	.79	disc	.5
94	pЄds	.64	rod	.4
95	pЄds	.76	disc	.4
96	pЄp	.86	sphere	.3
97	pЄp	.75	disc	.4
98	pЄds	.73	sphere	.4
99	pЄds	.63	rod	.3
100	pЄds	.65	bladed	.4

Locality: Mid-graben north of Gerald Wash road bench mark 3751
Number of count: 200
Length range of pebbles: 8-28 millimeters (small pebbles)
Formation represented: pЄds 96, db 35, pЄp 29, pЄm 12, Td 11, pЄbcgl 18, Dm 5, misc. 4
Shapes: spheres 73 (36.5%), rods 20 (10%), discs 85 (42.5%), blades 22 (11%)
Average sphericity: .71
Average roundness: .35

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
1	pЄds	.64	rod	.2
2	Dm	.74	disc	.3
3	pЄm	.68	disc	.4
4	pЄds	.77	sphere	.4
5	pЄp	.58	disc	.3
6	db	.74	sphere	.3
7	pЄp	.61	rod	.3
8	pЄm	.57	bladed	.3
9	pЄp	.52	disc	.2
10	Td	.83	sphere	.1
11	pЄds	.60	rod	.3
12	pЄm	.67	rod	.2
13	pЄds	.82	sphere	.3
14	pЄds	.64	disc	.4
15	db	.76	sphere	.3
16	pЄds	.71	rod	.4
17	Dm	.88	sphere	.4
18	pЄds	.64	disc	.3
19	pЄm	.87	sphere	.4
20	pЄds	.70	rod	.2
21	pЄds	.46	bladed	.4
22	pЄbcgl	.63	disc	.2
23	pЄds	.75	sphere	.2
24	pЄds	.68	rod	.3
25	pЄp	.65	disc	.4
26	db	.71	disc	.3
27	pЄds	.66	disc	.3
28	pЄds	.67	disc	.4
29	pЄds	.68	disc	.4
30	pЄm	.70	disc	.3
31	pЄm	.86	disc	.1
32	pЄbcgl	.74	disc	.6
33	pЄds	.63	disc	.2
34	pЄds	.87	disc	.3
35	pЄds	.80	disc	.4
36	pЄds	.69	rod	.4
37	pЄdb	.73	rod	.4
38	pЄds	.77	sphere	.3
39	pЄp	.52	disc	.3

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
40	db	.81	sphere	.3
41	p€ds	.63	disc	.4
42	p€p	.74	disc	.5
43	db	.73	sphere	.2
44	p€ds	.57	bladed	.3
45	p€ds	.80	disc	.4
46	Dm	.76	sphere	.4
47	db	.87	disc	.4
48	p€ds	.86	sphere	.3
49	db	.73	sphere	.1
50	p€p	.55	bladed	.3
51	db	.67	disc	.3
52	p€ds	.82	sphere	.2
53	db	.81	sphere	.1
54	p€ds	.83	sphere	.2
55	p€ds	.71	disc	.5
56	p€ds	.84	sphere	.2
57	p€ds	.75	disc	.4
58	Td	.76	sphere	.2
59	p€p	.76	disc	.3
60	p€ds	.82	disc	.4
61	p€p	.78	disc	.4
62	p€m	.56	rod	.5
63	Td	.73	sphere	.2
64	p€ds	.78	disc	.4
65	p€ds	.67	bladed	.3
66	db	.66	disc	.2
67	p€ds	.88	sphere	.3
68	Dm	.82	sphere	.4
69	p€ds	.66	disc	.4
70	db	.74	rod	.5
71	db	.88	sphere	.1
72	p€ds	.66	disc	.4
73	p€bcgl	.83	sphere	.5
74	p€ds	.67	disc	.4
75	p€m	.84	sphere	.3
76	p€ds	.77	sphere	.3
77	p€bcgl	.84	sphere	.5
78	db	.81	sphere	.3
79	p€ds	.88	sphere	.3
80	p€ds	.87	sphere	.4
81	db	.87	sphere	.4
82	p€p	.83	sphere	.3
83	db	.86	sphere	.5
84	p€ds	.60	disc	.2
85	db	.78	disc	.2
86	Td	.86	sphere	.4
87	Td	.80	disc	.2
88	p€ds	.87	disc	.2
89	db	.75	sphere	.3

Pebble Number	Rock	Sphericity	Shapes	Visual Roundness
90	pЄds	.56	disc	.4
91	pЄ Scanlan	.84	sphere	.4
92	db	.71	sphere	.2
93	pЄds	.85	sphere	.2
94	db	.77	sphere	.2
95	pЄp	.76	sphere	.4
96	pЄds	.87	disc	.2
97	Td	.83	sphere	.1
98	db	.75	sphere	.2
99	pЄds	.64	disc	.4
100	db	.65	disc	.5
101	pЄbcgl	.74	sphere	.7
102	pЄds	.73	sphere	.3
103	pЄds	.64	disc	.4
104	Dm-ls	.74	disc	.4
105	pЄds	.61	disc	.4
106	pЄp	.70	rod	.4
107	db	.77	sphere	.2
108	pЄds	.70	disc	.5
109	pЄds	.80	sphere	.4
110	db	.78	sphere	.3
111	pЄds	.43	bladed	.3
112	pЄds	.66	disc	.4
113	pЄds	.50	bladed	.3
114	db	.85	sphere	.5
115	pЄp	.73	disc	.5
116	pЄp	.73	disc	.3
117	pЄds	.58	bladed	.4
118	pЄds	.74	sphere	.4
119	pЄds	.88	sphere	.4
120	pЄm	.72	disc	.4
121	pЄds	.82	disc	.4
122	Td	.73	rod	.5
123	pЄds	.77	disc	.3
124	pЄds	.64	rod	.4
125	pЄp	.65	disc	.3
126	pЄp	.82	sphere	.5
127	pЄds	.72	disc	.5
128	db	.79	disc	.4
129	pЄds	.72	sphere	.4
130	pЄds	.52	disc	.3
131	pЄds	.47	bladed	.3
132	pЄds	.65	bladed	.4
133	Td	.72	disc	.6
134	db	.64	rod	.1
135	pЄds	.66	disc	.3
136	pЄds	.41	bladed	.5
137	pЄds	.52	bladed	.3
138	pЄds	.70	disc	.4

Pebble Number	Rock	Sphericity	Shape	Vis_ual Roudness
139	pЄbcgl	.80	disc	.2
140	pЄds	.55	disc	.4
141	pЄbcgl	.80	sphere	.3
142	pЄds	.52	bladed	.4
143	pЄds	.77	disc	.4
144	db	.77	disc	.3
145	pЄp	.43	disc	.4
146	pЄp	.56	bladed	.4
147	pЄds	.56	bladed	.3
148	pЄds	.80	sphere	.3
149	db	.89	sphere	.4
150	pЄds	.53	disc	.3
151	pЄbcgl	.63	bladed	.4
152	pЄds	.66	disc	.3
153	pЄds	.74	disc	.4
154	Ce-ls	.82	sphere	.4
155	pЄds	.79	disc	.3
156	db	.75	sphere	.3
157	pЄp	.54	disc	.3
158	pЄds	.82	sphe	.4
159	pЄm	.63	rod	.2
160	pЄds	.63	disc	.2
161	db	.62	rod	.5
162	pЄds	.57	disc	.4
163	pЄm	.64	disc	.3
164	pЄds	.52	bladed	.2
165	db	.78	disc	.4
166	pЄds	.77	sphere	.5
167	pЄbcgl	.90	sphere	.6
168	pЄds	.87	sphere	.4
169	pЄp	.75	disc	.6
170	pЄds	.79	disc	.4
171	pЄp	.49	bladed	.3
172	db	.75	sphere	.4
173	pЄds	.72	sphere	.4
174	pЄm	.56	disc	.4
175	pЄds	.72	disc	.4
176	pЄp	.54	disc	.3
177	pЄds	.72	sphere	.5
178	pЄp	.59	bladed	.4
179	pЄds	.78	sphere	.4
180	pЄds	.74	rod	.3
181	pЄp	.62	disc	.5
182	pЄds	.70	disc	.4
183	pЄp	.50	disc	.4
184	pЄds	.91	sphere	.3
185	db	.66	bladed	.4
186	pЄds	.67	disc	.4
[illegible]	pЄp	.72	disc	.4

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
188	pep	.64	disc	.5
189	pep	.77	sphere	.4
190	Td	.83	sphere	.6
191	peds	.70	rod	.4
192	peds	.62	disc	.4
193	peds	.76	sphere	.5
194	Td	.74	sphere	.5
195	peds	.78	sphere	.3
196	db	.69	disc	.4
197	Td	.76	sphere	.6
198	peds	.53	bladed	.2
199	Dm-ss	.71	rod	.3
200	pep	.52	bladed	.4

Locality: Southern end of graben 100 feet east of wash
Number of count: 100
Lengts range of pebbles: 28-134 millimeters (large pebbles)
Formation represented: Dm-ls 40, Dm-ss 15, Td 36, Ce 8, pGds 1
Shapes: spheres 10, rods 12, discs 49, blades 29
Average sphericity: .65
Average roundness: .39

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
1	Td	.65	disc	.5
2	Td	.50	bladed	.6
3	Dm-ls	.62	disc	.4
4	Dm-ls	.53	bladed	.2
5	Td	.72	disc	.4
6	Ce-ls	.65	bladed	.4
7	Dm-ss	.72	disc	.4
8	Td	.59	bladed	.4
9	Dm-ls	.58	bladed	.5
10	Td	.54	bladed	.3
11	Td	.57	bladed	.3
12	Dm-ss	.67	disc	.1
13	Ce-ls	.67	rod	.3
14	Td	.60	bladed	.4
15	Td	.31	disc	.6
16	Dm-ls	.42	bladed	.2
17	Dm-ls	.60	bladed	.3
18	Td	.57	bladed	.4
19	Td	.65	disc	.4
20	Dm-ls	.64	bladed	.4
21	Dm-ls	.73	disc	.5
22	Dm-ss	.66	rod	.4
23	Td	.73	disc	.3
24	Td	.53	disc	.4
25	Dm-ss	.58	disc	.4
26	Td	.57	bladed	.4
27	pGds	.75	disc	.2
28	Dm-ls	.65	bladed	.4
29	Dm-ls	.58	rod	.4
30	Td	.55	bladed	.4
31	Dm-ls	.73	disc	.2
32	Dm-ss	.67	disc	.4
33	Td	.79	disc	.4
34	Dm-ls	.66	disc	.5
35	Dm-ls	.66	disc	.5
36	Td	.77	sphere	.4
37	Dm-ls	.51	disc	.3
38	Dm-ss	.83	sphere	.4
39	Dm-ls	.79	disc	.5
40	Td	.86	disc	.5
41	Dm-ls	.61	rod	.1
				.3

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
42	Dm-ls	.76	disc	.4
43	Td	.77	disc	.5
44	Dm-ls	.61	bladed	.2
45	Dm-ls	.75	sphere	.3
46	Td	.62	rod	.5
47	Td	.58	bladed	.5
48	Td	.52	bladed	.3
49	Dm-ls	.64	disc	.5
50	Dm-ss	.63	disc	.4
51	Ce-ls	.74	disc	.5
52	Dm-ls	.68	disc	.5
53	Td	.74	disc	.5
54	Dm-ls	.80	disc	.4
55	Dm-ss	.74	sphere	.3
56	Td	.66	rod	.4
57	Dm-ls	.68	disc	.4
58	Dm-ss	.57	bladed	.4
59	Dm-ls	.74	sphere	.4
60	Td	.77	disc	.6
61	Dm-ls	.66	disc	.4
62	Dm-ls	.65	rod	.2
63	Ce-ls	.46	bladed	.3
64	Td	.74	disc	.3
65	Dm-ls	.43	bladed	.1
66	Dm-ss	.88	sphere	.7
67	Dm-ls	.60	disc	.5
68	Dm-ss	.46	bladed	.3
69	Dm-ls	.69	rod	.4
70	Td	.56	bladed	.3
71	Td	.77	disc	.5
72	Dm-ls	.59	bladed	.4
73	Td	.61	rod	.2
74	Dm-ls	.66	disc	.7
75	Td	.81	sphere	.5
76	Ce-chert	.86	sphere	.4
77	Ce-ls	.79	sphere	.3
78	Td	.73	disc	.5
79	Ce-ls	.82	disc	.4
80	Dm-ls	.75	sphere	.4
81	Dm-ls	.74	disc	.3
82	Td	.69	disc	.2
83	Dm-ls	.57	rod	.3
84	Dm-ls	.73	disc	.5
85	Td	.72	disc	.4
86	Ce-ls	.63	disc	.4
87	Dm-ls	.56	bladed	.3
88	Td	.76	disc	.2
89	Dm-ss	.66	bladed	.5
90	Dm-ls	.56	disc	.4

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
91	Dm-ls	.59	bladed	.3
92	Dm-ls	.73	disc	.5
93	Dm-ss	.65	disc	.4
94	Td	.65	rod	.3
95	Td	.45	bladed	.2
96	Dm-ls	.69	rod	.4
97	Dm-ls	.68	disc	.4
98	Dm-ss	.55	disc	.5
99	Dm-ls	.69	disc	.5
100	Td	.62	bladed	.4

Locality: Southern end of graben 100 feet east of wash
Number of count: 200
Length range of pebbles: 8-28 millimeters (small pebbles)
Formation represented: Td 88, Dm-ls 64, Dm-ss 34, Ce 14
Shapes: spheres 32 (16%), rods 34 (17%), discs 94 (47%), blades 40 (20%)
Average sphericity: .65
Average roundness: .35

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
1	Dm-ls	.62	disc	.2
2	Dm-ls	.77	sphere	.4
3	Dm-ss	.62	disc	.3
4	Dm-ls	.61	rod	.3
5	Dm-ls	.64	rod	.3
6	Dm-ss	.50	bladed	.2
7	Dm-ss	.72	disc	.3
8	Dm-ls	.67	rod	.3
9	Td	.62	disc	.1
10	Dm-ls	.74	sphere	.5
11	Td	.74	disc	.2
12	Dm-ls	.64	disc	.4
13	Dm-ss	.53	disc	.3
14	Td	.59	bladed	.2
15	Dm-ss	.94	sphere	.6
16	Td	.82	disc	.2
17	Dm-ls	.71	disc	.3
18	Td	.61	disc	.1
19	Dm-ss	.66	disc	.3
20	Dm-ls	.72	sphere	.4
21	Td	.52	disc	.1
22	Ce-ls	.68	disc	.5
23	Ce-ls	.57	bladed	.3
24	Td	.80	disc	.1
25	Dm-ls	.50	bladed	.3
26	Td	.65	disc	.2
27	Td	.71	disc	.2
28	Td	.89	sphere	.1
29	Ce-ls	.61	disc	.5
30	Td	.75	disc	.2
31	Dm-ls	.63	rod	.3
32	Dm-ss	.72	sphere	.2
33	Dm-ss	.68	disc	.2
34	Dm-ss	.74	sphere	.3
35	Td	.74	sphere	.2
36	Td	.77	sphere	.2
37	Dm-ls	.45	bladed	.5
38	Ce-ls	.57	bladed	.4
39	Dm-ls	.76	disc	.5
40	Dm-ls	.54	bladed	.2

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
41	Td	.64	disc	.2
42	Dm-ls	.55	disc	.3
43	Td	.62	disc	.3
44	Dm-ss	.57	rod	.3
45	Dm-ls	.68	sphere	.3
46	Td	.90	sphere	.1
47	Dm-ls	.86	sphere	.4
48	Dm-ss	.80	disc	.4
49	Td	.60	bladed	.2
50	Dm-ss	.73	sphered	.3
51	Td	.88	sphere	.2
52	Ce-ls	.56	disc	.4
53	Dm-ls	.66	disc	.4
54	Dm-ls	.50	rod	.3
55	Td	.82	disc	.2
56	Dm-ss	.66	disc	.5
57	Dm-ss	.44	bladed	.3
58	Dm-ls	.73	disc	.4
59	Td	.74	disc	.2
60	Dm-ls	.57	bladed	.4
61	Ce-ls	.75	sphere	.4
62	Ce-ls	.52	bladed	.3
63	Td	.58	disc	.2
64	Td	.54	bladed	.2
65	Td	.63	bladed	.2
66	Dm-ls	.65	rod	.4
67	Td	.57	disc	.1
68	Td	.68	disc	.2
69	Td	.58	rod	.1
70	Td	.56	rod	.1
71	Td	.62	bladed	.2
72	Dm-ls	.79	disc	.4
73	Dm-ss	.79	disc	.4
74	Dm-ls	.66	disc	.4
75	Dm-ls	.63	disc	.4
76	Td	.66	disc	.2
77	Dm-ss	.54	bladed	.3
78	Td	.62	bladed	.1
79	Td	.76	sphere	.2
80	Td	.64	disc	.3
81	Dm-ls	.69	disc	.4
82	Dm-ls	.69	disc	.5
83	Dm-ls	.74	disc	.4
84	Td	.60	rod	.1
85	Td	.73	disc	.2
86	Dm-ls	.53	disc	.5
87	Dm-ls	.60	disc	.4
88	Td	.55	bladed	.2
89	Td	.63	disc	.1

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
90	Td	.51	disc	.1
91	Td	.63	bladed	.2
92	Dm-ls	.71	disc	.5
93	Td	.68	rod	.3
94	Dm-ls	.48	bladed	.4
95	Td	.76	sphere	[illegible]
96	Td	.74	disc	.2
97	Dm-ls	.59	disc	.4
98	Td	.51	rod	.1
99	Td	.57	disc	.2
100	Td	.70	disc	.3
101	Td	.50	disc	.4
102	Dm-ss	.67	rod	[illegible]
103	Td	.52	bladed	.5
104	Dm-ls	.71	disc	.4
105	Td	.63	rod	.3
106	Ce-ls	.51	disc	.6
107	Dm-ls	.83	sphere	.5
108	Td	.67	disc	.4
109	Dm-ls	.80	disc	.3
110	Dm-ss	.50	bladed	.4
111	Td	.56	disc	.4
112	Ce-ls	.49	disc	.4
113	Td	.57	disc	.6
114	Dm-ls	.50	bladed	.4
115	Dm-ls	.52	disc	.4
116	Dm-ss	.56	bladed	.3
117	Dm-ls	.56	bladed	.5
118	Td	.63	disc	.3
119	Td	.69	disc	.5
120	Dm-ls	.52	bladed	.5
121	Dm-ss	.65	disc	.4
122	Dm-ss	.79	sphere	.4
123	Td	.67	sphere	.4
124	Td	.58	sphere	.5
125	Dm-ls	.44	bladed	.3
126	Dm-ss	.86	sphere	.4
127	Td	.57	disc	.4
128	Td	.46	bladed	.5
129	Dm-ls	.78	sphere	.6
130	Dm-ss	.60	bladed	.5
131	Td	.62	disc	.5
132	Dm-ls	.72	disc	.4
133	Dm-ls	.67	disc	.6
134	Dm-ss	.69	disc	.5
135	Td	.56	bladed	.4
136	Td	.56	bladed	.6
137	Td	.79	disc	.4
138	Td	.70	rod	.3

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
139	Td	.65	disc	.6
140	Dm-ss	.86	sphere	.6
141	Dm-ls	.57	disc	.5
142	Dm-ss	.77	disc	.3
143	Dm-ss	.75	disc	.5
144	Td	.69	disc	.3
145	Td	.64	bladed	.5
146	Dm-ls	.65	disc	.4
147	Dm-ls	.76	disc	.5
148	Dm-ls	.67	rod	.4
149	Dm-ls	.58	bladed	.6
150	Dm-ss	.60	bladed	.3
151	Ce-chert	.68	rod	.3
152	Dm-ls	.62	disc	.5
153	Td	.73	sphere	.2
154	Dm-ls	.43	bladed	.4
155	Dm-ls	.58	bladed	.5
156	Td	.53	disc	.4
157	Dm-ls	.68	disc	.6
158	Dm-ls	.56	disc	.5
159	Td	.67	sphere	.2
160	Td	.48	disc	.4
161	Dm-ss	.63	disc	.3
162	Dm-ls	.77	disc	.4
163	Ce-ls	.74	disc	.4
164	Ce-ls	.72	rod	.5
165	Dm-ls	.65	rod	.4
166	Dm-ss	.61	rod	.3
167	Td	.72	disc	.3
168	Td	.61	bladed	.6
169	Td	.71	sphere	.6
170	Td	.48	rod	.3
171	Dm-ls	.61	disc	.4
172	Td	.58	rod	.3
173	Ce-ls	.72	rod	.4
174	Ce-ls	.78	sphere	.5
175	Td	.67	rod	.5
176	Td	.60	bladed	.3
177	Dm-ss	.67	disc	.5
178	Td	.56	rod	.4
179	Dm-ss	.79	disc	.5
180	Td	.57	bladed	.3
181	Dm-ss	.67	rod	.5
182	Dm-ss	.68	disc	.4
183	Td	.60	rod	.5
184	Td	.78	sphere	.4
185	Td	.66	disc	.3
186	Td	.39	bladed	.4
187	Dm-ls	.41	disc	.5

Pebble Number	Rock	Sphericity	Shape	Visual Roundness
188	Td	.62	rod	.3
189	Td	.59	rod	.2
190	Td	.57	disc	.4
191	Td	.58	rod	.3
192	Td	.81	sphere	.4
193	Dm-ls	.82	sphere	.4
194	Dm-ls	.77	sphere	.3
195	Td	.68	disc	.3
196	Td	.66	disc	.5
197	Dm-ls	.40	bladed	.4
198	Dm-ls	.75	disc	.5
199	Dm-ls	.63	disc	.6
200	Dm-ss	.57	disc	.3

Alluvium

The Recent Alluvial accumulation in the Ruin Basin area is relatively thin. It occurs throughout the hills and partly fills most valleys. The alluvium is indicated on the geologic map (Pl. 1) only where it completely masks the underlying rocks.

The Recent alluvium is light brown, thin-to thick-bedded and unconsolidated. The gravels are pebble to cobble size and are composed of rocks from all older formations. The matrix is mainly fine sand and silt (Pl. 21).

The two main areas of alluvium, as mapped, are in strips along Gerald Wash. Here the deposit attains its greatest thickness of about 50 feet. Two small bodies of alluvium occur along the margin of the Ruin Basin area in the southeastern quarter. Here the alluvium on the slopes is locally thicker than in other places.

The Recent alluvium is a deposit of the present erosion cycle; the accumulated debris is still being added to from outcrops now exposed.

Measured sections of sedimentary rocks

Sections were measured at several localities as indicated at the top of each section. The code color descriptions are from the "Rock Color Chart" (1948) distributed by the National Research Council.

Measured section of Ruin granite, Scanlan conglomerate, and base of Pioneer shale.

At outcrop on east-central side of Ruin Basin 1000 feet north of Bench Mark 3539 on Gerald Wash road.

PIONEER SHALE

3. Quartzite: pale red purple (5RP6/2), fine-grained, medium bedded average 8 inches thick; dark gray (N3) blotches, elliptical shaped, average 2 millimeters in diameter, compose 35 percent of rock; weathers pale red purple (5RP6/2) plus limonite stain, moderately resistant, surface smooth; thickness.. 7' +

2. Quartzite: dusky blue (5PB3/2), very fine-grained, moderately thick-bedded average 2 feet; some beds contain circular white spots averaging 3 millimeters in diameter; weathers dusky blue (5PB3/2), resistant forms cliff, surface smooth, some beds badly fractured; thickness........ 25'

1. Arkose: moderate reddish orange (10R6/6), very coarse-grained, quartzitic, thick-bedded; few pebbles 5 millimeters in diameter, composed of pink feldspar (30 percent of rock) and white quartz (40 percent of rock); weathers moderate reddish orange (10R6/6), resistant forms cliff, surface smooth; thickness .... 1.5'

SCANLAN CONGLOMERATE

1. Conglomerate: moderate reddish orange (10R6/6), arkosic and quartzitic, thick-bedded; weathers to resistant cliff; thickness .... 3.5'
Matrix: moderate reddish orange (10R6/6), fine-to coarse-grained, arkosic and quartzitic; cement black silica, firm.
Gravel: 1-10 centimeters, angular to well rounded; composed of light gray quartz (40 percent of rock), pink feldspar, quartzite, and schist.

[illegible] GRANITE

2. **Granite:** moderate reddish orange (10R6/6) composed of **pink feldspar,** white quartz, and biotite; very much **weathered,** forms slope; thickness .... 0.5'

1. **Granite:** moderate reddish orange (10R6/6), por**phyritic** and coarse-grained, pink feldspar pheno**crysts** rounded; composed of white anhedral quartz, **subhedral** pink feldspar, and subhedral biotite; thickness .... 10' +

Measured section of Ruin granite, Scanlan conglomerate, and base of Pioneer shale.

At locality one quarter mile north of north-central margin of Ruin Basin area. (Beds horizontal).

PIONEER SHALE

2. Quartzite: dusky blue (5PB3/2), fine-grained, argillaceous, thin-bedded; small circular white spots abundant; few thin white beds; weathers dusky blue (5PB3/2) moderately resistant, forms slope; thickness .... 40'

1. Arkose: moderate reddish orange (10R6/6), very coarse-grained, thick-bedded; maximum pebble size 12 millimeters, grains mainly pink feldspar and white quartz; weathers moderate reddish orange (10R6/6), resistant forms cliff; thickness .... 10'

SCANLAN CONGLOMERATE

1. Conglomerate: moderate reddish orange (10R6/6), thick-bedded; weathers to cliff; thickness .... 2'
Matrix: moderate reddish orange (10R6/6), arkosic and quartzitic, fine-to coarse-grained; cement silica, firm, lower 5 inches black.
Gravel: pink feldspar crystals, rounded, average 20 millimeters in length; white, gray and black quartz, and quartzite 5-50 millimeters in length, angular to well-rounded.

RUIN GRANITE

1. Granite: moderate reddish orange (10R6/6), porphyritic and coarse-grained, slightly rounded pink feldspar phenocrysts compose 35 percent of rock, 10-35 millimeters in length; anhedral quartz, white, 2-12 millimeters in diameter; subhedral biotite crystals 2 millimeters in diameter; weathers grayish pink, resistant forms cliff; thickness .... 75' +

Measured section of Ruin granite, Scanlan conglomerate and Pioneer shale.

At peak one-half mile south of southwest corner of Ruin Basin area (average dip 28°).

BARNES CONGLOMERATE
UNCONFORMITY
PIONEER SHALE

7. Shale: pale red purple (5RP6/2), fine-grained, quartzitic, very thin-bedded (0.5 inch average); cement firm; white spot inclusions 1-7 millimeters in diameter; weathers to slope; a few beds in groups of 1-6 inches thick are light brownish gray (5YR6/1), medium gray (N5), and light olive gray (5YR6/1); thickness .... 60'

6. Quartzite: pale red (5R6/2) to light olive gray (5Y5/2) medium-grained, arkosic, thin-bedded; cement silica, firm; weathers grayish red (5R5/2) and produces limonitic and hematitic stain along fractures, resistant, but weathers to slope due to fractures; lower two feet contain white spots; thickness .... 3'

5. Quartzite: grayish olive green (5GY3/2), medium-grained, arkosic, thin-bedded (6 inches); cement silica, firm; weathers olive gray (5Y3/2), smooth, resistant but weathers to slope because of fracturing; weathering along fractures produced hematitic and limonitic stain; thickness .... 3'

4. Quartzite: grayish pink (5R8/2), medium-grained, arkosic, moderately thick-bedded (1.5 feet); cement silica, firm; weathers moderate reddish orange (10R8/2), smooth, resistant but weathers to slope because of extreme fracturing; thickness .... 3'

3. Arkose: similar to upper 17 feet of bed 2 except that a few thin grayish orange pink (10R8/2) beds are present; thickness .... 4'

2. Arkose: pale red purple (5RP6/2), very coarse-grained in general but with some medium-to fine-grained beds, sandy to quartzitic, thick-bedded (2 feet), cross-bedded; weathers grayish red purple (5RP4/2), smooth, resistant, forms cliff; upper 17 feet fine-grained and thinner bedded; thickness .... 25'

1. Shale: dusky red (5R3/4), fine-grained, quartzitic, arkosic, thin-bedded (6 millimeters average); cement moderately firm; weathers dusky red (5R3/4) smooth, forms slope; upper 20 feet contains some lighter red beds with white oval spots ranging from 1-5 millimeters in diameter; thickness .... 50'

SCANLAN CONGLOMERATE

1. Conglomerate: moderate red (5R5/4), moderately thin-bedded (1.5 feet); weathers to resistant cliff; thickness .... 1.5'
Matrix: dusky red (5R3/4), medium-grained (less than 1 millimeter in diameter), composes 25 percent of rock; cement silica, firm.
Gravel: 2-90 millimeters in diameter; angular to well-rounded; composed of white quartz, pink and white quartzite, schist, and feldspar.

UNCONFORMITY
RUIN GRANITE

2. Decomposed granite; pale reddish brown (10R5/4); some clay and silt present due to decomposition of minerals, mineral constituents same as in granite below; incompetent, can be picked apart by fingers; thickness ...... 0.5'

1. Granite: moderate reddish orange (10R6/6), coarse-grained matrix 1-10 millimeters in diameter composes 90 percent of rock, feldspar phenocrysts 20-50 millimeters long; mineral constituents are 60 percent orthoclase, 20 percent quartz, 10 percent plagioclase, and 10 percent biotite; not resistant, crumbles upon weathering; thickness .... 30'

Measured section of Barnes conglomerate and Dripping Spring quartzite

At locality north of Gerald Wash road 500 feet west of west margin of Ruin Basin area (average dip 23°).

TOP OF SECTION ABSENT ON THIS HILL
DRIPPING SPRING QUARTZITE

6. Quartzite: light gray (N6), very fine-grained, moderately thick-bedded (average 4 feet), limonite laminations along bedding planes; tiny black inclusions; weathers medium light gray (N7), moderately resistant; forms slope; thickness .... 100'

5. Quartzite: yellowish gray (5Y8/1) alternating with hematite red layers; red layers 1-50 millimeters thick; yellowish gray layers 2-200 millimeters thick; average thickness 25 millimeters; weathers hematite red, forms slope; thickness .... 30'

4. Covered (section possibly faulted here) .... 170'

3. Quartzite: white (N9), medium-grained, thin-bedded (1/2-6 inches); weathers grayish orange (10YR7/4), surface blocky, resistant forms cliffs; thickness ..... 20'

2. Quartzite: grayish orange (10YR7/4), fine-grained, arkosic, medium-bedded (0.5-2 feet); weathers grayish orange (10YR7/4), resistant forms cliff with blocky talus; thickness .... 80'

1. Sandstone: grayish orange (10YR7/4) coarse-grained, arkosic and quartzitic, thick-bedded (4-5 feet), laminae with limonitic stain; few thin-bedded friable, pale greenish yellow (10Y8/2) sandstone beds alternating with usual type; weathers grayish orange (10YR7/4) forms cliff; thickness .... 145'

BARNES CONGLOMERATE

1. Conglomerate: light brown (5YR6/4), thick-bedded (2-12 feet), resistant forms cliff but locally forms slope; thickness .... 30'
Matrix: light brown (5YR6/4), arkosic sandstone and quartzite; cement firm silica, but locally is weak, Gravel: 10-200 millimeters in diameter; well-rounded, composed of white, red-brown, brown, gray and pink quartzite, and white vein quartz and jasper.

Measured section of Dripping Spring quartzite and Mescal limestone.

At south side of Gerald Wash road, 500 feet west of western margin of Ruin Basin area (average dip 30°)

TOP OF MESCAL LIMESTONE NOT PRESENT
MESCAL LIMESTONE

23. Limestone: medium light gray (N6) medium-grained, crystalline, thin-bedded (1/4-8 inches), each bed has distinct fine laminations 1-2 millimeters thick; serpentinized; weathers very light gray (N8), surface smooth and obscures fine laminations; serpentinized layers weather out in relief; thickness .... 27'

22. Limestone: pale yellowish brown (10YR6/2), fine-grained, crystalline, brecciated; weathers very pale orange (10YR8/2), surface rough, resistant forms cliff; thickness .... 2'

21. Limestone: banded very light gray (N8) and pale brown (5Y R5/2), fine-grained, bands 1/2-8 inches thick, brown bands show some crystalline texture, white bands more resistant weather out in relief to form rough surface; weathers very light gray (N8) and medium light gray (N6), resistant forms cliff, thickness .... 2'

20. Limestone: moderate greenish yellow (10Y7/4), fine-grained, sugary, thin-bedded (4-12 inches), locally abundant vugs 1-10 millimeters in diameter; serpentinized; weathers grayish orange pink (10R8/2) plus some limonite stain; also many black blotches 1-2 millimeters in diameter, surface rough with small cavities, resistant cliff former; thickness .... 8"

19. Limestone : similar to 23; thickness .... 4'

18. Diabase sill; thickness .... 40'

17. Covered .... 3'

16. Limestone: similar to 21; thickness .... 6"

15. Limestone: moderate brown (5YR4/4) to grayish yellow (5Y8/4), fine-grained; bedding not well developed appears to be composed of nodular masses welded together, badly fractured and sealed by calcite; weathered surface grayish orange pink (10R8/2) to pale yellowish orange (10Y8/6) to medium light gray (N6) smooth to rough, forms cliff; thickness .... 1'

14. Limestone: medium dark gray (N4), medium-grained, sugary, crystalline; weathers medium light gray (N6), laminations produced, rough with tiny pits, moderately resistant, forms cliff; thickness .... 1.5'

13. Limestone: same as 20; thickness .... 2'

12. Covered alternating with thin limestone .... 13'
Limestone: light gray (N7) to medium gray (N6), medium-grained, crystalline, moderately thin-bedded (1/4-8 inches), flat bedded to somewhat gnarly or lenticular-bedded; weathers yellowish gray (5Y7/2) plus some limonite stain in little blotches, thicker beds cliff formers, thin beds form slope.

11. Limestone: very light gray (N8) and moderate reddish orange (10R6/6), fine-grained, silicified, thin-bedded (2-60 millimeters) lower 8 inches with many vugs; upper 4 inches weather to slope, lower 8 inches form cliff; thickness .... 1'

10. Limestone: dusky yellow green (5GY5/2) fine-grained thin-bedded (5-20 millimeters) fine whitish laminations; weathers grayish yellow green (5GY7/2), smooth, non-resistant, forms slope; thickness .... 4"

9. Limestone: medium gray (N5) fine-grained, crystalline, thin-bedded (8-30 millimeters) bedding gnarly to lenticular; weathers white (N9), rough scaly surface, non-resistant, forms slope; thickness .... 2.5'

8. Limestone: medium gray (N5), coarsely crystalline, some silicified bands, thin-bedded; upper 6 inches contain dark gray (N4) chert lenses; weathers very pale orange (10YR8/2) to dark yellowish orange (10YR6/6), moderately rough, forms cliff; thickness........................ 2'

7. Limestone: same as 9; thickness .... 1.5'

6. Covered: very light gray; thickness .... 4'

5. Limestone: light gray (N7), very fine-grained, dense, dolomitic; thin-bedded (1/4-5 inches), weathers very light gray to moderate reddish orange (10R6/6), surface pitted, resistant cliff former; thickness .... 8'

4. Covered alternating with thin-bedded limestones thickness .... 60'
Limestone: same as 12

3. Silica: dark gray (N3), aphanitic; light gray (N7)

amygdules 1-5 millimeters in diameter very abundant; weathers light gray (N6), rough with pits, resistant, but forms slope due to fracturing; thickness .... 1"

2. Limestone: medium gray (N5), silicified to chert, thin-bedded; chert lenses 5 millimeters thick; weathers light gray (N7), rough, resistant but forms slope due to extreme fracturing; thickness .... 1.5'

1. Silica: same as 3; thickness .... 1"

DRIPPING SPRING QUARTZITE

12. Sandstone: dusky yellow green (5GY5/2) with dark yellow orange (10YR6/6) specks and blotches, coarse-grained, limey and limonitic; thin-bedded (1-2 inches); weathers light brown (5YR6/4) to moderate greenish yellow (10YR7/4), rough with abundant tiny pits, local spots moderate red (5R4/6), forms slope; thickness .... 4'

11. Covered .... 2'

10. Quartzite: pale brown (5YR5/2) to brownish gray (5YR4/1), fine-grained, bed 1 foot thick, vugs 3-15 millimeters in diameter on weathered surface with limonite; weathers light brown (5YR6/4) to moderate brown (5YR4/4), moderately resistant, weathers to slope for fractured; thickness .... 1'

9. Quartzite: medium light gray (N6) plus some limonite stain; very coarse-grained with sparse fragments as large as 10 millimeters in length, extremely vuggy giving appearance of being rotten, thin-bedded (2-8 inches); weathers mostly to moderate yellowish brown (10YR4/4) but some moderate red (5R4/6), rough, moderately resistant, forms slope; thickness .... 4'

8. Quartzite: dark yellowish orange (10YR6/6); yellowish color due to limonite in rock, with limonite removed rock would have salt and pepper texture of dark gray and white grains, medium-to coarse-grained, flat and cross-bedded, thick-bedded (1-1/2 feet), limonite inclusions compose 30 percent of rock; weathers dark yellowish brown (10YR4/2), moderately resistant, forms slope, tiny pits on surface where limonite has been removed; thickness .... 1.5'

7. Sandstone: grayish orange (10YR7/4), this color produced by salt and pepper arrangement of limonitic specks in a gray matrix, yellowish orange to brown stains along bedding planes; medium-grained, quartzitic, thin-bedded (2-8 inches), flat-and cross-bedded; weathers yellowish brown (10YR5/4), moderately resistant, forms slope, surface smooth; thickness .... 4'

6. Sandstone: moderate red (5R5/4) to very light gray (N8) with limonitic stain dark yellowish orange (10YR6/6) along bedding planes; mostly medium-grained, some fine-grained, quartzitic, thin-bedded (2-6 inches); flat- and cross-bedded; weathers moderate red (5R4/6), grayish red (5R4/2) and medium light gray (N6), moderately resistant, form slope, surface smooth; thickness .... 64'

5. Quartzite: medium light gray (N6) with dusky red (5R3/4) to dark yellowish orange (10YR6/6) on bedding planes; medium-grained; laminations thin (1-80 millimeters); thick-bedded (1.5-5 feet); irregular with cross-bedding and ripple marks (distance from crest to crest 8 inches); weathers very light gray (N8); resistant forms cliff, surface smooth except along bedding planes; thickness .... 19'

4. Sandstone: grayish orange (10YR7/4) with black and limonitic blotches 1-6 millimeters in diameter, medium bedded (average 2 feet) some cross-bedding; cement moderately firm; weathers grayish orange (10YR7/4), resistant forms cliff, smooth surface; thickness .... 7'

3. Quartzite: light gray (N7) to yellowish gray (5Y7/2) fine-grained, thick-bedded (5 feet) with laminations 2-120 millimeters); beds wavy and cross-bedded; nodular inclusions weather to limonite; weathers yellowish gray (5Y7/2) to light olive gray (5Y5/2) to grayish orange pink (5YR7/2), resistant forms cliff, surface smooth; thickness .... 5'

2. Quartzite: moderate reddish orange (10R6/6) specks scattered through a yellowish gray (5Y7/2) matrix; fine-grained; very thin-bedded (0.25-1 inch) weathers moderate red (5R4/6) and pale greenish yellow (10Y8/2) resistant forms cliff, surface smooth; thickness .... 3'

1. Covered .... 50'

Measured section of Martin limestone.

At small Devonian outcrop in the southwest quarter of the Ruin Basin area, 300 feet south of Gerald Wash road, (average dip 19° and area considerably broken by small faults).

SECTION FAULTED
MARTIN LIMESTONE

Upper part

1. Limestone: mainly light gray (N7) but some yellowish orange (10YR6/2), fine-grained- to coarse-grained, thin-bedded (2-8 inches); weathers medium gray (N5), surface moderately rough, forms cliff; upper 2 feet contain abundant colonial corals <u>Pachyphyllum</u> and <u>Hexagonaria</u>;;lower 12 feet contain abundant brachiopods and crinoid stems; thickness .... 14'

Lower Part

14. Quartzite: light brown (5YR6/4), fine-to coarse-grained, cross-bedded and gnarly-bedded, thin-bedded (average 8 inches); cement silica, firm; weathers light brown (5YR6/4), rough surface, resistant forms cliff; coarse-grained beds contain frosted quartz grains; thickness ..... 12'

13. Quartzite: light brown (5YR6/4), fine-grained to coarse-grained, thin-bedded; cement silica, firm, some frosted quartz grains; resistant weathers to cliff; thickness...... 3'

12. Limestone: light olive gray (5Y6/1) and light red (5R6/6), fine-to coarse-grained, arenaceous, moderately thin-bedded (6-8 inches); frosted quartz grains 1-4 millimeters in diameter concentrated along bedding planes; weathers light gray (N7) to light red (5R6/6), surface rough, forms cliff; thickness .... 4.5'

11. Conglomerate: very light gray (N8), moderately thick-bedded (2 feet); weathers very light gray (N8), surface rough, forms cliff; thickness .... 5'
Matrix: very light gray (N8) very fine quartz; cement limestone and silica, firm.
Gravel: 1-6 millimeters frosted quartz pebbles compose 60 percent of the rock, 20-80 millimeter limestone and sandstone nodules compose 25 percent of the rock.

10. Limestone: light red (5R6/6), fine-grained, upper 3 feet medium-bedded (3-8) inches, lower part massive; much fractured and recemented by calcite; weathers light red (5R6/6), blocky, forms cliff; thickness .... 12'

9. Covered .... 8'

8. Limestone: pale red (5R6/2), fine-grained, thick-bedded; contains bands of fine-grained quartz and frosted quartz grains 1-10 millimeters in diameter; weathers grayish orange pink (10R8/2), forms cliff; thickness........... 4'

7. Covered .... 9'

6. Limestone: pale red (10R6/2), fine-grained, thick-bedded (1.5-2.5 feet); weathers grayish pink (5R8/2) smooth, forms cliff; thickness .... 8'

5. Alternating limestone and conglomerate thickness .... 8'
Limestone: pale red (10R6/2), very fine-grained, dolomitic, thin-bedded (10-40 millimeters); some very dark red laminations between beds in upper 2 feet; weathers grayish pink (5R8/2), moderately resistant, smooth.
Conglomerate: grayish pink (5YR8/2), moderately thick-bedded, moderately resistant, weathers to rough surface.
Matrix: grayish pink (5YR8/2), limestone; cement limestone, firm.
Gravel: 1-35 millimeters in diameter, moderately well-rounded; composed of white, black, and red quartzite and white quartz, compose 30 percent of rock.

4. Conglomerate: light red (5R6/6), thin-to thick-bedded (4-18 inches), moderately resistant weathers to rough surface; thickness .... 10'
Matrix: light red (5R6/6), fine-grained quartz and limestone; cement limestone, firm.
Gravel: 1-20 millimeter diameter, rounded gray and red limestone; 1-2 millimeter diameter frosted quartz grains.

3. Limestone: pale reddish brown (10R5/4), medium-grained, arenaceous, thin-bedded (3-50 millimeters); some beds contain blotches which are very dark red (5R2/6), weathers pale reddish brown, moderately resistant, thickness .... 15'

2. Covered .... 4'

1. Conglomerate: moderate reddish orange (10R6/6), arkosic and quartzitic, thin-to thick-bedded, weathers moderate reddish orange (10R6/6), resistant, forms cliff, thickness .... 4'
Matrix: moderate reddish orange (10R6/6), arkose; cement silica, firm.
Gravel: 1-10 millimeters in diameter, angular to moderately-rounded; composed of white quartz and red feldspar; pebbles compose 60 percent of rock.

Measured section of Martin limestone and Escabrosa limestone

At southwest quarter Ruin Basin area, west of Gila graben
1600 feet south of Gerald Wash road (average dip 17°).

UPPER PART OF SECTION MISSING ON THIS HILL
ESCABROSA LIMESTONE

2. Limestone: light olive gray (5Y6/1), fine-grained, crystalline, sugary, thick-bedded (average 6 feet) badly fractured; weathers yellowish gray (5Y7/2), resistant forms cliff; surface with large sharp-edged pits; thickness .... 15'

1. Limestone: light olive gray (5Y5/2), fine-grained, crystalline with chert nodules up to 10 inches long; bedding indeterminent due to excessive fracturing; weathers yellowish gray (5Y7/2), resistant forms cliff, surface smooth to rough, extremely rough at chert nodules; thickness .... 12'

MARTIN LIMESTONE

Upper part

14. Limestone: medium gray (N5), medium-grained, crystalline, thick-bedded (average 5 feet); arenaceous nodules 2-35 millimeters in diameter, upper 10 feet free of nodules; fossils brachiopods and crinoid stems; weathers light gray (N7), nodules weather to limonitic and hematitic color, resistant forms cliff; thickness .... 14'

13. Limestone: mottled moderate pink (5R7/4) and grayish orange (10YR7/4), fine-grained, crystalline, argillaceous, moderately thick-bedded (1-3 feet), weathers moderate pink (5R7/4) and grayish orange (10YR7/4), resistant forms cliff, surface smooth; thickness .... 14'

12. Limestone: grayish orange (10YR7/4), very fine-grained argillaceous, thin-bedded (2-20 millimeters); weathers grayish orange (10YR7/4) surface smooth, forms slope; thickness .... 1'

11. Covered, lower part probably similar to 10 .... 30'

10. Limestone: moderate yellow brown (10YR5/4), fine-grained crystalline, thin-bedded (2-4 inches); fossils brachiopods; weathers pale yellowish brown (10YR6/2) plus some limonitic stain, surface smooth except for fossils, forms slope; thickness .... 1'

9. Limestone: medium gray (N5), medium-grained crystalline, thin-bedded (4-8 inches); fossils brachiopods and crinoids; weathers light gray (N7), surface slightly rough with small pits, forms cliff; thickness .... 2'

8. Limestone: pale brown (5YR5/2), medium-to coarse-grained, crystalline, thin-bedded (4-8 inches); fossils brachiopods (Atrypa) and crinoids, good preservation; weathers dusky yellow (5Y6/4), resistant forms cliff, surface rough due to fossils which weather out in relief; thickness. 5'

7. Limestone: medium dark gray (N4), coarse-grained, crystalline, thick-bedded (average 6 feet); lenses of coarse frosted quartz grains; fossils brachiopods, abundant; weathers medium light gray (N6), quartz lenses to limonitic and hematitic color, surface rough, resistant forms cliff; thickness .... 21'

6. Covered .... 4'

5. Limestone: medium gray (N5), fine-grained, crystalline, argillaceous, bedding lenticular average thickness 1 foot ; fossils brachiopods and crinoid stems abundant; weathers yellowish gray (5Y7/2), moderately resistant forms cliff; thickness .... 4'

4. Limestone: light olive gray (5Y5/2), coarse-grained, crystalline, thin-bedded (2-8 inches); fossils brachiopods and crinoid stems, locally abundant; weathers light gray (N7), moderately resistant, forms cliff, surface rough with small pits; thickness .... 8'

3. Limestone: medium gray (N5), medium-grained, crystalline; arenaceous lenses (1-4 millimeters thick); fossils brachiopods; weathers light gray (N7), arenaceous lenses weather to limonite color, resistant forms cliff, surface rough; thick .... 1'

2. Covered .... 6'

1. Limestone; medium light gray (N6), fine-grained, crystalline, thin-bedded (4-6 inches) ; fossils abundant colonial corals, Hexagonaria and Pachyphyllum; weathers very light gray (N8), moderately resistant forms cliff; thickness .... 1.5'

Lower Part

8. Sandstone: light gray (N8), coarse-grained, medium-bedded (1 foot), cross-bedded, cement moderately firm to weak; weathers grayish orange (10YR7/4), moderately resistant forms cliff; surface rough and pitted; thickness........... 20'

7. Limestone: very light gray (N8), very coarse-grained, arenaceous to pebbly (0.5-7 millimeter diameter frosted quartz grains), medium-bedded; fossils brachiopods sparse; cement moderately firm; weathers very light gray (N8) and light brown (5YR6/4), resistant forms cliff with spaling surface; thickness.................... 3'

6. Covered .... 3'

5. Limestone: pale red (10R6/2), medium-grained; weathers moderate orange pink (10R7/4), resistant forms cliff, surface smooth; thickness .... 2'

4. Limestone: pale red (5R6/2), medium-grained, arenaceous to pebbly, thin-bedded (6 inches), frosted quartz, basalt and quartzite pebbles localized along bedding planes; cement firm, calcareous; weathers pale yellowish brown (10YR5/4), moderately resistant forms steep slope; thickness .... 1.5'

3. Limestone: pale reddish brown (10R5/4), fine-grained, dolomitic; moderately thick-bedded (average 2 feet) ; weathers grayish orange (10YR7/4), upper 3 feet very light gray (N8), resistant forms cliff; surface contains large smooth pits; thickness .... 10'

2. Limestone: medium light gray (N6) fine-grained, dolomitic; moderately thick-bedded (average 1.5 feet) weathers very light gray (N8), resistant forms cliff, surface smooth; thickness .... 22'

(Change to another part of slope for section very badly faulted).

1. Conglomerate: moderate reddish orange (10R6/6) quartzitic and arkosic, thick-bedded (3 feet average); resistant forms cliff; thickness .... 40'
Matrix: moderate reddish orange (10R6/6), of feldspar, quartz, and quartzite; cement silica, firm.
Gravel: 1-35 millimeters, average 6 millimeters composed of pink feldspar, white and gray quartzite; pebbles larger than 1 millimeter compose 70 percent of rock.

Diabase

Igneous Rocks

Igneous rocks cover about two-thirds of the Ruin Basin area. The largest single mass is that of pre-Cambrian Ruin granite which occurs as a horst in the central and northwestern part of the area (Pl. 1). Diabase of post-Mississippian age intrudes the sediments in every part of the area. Diorite porphyry, possibly a late phase of the diabase, occurs only as dikes in this area. Tertiary dacite flows probably once covered the Ruin Basin area, but now occur only as capping remnants.

Ruin granite

Ruin granite occurs as a large horst in the central and northwestern part of the Ruin Basin area. The granite outcrop is two-and-three quarters miles long and one mile wide, and it has a northwesterly trend. The principal facies is a coarse-grained, porphyritic granite with rounded, pink feldspar phenocrysts ranging in length from 10 to 35 millimeters. Local facies of granite porphyry, syenite, and pegmatite occur. Aplite dikes cut the granite in many places, but because these dikes could not be followed for any appreciable distance through the weathered granite, they were not mapped separately.

The main constituents of the granite are orthoclase, quartz, biotite, and oligoclase with a perthitic intergrowth of oligoclase. Many of the phenocrysts are Carlsbad twins. Enough oligoclase is present to use the name of quartz monzonite for the rock, but as the name "granite" is well established in the literature, no attempt is made to change it here.

The groundmass minerals are coarse-grained and subhedral to anhedral in form. Plates 22 and 23 are photomicrographs of the Ruin granite and a petrographic description appears at the end of the section on igneous rocks (page 80).

The surface of the Ruin granite is characterized by gentle slopes, generally subdued, for this rock weathers rapidly, and is covered with arkosic debris (Pl. 24). In places where resistant sediments cap the granite, it stands as a cliff.

The Ruin granite was intruded into the older pre-Cambrian Pinal schist, for xenoliths of schist, ranging from two to twelve inches in diameter, are found in the granite in many places. Pinal schist does not crop out in the Ruin Basin area, but it occurs abundantly 5 miles south of this area in the Pinal Mountains.

<u>Contact of Ruin granite with Scanlan conglomerate</u>: The Scanlan conglomerate, which is the basal member of the late pre-Cambrian Apache group, overlies the Ruin granite in many places. Because of considerable controversy over the character of this contact, the writer has made a detailed study of it. The problem is whether the granite was intruded under the Scanlan, or the Scanlan was deposited on the granite. Because of poor exposures of the contact in question within the Ruin Basin area, two outcrops outside this area were also studied. Detailed descriptions of measured sections including this contact appear at the end of the division on sedimentary rocks (pages 48-52).

A quarter of a mile north of the central margin of the Ruin Basin area, the Scanlan conglomerate overlies fresh, firm granite in an outcrop that forms a 75-foot cliff (Pl. 6B). Here the basal bed of the Scanlan is composed of white, gray, and black pebbles of quartz and quartzite, and rounded grains of pink feldspar. The matrix is black, aphanitic silica in the lowest five inches and it makes a striking contrast with porphyritic, coarse-grained granite below. Large, rounded feldspar crystals, 5 to 20 millimeters in diameter, in the conglomerate look identical to the rounded feldspar phenocrysts in the granite. Viewed under the microscope, the two feldspars prove to have the same characteristics, for both are orthoclase with a perthitic intergrowth of oligoclase. No evidence of chilling is found in the granite and no contact metamorphism has been observed in the Scanlan conglomerate.

Throughout the area mapped in this project weathered granite occurs beneath the Scanlan conglomerate. The very top of the decomposed granite may have been transported a short distance but nearly all of the weathered granite has not been moved and is gradational to granite. The weathered granite has no bedding and thus differs from the Scanlan conglomerate in the lack of large, white, vein quartz pebbles, and the lack of transportation before deposition. The decomposed granite weathers to a slope so that its contact with the conglomerate is difficult to observe (Pl. 6, A). Below two feet of weathered granite, relatively fresh granite occurs.

A half mile south of the southwest corner of the Ruin Basin area is another good exposure of the Scanlan conglomerate-Ruin granite contact. Here the conglomerate can be followed continuously from where it overlies solid granite to where as much as 30 feet of weathered granite separate it from the granite (Pl. 7).

In this outcrop the conglomerate is composed of the same constituents as the weathered granite but with the addition of white vein quartz, and white and pink quartzite pebbles. No chilled border occurs in the granite and no contact metamorphic effects were observed in the Scanlan.

The writer believes the Scanlan conglomerate in the Ruin Basin area was deposited on a peneplained surface of Ruin granite. This surface was mantled by a residual regolith developed by subaerial weathering, and the regolith remained on the peneplained surface and was not removed by the agents that deposited the Scanlan conglomerate. The pebbly conglomerate was probably deposited rapidly, for though much of the weathered granite is incorporated in the conglomerate, some of the regolith remained in situ. The ep-Archean surface in Grand Canyon, Arizona, described by Sharp (1940) is similar to the Ruin granite surface in that both surfaces had a regolith developed which was partly preserved under later sediments.

Places where the weathered granite is only several inches thick may represent areas where the loose debris was stripped off, but some of the weathered surface of granite remained to be buried by the conglomerate.

Places where the weathered granite is several feet thick may represent low areas from which very little of the weathered granite was removed before the conglomerate was deposited. Areas where the Scanlan conglomerate lies on relatively fresh granite were probably high places on the peneplain from which all the residual regolith was stripped before the conglomerate was deposited.

The lack of chilling effects in the granite and the absence of thermal metamorphism in the Scanlan conglomerate support the interpretation that the conglomerate was deposited on an eroded surface of Ruin granite. Nine miles east of Ruin Basin Bishop (1935) studied the Ruin granite-Scanlan conglomerate contact. His conclusions about this contact are the same as those reached independently by the present writer.

Diabase

Diabase occurs as dikes, sills, and irregular plutons, and its outcrops cover about one-third of the Ruin Basin area (Pl. 1). It generally weathers rapidly and forms a slope, but it is locally resistant and a cliff-former (Pl. 25). Where the diabase is capped by more resistant sedimentary rocks, it forms steep slopes (Pls. 11, B and 19, B). The final weathering product of this diabase is a fine black sand which fills many of the washes.

Facies of diabase: Nine facies of diabase are found in the Ruin Basin area. These are distinguished on the basis of texture and mineral composition. In many places a sharp line cannot be drawn between facies, for boundaries are gradational. Facies of diabase which are believed to be distinctive enough to warrant attention are described below.

The most widespread facies of diabase is dark gray and medium-grained with plagioclase laths that range from one to five millimeters in length. The texture of this diabase is ophitic and in most specimens the plagioclase is labradorite. Other mineral constituents are hornblende, augite, magnetite, apatite and biotite. This type of diabase is designated facies one in this paper. Plate 26 is a photomicrograph showing its characteristics. A petrographic description appears at the end of this section (page 80).

Diabase of facies two is black, very fine-grained to aphanitic, and occurs as a chilled zone bordering intruded rocks. No petrographic description is given for this facies because the minerals are too small to be identified.

Diabase of facies three is dark gray and fine-grained. The mineral constituents are similar to those of facies one, but most of the crystals are less than 1 millimeter in length. The diagnostic characteristic of this diabase facies is that it weathers to a knobby surface. It occurs in masses as large as 1000 feet in diameter (Pls. 27 and 28, A).

Diabase of facies four is dark gray and coarse-grained. It is similar to diabase of facies one in all respects except that it is coarser-grained. Furthermore, it is not as abundant. A petrographic description is given for this facies on page 81; its minerals are almost identical to those of facies one. The crystals are 5 to 15 millimeters in length so it may be considered a facies transitional between facies one and pegmatitic diabase (Pl. 28, B).

Diabase of facies five is gray and pegmatitic. Plagioclase crystals in it range from 15 to 35 millimeters in length and form a coarse ophitic texture (Pl. 29, A). Rock of this facies occurs in masses as great as 35 feet in diameter, surrounded by finer-grained diabase. Mineral constituents are mainly plagioclase and hornblende. The large plagioclase crystals are zoned with yellow plagioclase in the middle and white plagioclase on the margins.

Diabase of facies six is pegmatitic like that of facies five, but it is red, coarser-grained, and in many places contains visible quartz. The plagioclase crystals range from 15 to 65 millimeters in length. Because these crystals are extremely coarse the ophitic texture is not conspicuous (Pl. 29, A). Mineral constituents are plagioclase, hornblende, orthoclase and quartz. The plagioclase crystals are zoned with white plagioclase in the middle and pink feldspar on the margins. Without the ophitic texture, this rock would be considered porphyritic monzonite or quartz monzonite.

Diabase of facies seven is red and coarse-grained and it contains considerable quartz. Rock of this facies occurs in irregular masses as large as 50 feet in diameter and it grades laterally into that of facies one. Mineral grains range from 5 to 12 millimeters in length and are mainly orthoclase, oligoclase, hornblende, biotite and quartz. A detailed petrographic description appears at the end of this section and Plate 30, A and B are photomicrographs of facies seven. From microscopic determination this rock might be classed as quartz-monzonite.

Diabase of facies eight differs from that of all other facies in that it has conspicuous lineation parallel to an intrusive contact with Devonian rocks located west of the centbal part of the Gila graben (Pl. 1). The diabase is light gray and medium-grained. Plagioclase crystals 1 to 6 millimeters in length tend to be in the plane of lineation (Pl. 31, A). Mineral constituents are the same as in facies one.

Plate 31 is a photomicrograph of facies eight. A petrographic description appears at the end of this section (page 80).

Diabase of facies nine is light gray, coarse-grained and has a granular texture. Crystals are 1 to 8 millimeters in length and composed of microperthite (orthoclase and albite), albite, augite and sphene (Pl. 32). A petrographic description appears at the end of this section (page 81). This rock occurs as a six-foot-wide dike in diabase one-quarter mile west of the central margin of the Ruin Basin area. Because no large plutons of this rock type were found, the writer suggests that it might be a late differentiate of the diabase magma. However, in so far as field and thin-section evidence goes, it might just as likely be a late intrusion not related to the diabase magma. Judging from thin-section determination the rock might be classed as monzonite.

Contact metamorphism and alteration: Little metamorphism has resulted directly from the diabase intrusion. However, some Mescal limestone within a few inches of the diabase has been recrystallized.

Following the intrusion of diabase, hydrothermal solutions invaded the sediments above the diabase. These solutions followed the contact of the diabase and sediments and other easy avenues of access. Locally, Mescal limestone is altered to tremolite. Magnetite occurs along with the tremolite in some places. Dripping Spring quartzite and Devonian sandstone have been chloritized above the diabase contact for a few feet in several places.

Alteration by hydrothermal solutions occurs in Mescal limestone. Intense serpentinization occurs in many places, a foot or more above the diabase contact, but only in a few places does alteration occur below the diabase contact.

Alteration to serpentine is partially selective, for it has taken place either in thin beds alternating with relatively unaltered limestone, or in thin lenticular masses surrounded by less altered limestone (Pl. 14, A).

The serpentine alteration is considered to be hypothermal because the recrystallized limestone immediately above the diabase is not serpentinized, and the diabase is altered by the hypothermal solutions in many places (Wilson 1928, p. 30). Magnesium and silicon to form the serpentine must have been introduced mainly by solutions, but some of the magnesium may have come from dolomitic beds in the Mescal limestone. The hydrothermal solutions were probably the final emanations from the diabase magma.

Locally where the alteration has been intense, chrysotile astestos occurs in veins as cross-fiber, but none of the deposits in the Ruin Basin area are of commercial grade (Pl. 3). Near the town of Chrysotile, Arizona, 25 miles northeast of this area, are asbestos deposits of small volume but high grade.

<u>Age</u>: Considerable difference of opinion has existed concerning the age of the diabase in the Globe quadrangle. Ransome (1902, p. 80) in describing this diabase reported two age groups to be represented, one pre-Cambrian and the other post- Pennsylvanian. N. P. Peterson (1949) remapped on a larger scale the area in which Ransome described pre-Cambrian diabase and concluded that all the diabase in the Globe quadrangle was of one age, post-Pennsylvanian.

About 30 miles northeast of Ruin Basin, A. F. Shride (1949) reported Devonian sediments overlying an erosion surface on a diabase dike which cut Apache group sediments. This evidence suggests that at least some of the diabase in southeastern Arizona is pre-Devonian.

In an attempt to determine the age of the diabase in the Ruin Basin area, a detailed study was made of several contacts between diabase and the two Paleozoic formations that occur here.

Considerable difficulty was encountered in interpreting the significance of the contact between the diabase and the Martin formation because of excessive small-scale faulting and local bedding plane movements in the Martin (Pls. 16, A and 18). However, most diabase-Martin limestone contacts appear to be intrusive contacts.

At the Devonian outcrop west of the Gila graben, and about 500 feet south of the Gerald Wash Road, the diabase has apparently come in along a fault contact for lineation in the diabase parallels the fault line. Diabase of facies 8 occurs at this locality.

At the Devonian outcrop west of the Gila graben, but about 1200 feet north of Gerald Wash Road, the base of the limestone is much brecciated. The diabase below the limestone is fractured but is very fine-grained leading to the suggestion that the diabase fracturing occurred after intrusion (Pl. 18). At some exposures the diabase was lineated parallel to the Devonian contact. In one place a red diabase pegmatitic dike (facies 6) cut the black diabase near the limestone contact, but no contact was made with the limestone. In one place, black diabase appears to have penetrated a break in the limestone for a distance of two feet.

A plane of weakness appears to have developed at the Devonian limestone-diabase contact. Animals dig their burrows at this horizon and the slope invariably changes from a steep limestone slope to a more gentle diabase slope. This weakness may be due to the brecciation of the basal limestone beds or to hydrothermal or surface waters moving laterally along the contact.

In the south-central part of the Ruin Basin area, the diabase-Martin limestone contact is covered by talus from the limestone. No clear-cut relationship could be determined in most places. However, a short dike or a plug of diabase occurs along a fault in the Martin limestone near the Gila graben contact on the east (Pl. 1).

In two places diabase has been found in intrusive contact with the Mississippian limestone. One location is near the western margin of the Ruin Basin area in the central portion, and the other is in the southeastern corner (Pl. 1). The latter outcrop is extremely broken up by small faults so its interpretation is difficult.

The age of all the diabase in the Ruin Basin area is determined to be post-Mississippian. From its relationship to the structure of the area, an early Tertiary age is suggested. A discussion of the relationship of diabase to structure is given in the section on local structure (page 86).

Diorite porphyry

Diorite porphyry in the Ruin Basin area, occurs as dikes in Devonian strata; it ranges in thickness from 10 to 50 feet and in all places one end of the dike merges into diabase. The porphyry is pale olive in color and 65 percent of it is a very fine-grained groundmass. The phenocrysts are of oligoclase, hornblende, apatite, and magnetite, ranging from 0.1 to 3.0 millimeters in length. The rock weathers readily in most places to form slopes which look very much like those formed of weathered diabase. A petrographic description appears at the end of this section (page 83). Plate 33, B is a photomicrograph of the porphyry.

Diorite porphyry is limited in occurrence to the southwesterly part of the Ruin Basin area where four dikes cut the Martin formation. The largest dike, 50 feet wide and 1100 feet long, is in the Devonian block on the southwest margin of the Gila graben (Pl. 1). Another occurs alongside a fault in the northwest part of the same Devonian block. The smallest occurrence of diorite porphyry is in Martin limestone southwest of the Gila graben. This dike pinches out at the base of the Mississippian limestone but the fault along which it was intruded continues through the block. Another diorite porphyry dike crops out in the same Devonian block about 1000 feet west of the small dike and 500 feet south of the largest porphyry dike. There the diorite porphyry is much weathered and partly concealed by Martin limestone debris.

Diorite porphyry dikes appear to be late intrusives for they are nowhere displaced by faults. They cannot be followed in the diabase because the weathered slopes conceal them.

The diorite porphyry is believed to be a late facies of the diabase, but because it can readily be distinguished from diabase in the field, it was mapped separately. Other outcrops of diorite porphyry occur south of the Ruin Basin area.

Dacite

Tertiary dacite occurs as flows that probably once covered all of the Ruin Basin area. Present outcrops appear as a capping over older formations and as small residual masses. In general these dacite flows have no conspicuous layering, but in places visible lineation occurs. In some areas dacite outcrops are covered by large dacite boulders formed by weathering in place along rectangular joints (Pl. 29, B). In most places the dacite forms a cliff upon weathering. The maximum thickness of the dacite flows in this area is 200 feet.

A black vitrophyre bed occurs at the base of the dacite in many places. This bed ranges in thickness from a few inches to several feet. In places below the vitrophyre is a tuff that appears to be water-laid. The tuff ranges in thickness from nearly zero to 80 feet and was accumulated in troughs or basins before the dacite flows erupted.

The dacite is pinkish gray and fine-grained and is composed primarily of feldspar, quartz and biotite. The feldspar was determined to be andesine. Small amounts of sphene, hornblende, and pyrite also occur. A petrographic description of this rock appears at the end of this section (page 84), and a photomicrograph of it is seen in Plate 34.

In two localities along the southern margin of the Ruin Basin area dacite occurs as a capping over Martin limestone, Escabrosa limestone, and diabase. South and west of Ruin Basin dacite flows are thicker and much more extensive than in the basin.

In the northeastern quarter of the Ruin Basin area are three small residual masses of dacite. The largest of these retains some of the features of a flow though it has weathered to a bouldery surface. The smaller two outcrops are composed of fine-grained, friable rock containing some pumice. These rocks were probably tuff which underlies the dacite in many places.

In the central part of the western margin of the Ruin Basin area is an outcrop of tuff containing a few scattered boulders of dacite (Pl. 1 and cross section A-A' Pl. 2). The tuff lies on diabase and is overlain by Gila conglomerate. In this locality the tuff probably was formed in a trough on the diabase surface and subsequently dacite flows covered it. Erosion later stripped most of the dacite and formed a second trough in which Gila conglomerate was deposited.

<u>Theories on formation of vitrophyre:</u> Two points of view concerning the mode of formation of the vitrophyre which underlies the dacite are:

1. The vitrophyre resulted from the welding of tuff through heat and pressure supplied by overlying dacite flows.

2. The vitrophyre was deposited by a nuées ardentes, burning or glowing cloud, (Perret 1935, pp. 84 and 89) or possibly by a flow between the time of the accumulation of tuff and the eruption of dacite flows.

Let the viewpoint that the vitrophyre was formed by heat and pressure of the overlying dacite flows be tested according to principles of heat conduction (Lovering, 1935 and 1936). In order to use heat conduction formulae certain constants must be obtained or estimated. The following approximations were made in this case. Thermal constants for the rocks concerned are not published (Lovering 1936, p. 96). The constants for dacite tuff were approximated as equal to those of rhyolite tuff. The constants for dacite were approximated as equal to those of diorite. Temperature of dacite flow extrusion was taken as 1025° C. and the initial surface temperature on the tuff was taken as 25° C.

Based on the above assumptions, the maximum temperature, a few inches beyond the tuff-flow contact in the tuff, would never exceed 60 percent of the initial difference in temperature between the two rocks (Lovering 1936, Pl. 2, p. 99). This means the highest temperature to effect the tuff was 600° C. In this case the maximum temperature gradient is about 100° C. per 100 feet (Lovering 1935, Pl. 7, p. 86).

The estimated thermal constants are believed as accurate as possib from the limited information available. The assumptions were based on the belief that the texture of the rock is as important as the mineral composition in determining thermal constants.

However, some question may be raised as to basing an estimate of dacite tuff thermal constants on those of rhyolite tuff. If mineral composition is the most important character of the rock in this determination, then the tuff and the dacite flow have the same constants. In this case the problem is simplified and all relationships can be determined from one graph (Lovering 1935, Pl. 3, p. 97).

On the basis of the above assumption, the maximum temperature a few inches beyond the tuff-flow contact, in the tuff, would never exceed 50 percent of the initial difference in temperature between the tuff and flow. Assuming, as before, that 1000° C. is the initial difference in temperature, the maximum contact temperature would be 500° C. The maximum thermal gradient would be, as before, about 100° C. per 100 feet.

If either of the estimates of the thermal constants is near correct, then the maximum temperature at the contact of the flow and tuff never exceeded 600° C. To melt a diorite[1] the temperature must be at least 1125° C. for the entire thickness affected (Daly 1933, table 16a, p. 66). It therefore appears improbable that a temperature of 600° C. could weld the tuff for a thickness of several feet.

What was the effect of pressure in the formation of the vitrophyre? In the region south and west of Ruin Basin the dacite flows attain a thickness of about 1000 feet, so let it be assumed that an equal thickness existed in this area. However, the dacite probably was not extruded as one flow a 1000 feet thick, but rather as a series of thinner flows. As the weight of flows built up the pressure on the tuff, the effective temperature in the tuff was greatly reduced by insulation afforded by earlier flows. So for the maximum temperature at the flow-tuff contact the pressure of overlying rocks can be neglected, and as the pressure increased the temperature in the tuff dropped rapidly (100° per 100 feet of flow) below an effective welding temperature.

The second viewpoint on the mode of formation of the vitrophyre

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[1] No melting temperature was given for quartz-diorite or dacite.

was by a nuees ardentes (burning or glowing cloud), or by a flow. The following sequence of events might have occurred. Light colored, pumiceous tuff was violently erupted over the area and was water transported to basins of deposition.

While tuff was still being accumulated some vitrophyre was extruded in the area in the form of nuées ardentes, or as a flow. The first extrusion of vitrophyre left only a thin layer on the surface. This thin mantle was broken up by erosion and deposited in the basins along with the tuff. Extrusion of vitrophyre continued and increased in volume until it covered the surface. After the cessation of vitrophyre extrusion, dacite was extruded as lava flows. The earliest flows incorporated some vitrophyre that was picked up on the surface by the flows.

The viewpoint that the vitrophyre was formed by a nuées ardente or by a flow fits the field evidence, for the contact between the vitrophyre and the tuff below is gradational. In the upper part of the tuff elongate shards of vitrophyre occur lined up parallel to the bedding in water-laid tuff. The frequency and amount of vitrophyre shards increases upward to a place where the tuff is unrecognizable in the rock. A similar contact between tuff and vitrophyre is described from the Superior Mining district (Short and others 1943, p. 46).

The contact between the vitrophyre and dacite flow is fairly sharp, but for a few feet above the vitrophyre, the dacite flow contains fragments of vitrophyre. These vitrophyre fragments were probably picked up on the surface over which the dacite flowed.

Petrographic Descriptions

Ruin granite

minerals	percentage of rock	length of crystals
orthoclase	25	0.5 - 6 mm
albite	25	0.5 - 2 mm
quartz	40	0.25 - 6 mm
pyrite	10	0.1 - 0.3 mm

alteration = sericite, allophane, and limonite.

The rock texture is coarse-grained granular. The feldspars are difficult to differentiate, for although both orthoclase and albite can be determined, the exact percentage of each is dubious because of extreme alteration to allophane and sericite. The feldspar crystals are subhedral to remnant masses. Quartz is anhedral. Small remnant masses of pyrite scattered throughout the rock have been almost completely altered to limonite. Photomicrographs are on Plate 22.

Ruin granite

minerals	percentage of rock	length of crystals
orthoclase	45	2 - 6 mm
oligoclase (Ab_8An_2)	25	2 - 4 mm
muscovite	15	0.25 - 0.5 mm
quartz	10	0.25 - 8 mm
ilmenite	5	0.25 - 3 mm

alteration = sericite, allophane, limonite, and leucoxene.

The rock texture is coarse-grained granular. Orthoclase crystals are euhedral to subhedral and have been considerably altered to sericite and allophane. Oligoclase is also euhedral but is only altered to a minor degree. Both albite and Carlsbad twinning is present in the feldspars. Muscovite occurs in fan shaped aggregates; it might be more accurate to call this occurrence sericite for it is apparently a secondary mineral. Quartz occurs in anhedral masses throughout the slide. Ilmenite occurs as specks and remnants of crystals; most of it is considerably altered to leucoxene and limonite. Photomicrographs are on Plate 23.

Diabase (facies 1)

minerals	percentage of rock	length of crystals
andesine (Ab_6An_4)	50	1 - 3 mm
augite	15	1 - 3 mm
biotite	15	0.5 - 3 mm
magnetite	10	0.5 - 1 mm
olivine	10	0.5 - 2.5 mm

alteration = sericite, chlorite, serpentine, and hornblende.

The rock texture is ophitic, but the slide is so thoroughly altered that the texture is not obvious. Andesine occurs in euhedral crystals that are much altered to sericite. Olivine is highly altered to serpentine with magnetite forming along the cleavage planes. Augite is relatively fresh in subhedral crystals but some shows deuteric alteration to hornblende (uralite). Biotite was subhedral but has been almost completely altered to chlorite. Most of the magnetite is in euhedral to subhedral crystals. Photomicrographs are on Plate 26.

Diabase (facies 3)

minerals	percentage of rock	length of crystals
labradorite (Ab_4An_6)	65	0.25 - 3 mm
biotite	15	0.25 - 0.75 mm
pigeonite (augite)	5	0.25 - 0.5 mm
pyrite	5	0.5 - 1 mm
hornblende	5	0.5 - 1.5 mm

accessories = quartz, jarosite, and magnetite
alteration = hydromica, chlorite, and limonite.

The rock texture is ophitic. Labradorite is euhedral to subhedral; some of the crystals are relatively fresh. The subhedral biotite is almost completely altered to chlorite. Pigeonite is almost all anhedral, filling the spaces between plagioclase and biotite. Pyrite crystals are euhedral to subhedral and all show more or less alteration to limonite. Hornblende occurs as broken crystals and slivers, many partly altered to chlorite. Quartz, jarosite, and magnetite occur in small amounts. Photomicrograph is Plate 28, A.

Diabase (facies 4)

minerals	percentage of rock	length of crystals
labradorite (and orthoclase)	50	1 - 8 mm
hornblende	30	1 - 4 mm
magnetite	10	0.5 - 4 mm
apatite	5	0.5 - 2 mm

accessories = augite and biotite
alteration = allophane, sericite, jarosite, limonite, and chlorite.

The rock texture is ophitic but intensive alteration has partly obliterated the texture. Labradorite in euhedral to subhedral crystals is very much altered to allophane, sericite, and jarosite. Some orthoclase is present but due to the alteration a clear division between the feldspar could not be made. Hornblende in subhedral crystals and anhedral masses shows some alteration to chlorite. The few crystals of augite are partly altered to hornblende. Magnetite occurs in long needles and irregular masses and is somewhat altered to limonite. Apatite is primarily in euhedral crystals displaying good basal sections. A few small flecks of biotite are present. Photomicrograph is Plate 28, B.

Diabase (facies 7)

minerals	percentage of rock	length of crystals
orthoclase	20	1 - 4 mm
oligoclase	25	1 - 4 mm
hornblende	30	0.25 - 8 mm
biotite	10	0.25 - 0.5 mm
quartz	10	0.25 - 2 mm

accessories = magnetite, and apatite
alteration = allophane, sericite, and limonite.

The rock texture is granular with long prismatic blades of hornblende. Subhedral feldspar crystals are altered chiefly to allophane but in part to sericite. Much of the quartz and orthoclase are intergrown as graphic granite. Hornblende, in addition to occurring in long blades, is present in anhedral masses. Biotite ranges from flecks to radial aggregates. This may partly be due to alteration of hornblende. Some of the masses of anhedral quartz contain needles of apatite. Some subhedral to euhedral crystals of apatite are also present. Magnetite in subhedral crystals and remnant masses has been greatly altered to limonite. Photomicrographs are on Plate 30.

Diabase (facies 8)

minerals	percentage of rock	length of crystals
labradorite	60	1 - 4 mm
magnetite	15	0.5 - 4 mm
augite	15	0.5 - 3 mm
hornblende	5	0.25 - 0.5 mm
apatite	5	0.1 - 0.3 mm

alteration = allophane, hydromica, chlorite, hornblende, and limonite.

The rock texture is coarsely ophitic, but because of extreme alteration this texture is not conspicuous. Labradorite is intensely altered to allophane and hydromica, so much so that even the albite twinning is obscured. Euhedral to subhedral crystals show a little alteration around the edges to hornblende. Magnetite occurs mainly as long needles, but some is in small masses. Most of the hornblende is in aggregates of needles, and some shows alteration to chlorite. Apatite is euhedral and several good basal sections occur in the slide. Photomicrograph is on Plate 31, B.

Diabase (facies 9)

minerals	percentage of rock	length of crystals
microperthite (orthoclase and albite)	40	2 - 1 mm
albite	40	2 - 6 mm
augite	10	1 - 2 mm
sphene	5	1 - 2 mm
limonite	5	0.25 - 1 mm

alteration = allophane, chlorite, and limonite.

The texture of the rock is coarse-grained granular. Microperthite crystals are euhedral to subhedral and consist of a fine-grained intergrowth of orthoclase and albite in about equal proportions. Large euhedral albite crystals occur but polysynthetic twinning is rare. Alteration to allophane occurs in both feldspars but it is more intense in the microperthite. Augite has almost completely altered to fan-shaped chlorite. Some good crystals of sphene are present and limonite occurs in blebs throughout the slide. Photomicrographs are on Plate 32.

Diorite porphyry

minerals	percentage of rock	length of crystals
oligoclase	15	0.5 - 2 mm
hornblende	5	0.2 - 3 mm
apatite	5	0.1 - 0.3 mm
magnetite	5	0.1 - 0.3 mm
groundmass	65	fine grained 0.1 mm

accessories = biotite and quartz
alteration = hydromica, jarosite, limonite, hematite, and chlorite.

The rock texture is porphyritic with euhedral to subhedral crystals 0.1 to 3.0 mm in length in a fine-grained groundmass. The groundmass may be largely composed of feldspar but no determination could be made on it. Euhedral to subhedral oligoclase phenocrysts are extremely altered to hydromica and jarosite, in fact in many case only the euhedral outline of the crystal can be detected in the groun mass. Subhedral hornblende in long needles and irregular masses of hornblende are partly altered to chlorite. Euhedral apatite and anhe quartz are present. Magnetite occurs in small masses and crystals scattered throughout the matrix and showing some alteration to limoni A few flecks of biotite are present. Photomicrograph is on Plate 33,

Dacite vitrophyre

minerals	percentage of rock	length of crystals
andesine (Ab_6An_4)	30	1 - 3 mm
quartz	15	0.25 - 0.5 mm
biotite	5	0.25 - 0.75 mm
accessories	5	
glass matrix	45	glassy

accessories = orthoclase, sphene, zircon, hornblende, pyrite, and muscovite.

The rock is porphyritic with phenocrysts enclosed in a black gla matrix. The rock is unaltered and the matrix has well developed flow lines around the phenocrysts. Most of the phenocrysts were euhedral but now many of them are crushed and broken with glass filling in betw the broken fragments. There is no preferential orientation of the ph crysts. The andesine is in euhedral and crushed fragments. Some of feldspar has very fine muscovite needles forming along the cleavage planes. These probably represent the beginning of alteration. Quart is chiefly anhedral. Biotite occurs in euhedral hexagons and bent an crushed fragments. Pyrite is in small crystals, as do the other acce eries hornblende, sphene, orthoclase, and zircon. The glass matrix is uniform in appearance and is filled with trichites (tiny hair-like projections). No relic pumice structure was observed. Photomicrographs are on Plate 36.

Dacite

minerals	percentage of rock	length of crystals
andesine	20	0.25 - 2 mm
quartz	10	0.25 - 2 mm
biotite	5	0.25 - 1 mm
accessories	5	
groundmass	60	

accessories = sphene, hornblende and pyrite
alteration = chlorite and limonite.

The rock texture is porphyritic with a glassy groundmass which shows flow structure. Many of the euhedral to subhedral albite crystals show a zoning which is interpreted as indicating a change in composition as the crystals grew. Some of the feldspar crystals are fractured but they are very little altered. Quartz crystals are subhedral to anhedral and some show embayments of groundmass. Biotite crystals are euhedral and somewhat altered to chlorite. Pyrite is euhedral and in tiny masses; much of it is altered to limonite. A little sphene and hornblende are present. Photomicrographs are on Plate 34.

Structure

Regional structure

The Globe region is in the Basin-Range province, about 60 miles southwest of the southern margin of the Colorado Plateau. The dominant structures and resulting mountain ranges strike northwesterly and parallel the margin of the Plateau (Butler 1949). This arrangement is primarily due to Laramide folding and subsequent block-faulting which is superimposed upon all earlier structures (Wilson 1949).

The structural history of southeastern Arizona begins with orogeny during older pre-Cambrian time when an east-west compressive force formed folds whose regional trend was a little east of north. However, in the area encompassing Prescott, Jerome and Globe the trend of the folds was swung to a north-northwesterly direction. Shear or tear faults transverse to the folds have been developed in many places (Wilson 1949). Later some north-northeast flexures were formed in the Apache group possibly by an orogeny of younger pre-Cambrian time. Apparently the Globe region was not affected by diastrophism between the time of the last pre-Cambrian revolution and that of the Laramide.

During Paleozoic and Mesozoic time the regions bordering the Colorado Plateau were a series of basins of heavy sedimentation (Butler 1949). The Globe region is on the northern flank of a basin which deepens to the south and extends into Mexico (McKee, isopach maps 1949). Therefore the thickness of the sediments at Globe is less than that of the area to the south and more than that of the area to the north. In addition to the rocks now found in the Globe area some Pennsylvanian and upper Cretaceous sediments were probably also deposited here judging from the projection of trends on McKee's isopach maps (1949). If Pennsylvanian and Upper Cretaceous beds were once present here they have been stripped off by erosion before the deposition of Tertiary rocks.

The Laramide orogeny resulted in the development of folds, reverse faults, thrust faults and associated igneous activity in the ancient basins of sedimentation in southeastern Arizona. The compressive forces acted toward the Colorado Plateau which was then a relatively stable area so the folds developed with a northwest trend. The Laramide orogeny, which extended over considerable time, was followed by a period of relaxation and tension.

Structural features, the result of tension, are sparse and of small magnitude in the Plateau area, but these features are greater in frequency and magnitude southwestward away from the Plateau margins. During the period of tension, Basin Ranges were formed by block faulting which was superimposed on all the earlier structures. According to Butler (1949) the tensional stresses may have resulted from release of compressive stresses due to collapse of folded strata and to the transfer of magma from subsurface to surface. This transfer of magma removed the subsurface support and promoted settling.

The trend of Basin Ranges in the Globe region is northwesterly but much of the regional dip, to the southwest, of these ranges has probably resulted from Laramide compression rather than from normal faulting. E. D. Wilson believes that many of the Basin-Range faults follow inherent zones of weakness along which there was movement in older pre-Cambrian time.

Normal faulting and intermittent volcanic activity continued through Tertiary to Recent time. Some compressive structures, folds and thrust faults, occur in Tertiary rocks in southeastern Arizona, but these are apparently local structures (Wilson 1949).

Local structure

The most pronounced structural feature in the Ruin Basin area is a development of horsts and grabens. The major faults have an average strike of about N 30° W which is in keeping with the post-Laramide structural trend of south-central Arizona. The regional dip of the strata is to the southwest, but many local variations exist. This regional tilt may be a result of the Laramide orogeny.

The fault pattern of this area is typical of Basin-Range structure; however, due to the rapid erosion of Ruin granite in this locality, the effect of the block faulting is just the reverse of that found in most parts of the Basin-Range province where the horsts stand up in bold relief above the graben areas.

Ruin basin horst: The largest block in the Ruin Basin area is a granite horst two-and-three quarters miles long and one mile wide within the Basin itself (Pls. 1 and 2). At the time of faulting, younger sedimentary formations must have covered this block, but subsequently these were eroded exposing the Ruin granite, which weathers rapidly and so accounts for the present low topographic position of the horst. The area which would normally be the southeastern extension of the horst is occupied by diabase and some Apache group sediments. Apparently a thick mass of diabase was intruded above the granite in this locality. The diabase intrusion probably followed the main Basin-Range faulting.

The vertical movement along the faults, which border the horst, must have been greater in the northwest than in the southeast with the result that the granite of the block does not crop out in this southeastern locality. The faults forming the horst may be hinge faults with the hinge in the southeast now covered by diabase. This apparent relationship may be partly due to deeper erosion in the basin. Beyond the diabase outcrop to the southeast, outside the Ruin Basin area, are extensive exposures of Apache group and Paleozoic sediments in which no evidence of a continuation of the horst is found.

Eastern graben: East of the Ruin Basin horst is the eastern graben which in its northern portion is composed primarily of Apache group sediments and intrusive diabase, whereas in its southern portion it also contains Paleozoic limestones. The northern part is very much broken up; the largest number of faults strike north or northwesterly, but some strike northeasterly (Pl. 1). Fault lines cannot be traced for long distances because they are partly obscured by intrusions of diabase. In a few places the diabase is faulted but only by minor breaks.

Erosion has removed much of the rock cover beneath which the diabase was intruded with the result that on the geologic map, Plate 1, the blocks of Apache group sediments appear to be floating in a sea of diabase. This pattern might be likened to fragments of ice floating in water (Pl. 2). It seems probable that the forceful intrusion of the diabase into the sediments jostled and separated the fault blocks to a considerable extent.

A flat anticline in the north-central part of the eastern graben strikes approximately N 20° W (Pl. 3). Near the southern end of the block is a second anticline with a strike of N 48° W. These anticlines may have been formed by compression during the Laramide orogeny, but it seems more probable that they represent local changes in dip caused by warping of beds during the forceful intrusion of diabase.

The southern part of the eastern graben is considerably less faulted than the northern part, and the amount of diabase intruded into the sediments here is less. An exception is a very large diabase mass along the western border of the graben which conceals the western fault margin of the graben.

Erosion at present is stripping off the Paleozoic limestones in this part of the block. Several erosional outliers of Devonian Martin limestone occur beyond the main masses of the formation, giving the impression of klippen, although the writer believes these outliers are remnants of erosion. Despite the fact that breccia formed by bedding plane movements at the base of the Martin underlies the outliers, there is no evidence that movements involved were of thrust proportions.

Western graben: Southwest of the Ruin Basin horst is another large block, the western graben, which is composed of Apache group and Paleozoic sediments, diabase and Tertiary formations. This graben, though considerably cut by faults, is in general not as broken up as the northern part of the eastern graben, but more faulted than the southern part. The breaks, in general, can be followed only short distances; some apparently were short breaks originally, whereas others, possibly once greater in length, are now partly obscured by diabase. As in the northern part of the eastern graben, the rock cover under which diabase was intruded has been eroded off to a considerable extent, creating the effect of blocks of sediments floating on a sea of diabase (Pl. 1). The diabase occurs as dikes, sills and irregular masses. The sills greatly favor the Mescal limestone and its contacts as hosts for intrusion.

Relationship of diabase: The diabase of the Ruin Basin area is considered post-Mississippian because it is intruded into

Mississippian strata[1]. More exact dating of the diabase emplacement in this area is impossible because of the absence of very late Paleozoic and Mesozoic rocks. Nowhere in southeastern Arizona has diabase been observed in Cenozoic formations, therefore, the diabase could have been intruded at any time between the Mississippian and the Tertiary.

The evidence suggests that the diabase came relatively late in the structural history of this area, since its emplacement obscures most of the normal faulting. The few faults that are in the diabase are of small displacement, and probably represent readjustments due to settling along old breaks after the diabase intrusion and dacite extrusion. A post-Laramide or early Tertiary age is therefore suggested for the major diabase intrusion. This conclusion is tentative, as supporting evidence is from a very limited area.

Gila graben: Near the eastern margin of the western graben is a long, narrow and smaller graben which probably was formed after the major block-faulting; apparently a trough existed in which Gila conglomerate was deposited. Downfaulting either accompanied or followed this deposition and accounts for the thickness of conglomerate accumulated. Part of the evidence for this assertion is the straight line contact of the Gila conglomerate with other formations (Pls. 1 and 2). A discussion of this problem appears in the section on Gila conglomerate (page 22).

1 Ransome (1919, p. 56) and Peterson (1949) have found diabase intruded in Pennsylvanian rocks outside the Ruin Basin area.

In the southern part of the Gila graben is a syncline with the beds dipping into the center of the graben (Pl. 3). This syncline may represent the original dip of the conglomerate or may be the result of local compression. It appears most probable, however, that this syncline was formed by deformation of beds due to drag on the bordering faults as the graben sank.

A long, thin wedge formed of Apache group sediments, Paleozoic limestones, and diabase separates the Gila graben and the Ruin Basin horst. The rocks of this wedge are part of the large western graben and are highly fractured. In fact the widest fault zone of the area is in the Pioneer shale near the southern part of the Gila block. North of the thin wedge, the Gila graben borders the granite horst.

Western granite horst: In the large western graben, near the west-central margin of the Ruin Basin area a small granite horst is exposed both north and south of the road. This block is 1100 feet long and averages about 400 feet in width. Here, as in Ruin Basin, the resistant sediments have been eroded off the horst, and the Ruin granite is exposed. Because the granite weathers rapidly, a topographic depression has resulted.

Ground Water

Ground water constitutes the only dependable water supply in the area for both prospectors and ranchers. Wells and springs are located on two types of geologic structures. Most wells and springs are in fractures in bedrock, but some are in alluvium. The locations of springs and wells are shown on Plate 3.

Wells and springs located on fractures may be divided into 3 types: 1. associated with faults; 2. associated with dikes; 3. associated with joints. All of these are producers only where the fractures are in valleys. Wells located on faults are more permanent than natural springs on similar structures but springs developed by tunneling on dikes become permanent where some development is done, otherwise they tend to go dry. Springs on joints are not permanent in this area.

Wells in the alluvium normally are dependable but one "artificial" spring made in the alluvium proved to be intermittent. This spring, Rockhouse trough, is located in the northwest corner of Ruin Basin on a north sloping wash (Pl. 3). Here a concrete dam two feet high was built across the wash on granite bedrock, and a pipe from the base of the dam fed a cattle trough. The purpose of the dam was to store water in the alluvium above the dam site. This spring proved to be only partially successful, for the granite underlying the alluvium is so jointed that the reservoir is slowly drained.

Two wells in alluvium in the east-central part of this area are permanent (Pl. 3). The more easterly one, on the south side of Gerald Wash road, is a dug well about 25 feet deep. It has been in continuous use as a domestic supply for several years. Faults in the vicinity, both north and south of the well, may help keep a steady supply of water (Pl. 2). The second well about 3000 feet west of the well described above was drilled to a depth of 100 feet, but the driller reported solid granite 30 feet down. Water from this well is used for cattle. The maximum amount that has been pumped at one interval is 300 gallons with no signs of diminishing supply. The delivery capacity of the 2 inch pipe is about 50 gallons in 15 minutes.

Another well in the alluvium occurs in the west-central part of Ruin Basin at Dixon Camp. This dug well is about 50 feet deep and probably was the only water supply for the mining camp. The well has not been used for many years but still contains water.

A dug well occurs on a fault in the east-central part of Ruin Basin about 1500 feet north of the drilled well (Pl. 3). This well was sunk about 50 feet in fault breccia and furnishes a permanent water supply.

Two springs occur along faults in the west-central part of Ruin Basin. They are designated Dixon spring and Whitebank spring on Plate 3. At both there has been a little development work in the form of tunneling, damming, and piping water to cattle troughs. These springs are intermittent.

Cottonwood springs are located on a fault in the southwestern corner of the area. The mouth of the tunnel, which was drifted 75 feet along the fault, is in diabase. The spring issues from the mouth of the tunnel though the water is collected due to the fault and the tunnel. This permanent spring supplies a cattle trough.

Two Sleeping Beauty springs occur on diabase dikes about 2000 feet northeast of Cottonwood spring (Pl. 3). The more westerly spring has not been developed and is intermittent. At the other spring, a ten foot tunnel has been cut in the diabase and a one foot concrete dam placed across the tunnel. This spring is permanent and has been used for domestic supply.

Amateur spring in the southeastern part of Ruin Basin occurs associated with joints in diabase. A tunnel, now caved, cuts across several strong joints, but the water supply is intermittent. Several seeps similar in origin to Amateur spring occur in Piebald gulch in the southwestern part of the area. In the vicinity of these seeps are many large cottonwood trees, but no good spring has been found there.

Weathering and Erosion

Weathering

Weathering in the Ruin Basin area is typical of that in semi-arid regions. The intrusive igneous rocks (granite, diabase, and diorite) all disintegrate rapidly (Pls. 24 and 27, B). In contrast, most of the sedimentary rocks are considerably more resistant to weathering.

The agents of weathering in this area are differential expansion and contraction due to extremes in temperature, hydration, and frost action given in order of believed effectiveness. Results of experiments by Griggs (1936, p. 796) showed that differential expansion and contraction had no appreciable effect on the rocks tested.

The main objection to the experiments of Griggs is that in them heat was applied to a rock rapidly and then the rock was cooled rapidly. The complete cycle took 15 minutes. Therefore heat was impressed on the rock for so short a time that it did not penetrate to any considerable depth but affected only the thin outer surface.

On a rock surface crystals have space into which to expand and contract (a free face) without affecting other crystals surrounding them. Thus, when heat is applied rapidly a crystal expands primarily in the direction of its free face (a bulging effect), and when cooled it contracts the free face, thereby not disrupting the crystal contacts. It is doubtful that even the outer layer of crystals had sufficient time in the experiments cited to reach its maximum expansion and contraction because the reversals in temperature were so rapid.

A heating and cooling cycle in nature usually takes 24 hours. This permits enough time for crystals beneath the surface of the rocks to be heated and cooled. Because these sub-surface crystals have no free face, their differential expansion and contraction loosen the bond between the crystals, and make the rock susceptible to hydration and frost action (Pl. 27, B).

In the environment under discussion sedimentary rocks weather more slowly, in general, than do intrusive rocks. This probably is due to their more uniform texture and composition. Limestones, quartzites, sandstones, and well consolidated conglomerates form cliffs in Ruin Basin (Pls. 10, A and 16). Shales and weakly cemented conglomerates are exceptions for they consistently weather to slopes (Pl. 11).

Active weathering agents affecting sedimentary rocks are hydration and frost action which act along joints, fractures, and bedding planes to produce blocky talus. Because sedimentary rocks are less effected by changes in temperature they weather more slowly than do igneous intrusive rocks.

Some wind erosion occurs in Ruin Basin but its effect on the rocks is slight and is masked by the effects of the other weathering agents.

Transportation

Transportation of eroded material in Ruin Basin is mainly by waters from thunder-storms and other rains. Only minor results of wind transportation have been observed.

Concentrated waters from thunder-storms are the most effective transportational agents in the Ruin Basin area. Time between thunder-storm periods may be considerable so that the intrusive rocks have an opportunity to weather to a depth of some inches, and sedimentary rocks are loosened along fractures and bedding planes before being removed. The effect of one devastating thunder-storm may be to strip off several inches of weathered intrusive rock on steep slopes. Likewise a considerable amount of loosened sedimentary rocks may be torn loose from outcrops and carried into the valleys.

Some unusual erosional features occur in the Ruin Basin area. The most spectacular is a monolith (pillar) of Ruin granite which rises 35 feet above the level of the surrounding weathered granite (Pl. 24). This monolith is composed of granite porphyry and differs from the normal porphyritic granite only in having a greater percentage of feldspar phenocrysts.

In only one locality does diabase occur as a cliff (Pl. 25, A). There the diabase is similar to facies one but it has been broken by joints about 2 feet apart allowing the rock to be somewhat silicified.

Mineral Deposits

Copper, silver and asbestos prospects occur in the Ruin Basin area, but none of these deposits has been a commercial success. Within eight miles of the southern margin of this area, however, are such well known mining camps as Castle Dome, Inspiration, Miami, and Globe, and 30 miles to the northeast are the commercial asbestos deposits of Arizona.

Metal prospects

All the metallization in the Ruin Basin area occurs in fissures cutting diabase. Ore minerals observed on prospect dumps are chrysocolla, malachite, and wulfenite. The gangue minerals are calcite, quartz, and pyrite. Ore from the Silver Belt shaft shown the writer contained chalcocite, and native silver but these minerals could not be seen in place because the drift was flooded. The metallization is probably of Tertiary age as it is post-diabase. Description of the prospects is given below.

Two metal prospects occur in the east-central part of Ruin Basin (Pl. 3). The more northerly one consists of 4 adits driven into fractured diabase. The fractures contain mainly calcite, but some chrysocolla, and malachite. The mineralized rock is low grade and is not continuous. The Silver Belt shaft is the other prospect in this locality. It occurs near the diabase-Pioneer shale contact south of Gerald Wash road.

Mr. Steve Tadich, owner of the Silver Belt, gave the writer the following information. The workings at this mine have two levels, the 100 foot level and the 180 foot level. Ore amounting to 300 tons was shipped from the 100 foot level and it ranged in grade between 50 and 500 dollars per ton. The ore occurred in fractures in diabase and had no apparent relationship to the Pioneer shale which crops out near the deposit.

A little mineralization occurs along a fault in diabase in the southwestern part of the Ruin Basin area (Pl. 3). The fault strikes into another fault between diabase and Devonian limestone. Nothing that could be called ore was found on the dump, but some mineralized rock was found that contains a little pyrite and very sparse wulfenite. Development at this prospect consists of a shaft about 50 feet deep and a drift about 100 feet long.

Asbestos prospects

Asbestos mineralization is attributed to hydrothermal solutions which came up along the diabase intrusion contacts. These solutions altered both the diabase and the Mescal limestone in addition to forming the asbestos. A discussion of this alteration and asbestos formation appears in the section on diabase, in the part on contact metamorphism. All the asbestos found in this area is chrysotile and it occurs in bedding planes in the Mescal limestone, near to and above diabase intrusions. Descriptions of the asbestos prospects are given

Asbestos prospects occur only in the southwestern quarter of the area (Pl. 3). At Dixon Camp are two adits and two shafts in Mescal limestone. Some cross-fiber asbestos is present, but most of the specimens on the dump showed short ($\frac{1}{4}$ to $\frac{1}{2}$ inch) slip-fiber asbestos. Movement apparently took place between the beds of Mescal limestone during or after the formation of the chrysotile.

Two asbestos prospects occur in Mescal limestone, near the diabase contact in the southwestern corner of the Ruin Basin area (Pl. 3). The southern prospect consists of several open cuts in the limestone. Some cross-fiber chrysotile with fibers one and a half inches long was mined here but the seam pinched out.

The northern prospect is an adit about 20 feet long that followed on cross-fiber asbestos one inch thick but the seam pinched out.

CHAPTER 3 GENERAL SUMMARY

The oldest rock in the Ruin Basin area is Ruin granite of older pre-Cambrian age. This granite, which probably was intruded into Pinal schist, is believed to underlie the entire area. Zenoliths of schist are included in the granite.

Extensive denudation which followed the intrusion of Ruin granite reduced the area to a peneplain upon which pre-Cambrian sediments of the Apache group were deposited.

The Apache group is composed of conglomerates, quartzites, shales, and limestones, locally with a total thickness of about 965 feet. No fossils have been found in rocks of this group. The formations included are, from oldest to youngest, Scanlan conglomerate, Pioneer shale, Barnes conglomerate, Dripping Spring quartzite, and Mescal limestone.

No record of strata of Cambrian, Ordovician or Silurian age was found in Ruin Basin. According to McKee's isopach maps (1949) Cambrian sediments probably were deposited here, but Ordovician and Silurian beds were not deposited in this part of Arizona. A long erosional period followed the Cambrian during which all of the Cambrian strata and part of those forming the Apache group were removed. Rocks of Devonian age were subsequently laid down on this erosional surface.

The Devonian Martin formation is composed mainly of limestone, but locally the lower part includes considerable conglomerate interbedded with limestone. This suggests that the Devonian sediments were deposited on an uneven surface, with gravel accumulating in the depressions. Limestone of Mississippian age conformably overlies the Martin limestone.

The Mississippian Escabrosa limestone is a capping remnant in the Ruin Basin area and is nowhere very thick. Pennsylvanian beds occur within 10 miles of this area but no strata of Permian, Triassic, Jurassic, or Cretaceous age are found. According to McKee's isopach maps (1949), Pennsylvanian and Upper Cretaceous beds may have extended across this area. Erosion was dominant during much of the long geologic interval between Pennsylvanian and Tertiary times.

A great orogeny, probably the Laramide Revolution at the end of the Cretaceous, affected the Ruin Basin area. Compressional stresses apparently resulted in a large fold, represented today by a regional dip to the southwest. Some faulting and considerable bedding plane movement occurred at this time.

The period of compression was followed by one of relaxation and tension. This probably occurred during the early Tertiary and produced most of the normal faults in Ruin Basin. Major horst-graben faulting and much of the minor faulting took place at this time.

The intrusion of diabase, probably during early Tertiary time, followed the major part of the normal faulting. The diabase came in along steep faults as dikes, and along bedding planes as sills. These intrusions were so extensive that diabase underlies large parts of the area (Pls. 1 and 2). Some of the diabase forms large irregular plutons. Diorite porphyry which occurs as dikes is believed to be a late phase of the diabase. Mineralization including both metals and asbestos, probably closely followed the diabase intrusion.

The intrusion of diabase in Ruin Basin was followed by a period of erosion during which the surface of the area was worn down to moderate relief. Probably about middle Tertiary, dacite extrusions poured out on this surface, and apparently once covered all of the Ruin Basin area.

Post dacite erosion must have been vigorous, for in many areas it completely removed the dacite and exposed older rocks, and in other places it eroded troughs between hills. About the same time some structural troughs (grabens) were formed by normal faulting. Into both types of troughs the stream-deposited gravels of the Gila conglomerate were deposited.

The rapid accumulation of Gila conglomerate in structural troughs may have caused recurrent depression of the troughs for great thicknesses of this formation are accumulated in such structures. The conglomerate is believed to have over filled the troughs and to have spread as a veneer over the country between troughs.

Minor faulting has continued into recent times, for the Gila conglomerate is faulted. Since deposition of this conglomerate, erosion has progressed to a considerable extent, for in most places the conglomerate has been stripped from the surface. However, Gila conglomerate remains where it occupied troughs. Subsequent dissection of the Gila conglomerate has continued nearly to the present, but today alluvium is accumulating in the stream channels.

Plate 6

A. Scanlan conglomerate-Ruin granite contact on east side of Ruin Basin. Shovel blade marks Scanlan conglomerate-Pioneer shale contact. End of hammer handle marks top of decomposed granite which forms slope.

B. Scanlan conglomerate-Ruin granite contact one quarter mile north of central margin of Ruin Basin area. Conglomerate rests on fresh, solid granite. Hammer handle on contact.

Plate 7

A. Scanlan conglomerate-Ruin granite contact, one half mile south of southwest corner of Ruin Basin area. Hammer head on contact, granite partly decomposed.

B. Scanlan conglomerate-Ruin granite contact, 5 feet away from Plate 7,A. Here the conglomerate is over fresh, solid granite.

Plate 8

A. Pioneer shale, one of the resistant quartzitic beds displaying elliptical white spots same as are found on less resistant Pioneer shale beds.

B. Pioneer shale, rain impressions on large specimen on the left side of picture, and hail impressions on smaller rock on the right.

Plate 9

A. Barnes conglomerate, pebbles sheared by faulting and recemented askew.

B. Typical Barnes conglomerate forming cliff.

Plate 10

A. Dripping Spring quartzite, series of cliff-forming arkosic beds in lower part of section. Each division on rod is one foot.

B. Dripping Spring quartzite beds displaying ripple marks. Note pistol for scale.

Plate 11

A. Upper Dripping Spring quartzite (pCds) is faulted against Mescal limestone (pCm) and forms a slope. A diabase (db) dike cuts the Mescal limestone in the foreground. Facing east near western margin of Ruin Basin area about 1000 feet south of Gerald Wash road.

B. Upper Dripping Spring quartzite (pCds) forms slope below Mescal limestone (pCm). A diabase (db) sill about 50 feet thick separates the two Mescal outcrops. Facing north about 500 feet west of the western margin of Ruin Basin area.

Plate 12

A. Upper Dripping Spring quartzite with thin hematite-red layers.

B. Silicified Mescal limestone bed which occurs near base of section.

Plate 13

A. Black silica with amygdules or concretions of calcite and quartz. Occurs at base of Mescal limestone section.

B. Photomicrograph of black silica. The spherical masses have calcite (cal) around the periphery and some quartz (qtz) in the center. Parallel light. X33.

Plate 14

A. Serpentinized Mescal limestone. The serpentine (ser) is localized in bands between relatively unaltered limestone (ls).

B. Chrysotile as cross-fiber seams in Mescal limestone. Seams seldom exceed one inch in thickness in the Ruin Basin area.

Plate 15

A. One of the conglomerate beds which alternate with limestone beds in the lower part of the Martin limestone.

B. Close-up of above conglomerate. Note flat-sided pebbles expressing bedding planes. Pebbles mainly of limestone.

Plate 16

A. Quartzite bed displaying gnarly surface upon weathering, found in the lower part of the Martin limestone.

B. Breccia at base of Martin limestone, the result of bedding plane movements.

Plate 17

A. Very fossiliferous bed in upper part of Martin limestone. The brachiopods are mainly Atrypa.

B. Fossiliferous bed in upper part of Martin limestone displaying mainly crinoid stems.

Plate 18

A. Brecciated base of Martin limestone over blocky, weathered diabase.

B. Brecciated Martin limestone over diabase, displaying zone of weakness at contact.

Plate 19

A. Massive Escabrosa limestone (Ce) cliffs above Martin limestone (Dm) slope. Facing south about half a mile southwest of Ruin Basin area.

B. Sleeping Beauty Peak located about 1000 feet south of the southeastern margin of the Ruin Basin area. Dacite (Td) flows overlie massive Escabrosa limestone (Ce) cliffs. Martin limestone (Dm) and diabase (db) form slopes. Facing south from Ruin Basin.

Plate 20

A. Well-stratified Gila conglomerate in basin between the Pinal and Apache mountains. Facing north along Apache Trail.

B. Gila conglomerate near the eastern margin of the Ruin Basin area, not well sorted or well stratified.

Plate 21

A. Diabase alluvium forming on a diabase slope in the southeastern quarter of the Ruin Basin area. Note deep wash cut into the fast weath - ering diabase.

[illegible]. Stratified alluvium in Siphon Wash in south-eastern part of Ruin Basin.

Plate 22

A. Photomicrograph of Ruin granite. Parallel light. X33. Petrographic description on page 85. Qtz=quartz, Or=orthoclase, Al=albite.

B. Photomicrograph of Ruin granite. Crossed-nicols. X33. Minerals as above.

Plate 23

1. Photomicrograph of Ruin granite. Petrographic description on page 85. Parallel light. X33. Or=orthoclase, Qtz=quartz, Ol=oligoclase, Mu=muscovite.

2. Photomicrograph of Ruin granite, crossed-nicols. X33. Minerals as above.

Plate 24

A. Granite monolith of granite porphyry rising above normal rapid-weathering Ruin granite. Note arkosic product of granite weathering.

B. Granite porphyry rising above plain of rapid-weathering Ruin granite. Facing southeast.

Plate 25

A. Resistant cliff-forming diabase in foreground is probably silicified. Normal slope-forming diabase in background.

Slope-forming diabase (db) near Silver Belt shaft (in lower center of picture). Alluvium (Qal) covers diabase in Siphon Wash. Ruin granite (rg) slopes in background.

Plate 26

A. Photomicrograph of diabase of facies one. Petrographic description on page 85. Parallel light. X33. M=magnetite, And=andesine, A=augite, H=hornblende.

B. Photomicrograph of diabase of facies one, crossed-nicols. X33. Minerals as above.

Plate 27

A. Knobby surfaced diabase of facies three occurring on east side of Siphon Basin. Photomicrograph - Plate 28,A, petrographic description page 86.

B. Exfoliation in knobby surfaced diabase of facies three. Note sphericity of smaller cobbles.

Plate 23

A. Photomicrograph of diabase of facies three. Petrographic description page 86. Partly crossed-nicols. X33. A=augite, Lab=labradorite, Qtz=quartz.

B. Photomicrograph of diabase of facies four. Petrographic description page 87. Parallel light. X30. Ap=apatite, M=magnetite, H=hornblende, Lab=labradorite.

Plate 29

A. Hand specimen of gray pegmatitic diabase of facies five on the left. Red pegmatitic diabase of facies six on the right. Note 65 mm. long plagioclase crystal. Descriptions on page 72.

B. Dacite weathering to bouldery surface along rectangular joints. Facing north with Old Dominipn mine tailings pond in foreground, near Globe, Arizona.

Plate 30

A. Photomicrograph of diabase of facies seven. Petrographic description on page 36. Parallel light. X30. Ol=oligoclase, Qtz=quartz, Ap=apatite, H=hornblende.

B. Photomicrograph of diabase of facies seven, crossed-nicols. X30. Minerals as above.

Plate 31

A. Lineated diabase of facies eight. Petrographic description on page 87. Note parallelism of white plagioclase.

Photomicrograph of diabase of facies eight. Parallel light. X30. A=augite, Lab=labradorite, M=magnetite.

Plate 32

Photomicrograph of diabase (?) of facies nine. Petrographic description on page 88. Parallel light. X33. Al=albite, Per=perthite, Sp=sphene.

Photomicrograph of diabase (?) of facies nine, crossed-nicols. X33. Minerals as above.

Plate 33

Hand specimen of diorite porphyry showing molds where hornblende phenocrysts have been leached out.

Photomicrograph of diorite porphyry. Petrographic description on page 88. Parallel light. X33. H=hornblende, B=biotite, [illegible]=matrix, M=magnetite.

Plate 34

A. Photomicrograph of dacite displaying flow structure in the matrix. Petrographic description on page 89. Parallel light. X33. Ma=matrix, Qtz=quartz, And=andesine, B=biotite, Sp=sphene.

B. Photomicrograph of dacite. Note broken crystals. Crossed-nicols. X30.

Plate 35

Bedding plane fault between dacite tuff above and diabase (db) below. In the center of the picture is an ancient valley filled with alluvium (gravel) which must have existed on the diabase surface before the eruption of tuff.

Sharp horizontal contact between tuff above and diabase (db) below. This diabase surface must have been free of alluvium at the time of the tuff eruption.

Plate 36

A. Photomicrograph of vitrophyre displaying flow structure around fresh phenocrysts. Petrographic description on page 89. Parallel light. X30. Py=pyrite, Qtz=quartz, And=andesine, B=biotite, Ma=matrix.

B. Photomicrograph of vitrophyre, crossed-nicols. X65.

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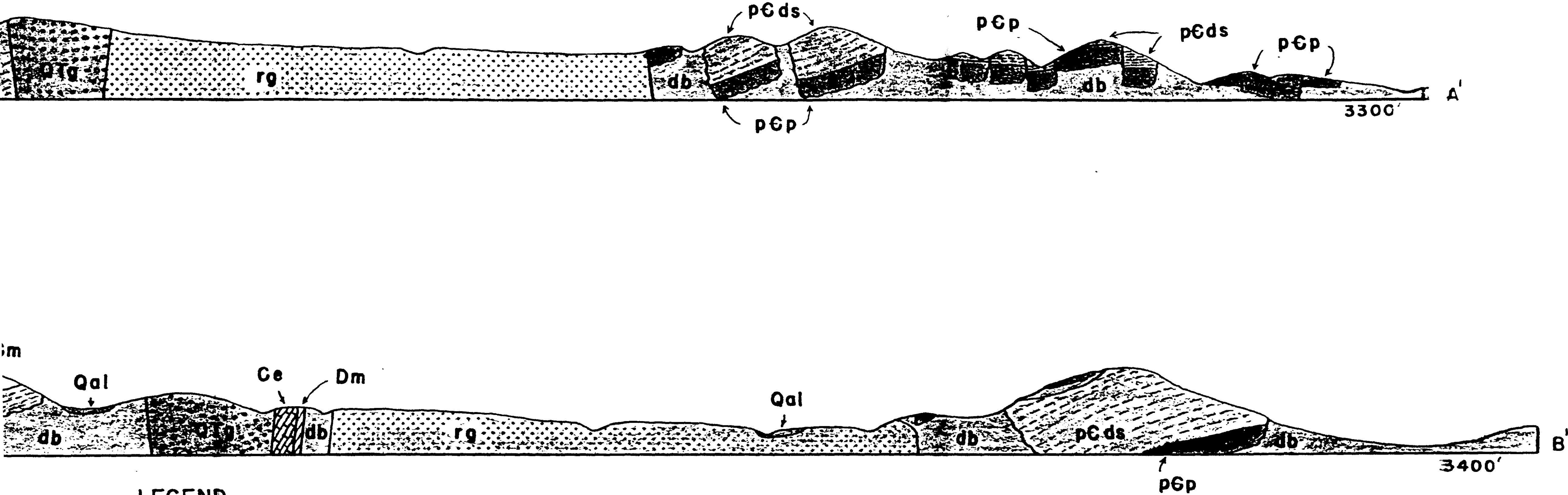
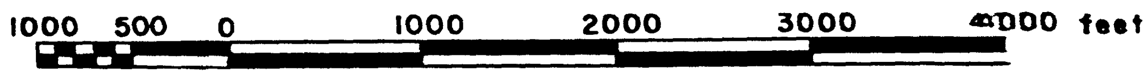


LEGEND

Qal	Alluvium	Quaternary	
Qg	Gila Cgl.	Tertiary	...onian
Td	Dacite	Tertiary	
db	Diabase	Post Mississippian	...ambrian
Ce	Escabrosa Ls.	Mississippian	

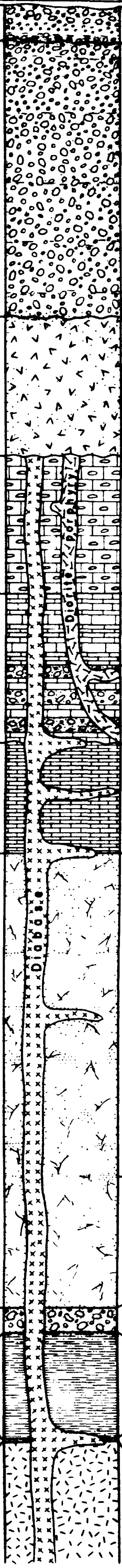
Sections to accompany geologic map plate II.

Horizontal and vertical scale 1" = 1000 feet.



GEOLOGIC SECTIONS OF THE RUIN BASIN AREA

51-54



PERIOD	FORMATION	SECTION	CHARACTER	THICKNESS (feet)
Q.	Alluvium		Conglomerate: light brown, thin-to thick-bedded; weathers to slope; matrix: light brown arenaceous; cement: weak, fine sand and silt; gravel: pebble to cobble size; composed of rocks from all older formations; stream deposited.	50 ±
	UNCONFORMITY			
Tertiary (?)	Gila conglomerate		Conglomerate: tan, white and grey, thick-bedded; weathers to slope; matrix: tan and grey, arenaceous to argillaceous; cement: calcareous, weak to firm; gravel: pebble to cobble size; composed of rocks from all older formations.	400 ±
	UNCONFORMITY			
Tertiary	Dacite		Dacite: pinkish gray, fine-grained; contains no conspicuous layering; usually weathers along rectangular joints to form bouldery surface; locally weathers to resistant cliff; water laid tuff capped by vitrophyre normally underlies dacite.	200 ±
			Diorite porphyry: buff, porphyritic; dikes and sills; weathers readily to soil and forms slope; phenocrysts: dark green hornblende 10 m.m. long, weathers out to leave molds; matrix: buff, fine-grained crystalline aggregate.	50 ±
	UNCONFORMITY			
			Diabase: very dark gray, ophitic texture, medium-grained and porphyritic; dikes, sills and intrusive masses; weathers to slope.	5 - 500 +
Lower Mississippian	Escabrosa limestone		Limestone: yellowish gray, fine-grained, sugary, massive; contains chert nodules, fossils: sparse silicified cup and colonial corals and brachiopods, weathers to surface with large sharp-edged pits; forms resistant cliff.	200 ±
Upper Devonian	Martin limestone		Limestone: light gray, medium-to coarse-grained, thin-to moderately thick-bedded (4"-3'), in places is argillaceous and at others contains arenaceous nodules; contains fossils (colonial corals, crinoids, brachiopods); weathers to resistant cliff.	102 ±
			Conglomerate alternating with limestone: weathers to cliff. Conglomerate beds: various shades of red and gray, thin-to thick-bedded; matrix: arkosic and quartzitic mineral aggregate; cement firm, silica; gravel: 1-35 m.m. diameter; not well rounded; composed of feldspar and quartz. Limestone beds: light grey, fine-to coarse-grained, thin-to moderately thick-bedded, dolomitic to arenaceous.	116 ±
	UNCONFORMITY			
Younger Pre-Cambrian, Apache group	Mescal limestone		Limestone: medium to light grey, fine-grained, dense, thin bedded; weathers with moderately rough surface; forms resistant cliff. Altered to serpentine and to fine-grained quartz.	160 ±
	Dripping Spring quartzite		Upper quartzite: light grey, yellowish grey and red; fine-grained, thin- to thick-bedded, argillaceous; weathers to slope. Beds predominantly grey in lower part and red in upper part.	470 ±
			Lower quartzite: greyish orange, medium-grained, moderately thin-bedded, arkosic, cross-bedded; cement firm; weathers to resistant cliff, 40 foot white massive member at top.	200 ±
	Barnes conglomerate		Conglomerate: light brown, massive; weathers to resistent cliff; matrix: light brown, arkosic, sandstone to quartzite; cement firm, siliceous gravel: white, red brown, brown, gray, pink and red; well rounded; pebble to cobble size; composed mainly of quartzite.	5-35
	Pioneer shale		Shale: red, arenaceous; fine-grained, thin-bedded; contains white spots; weathers to slope.	160 ±
	Scanlan conglomerate		Conglomerate: reddish orange, moderately thick-bedded; weathers to resistent cliff; matrix: grey, arkosic and quartzitic debris; cement siliceous, firm; gravel: gray quartz and red feldspar, ¼" to 4" diameter moderately rounded.	1-5
	UNCONFORMITY			
Older Pre-Cambrian	Ruin granite		Granite: reddish orange, coarse-grained to porphyritic; weathers to crumbly mass; forms slope.	

PLATE 4 GENERALIZED COLUMNAR SECTION, RUIN BASIN AREA, ARIZONA

N CHART OF MEASURED SECTIONS RUIN BASIN AREA, ARIZONA.

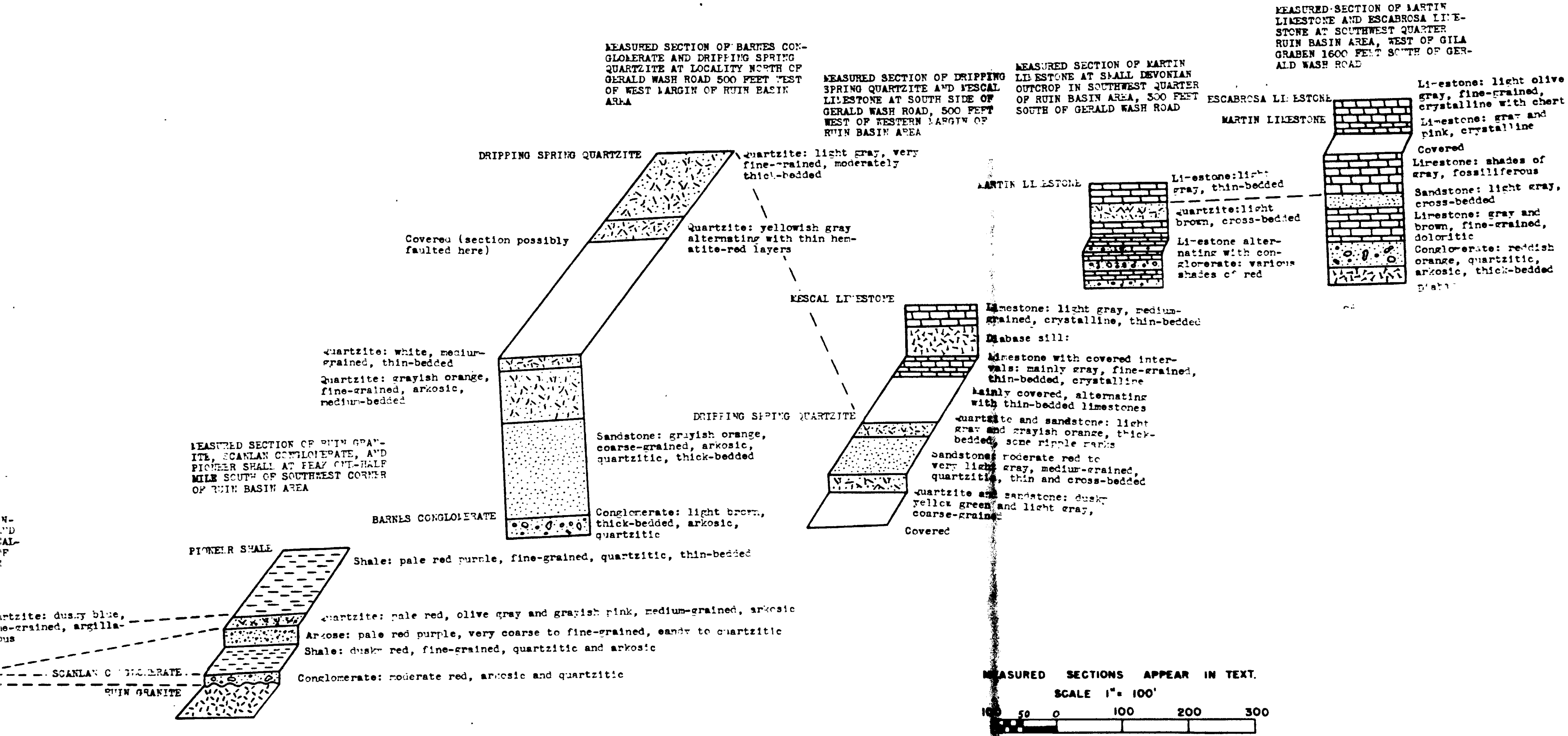
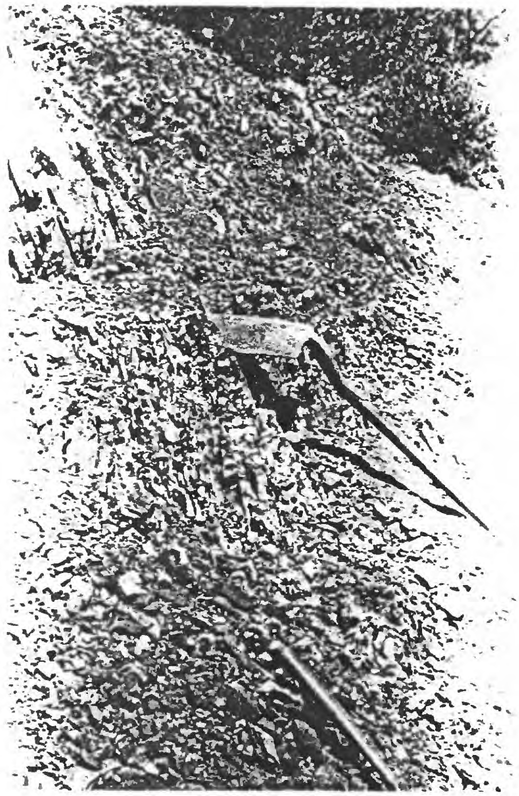


PLATE-6



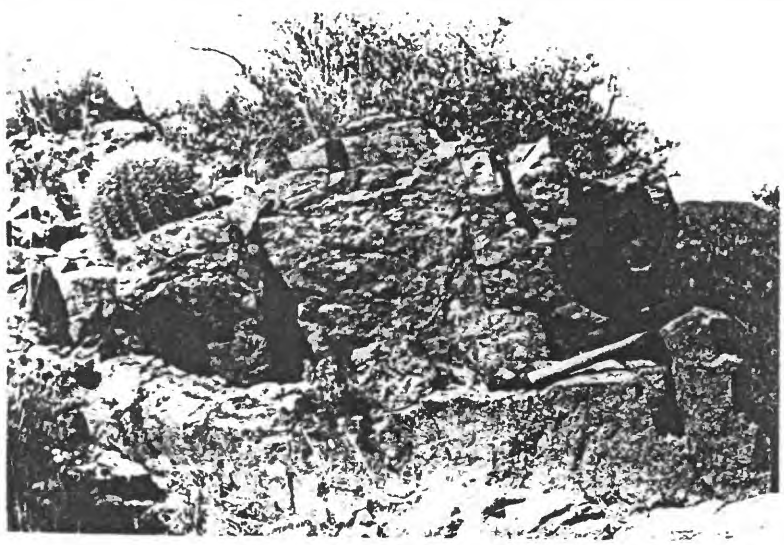
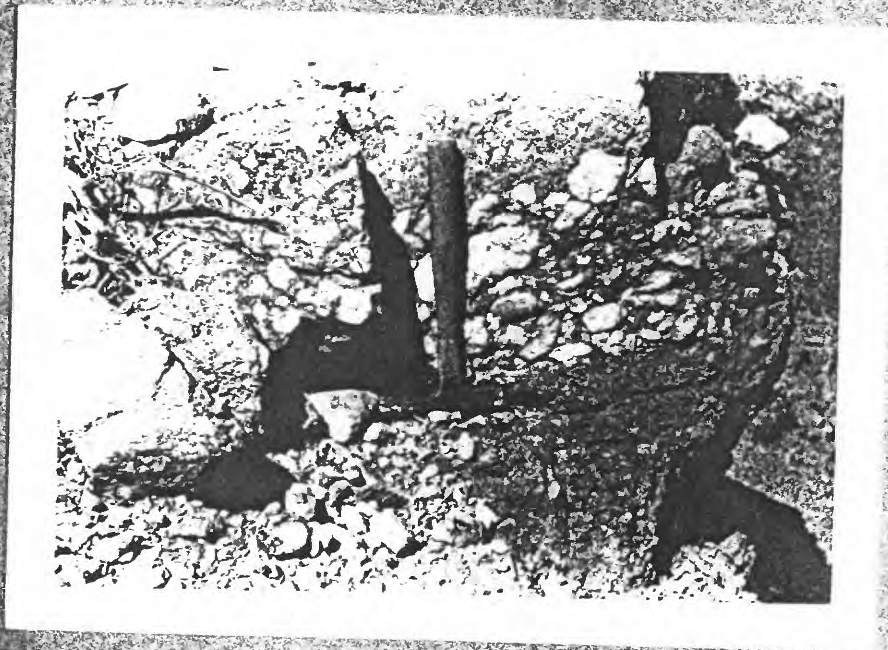


Plate 7



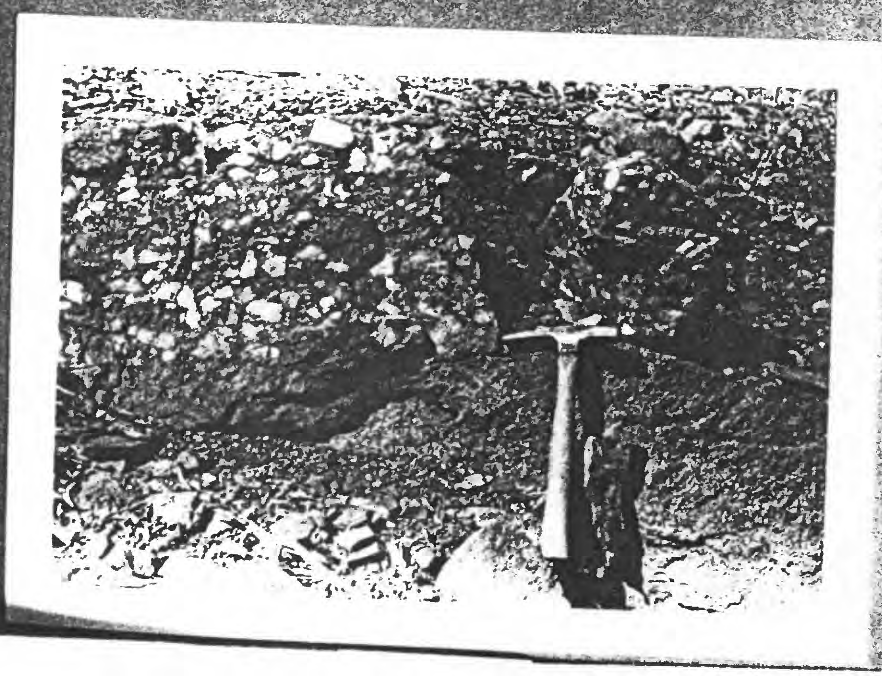
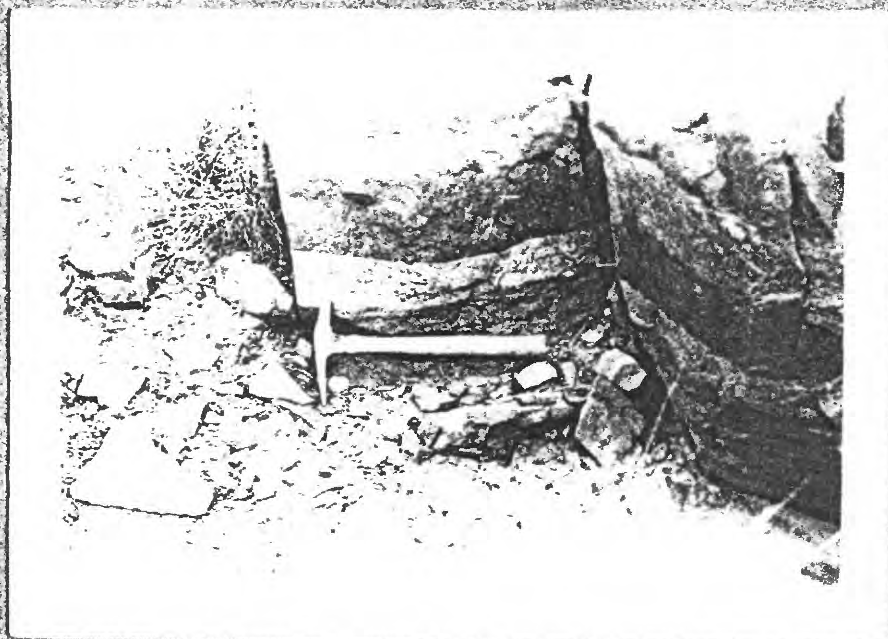
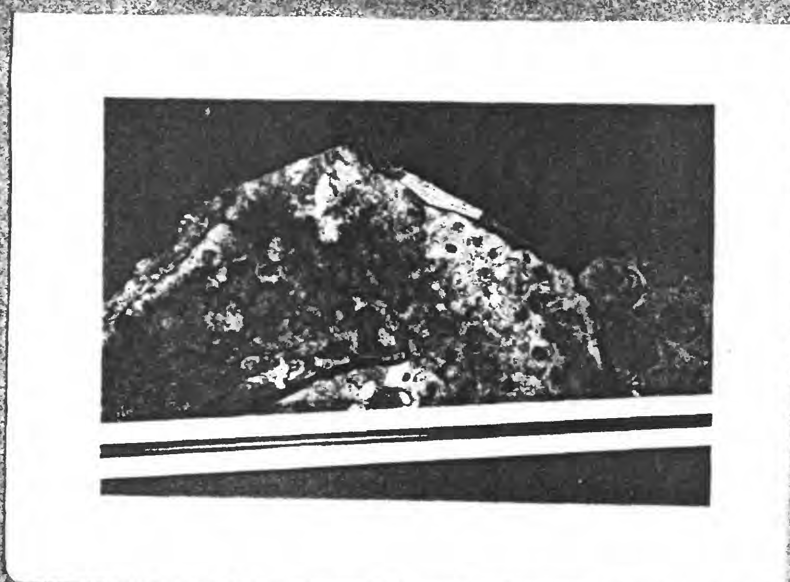
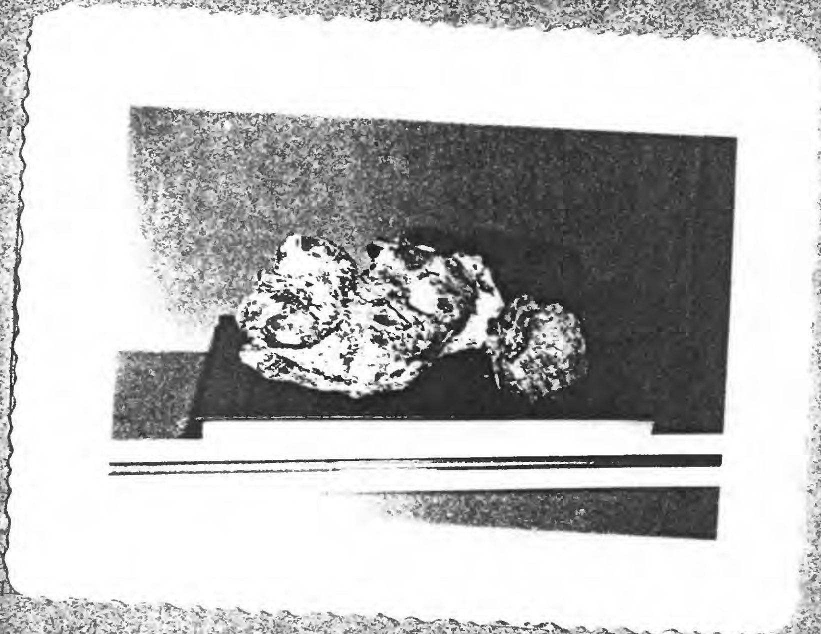
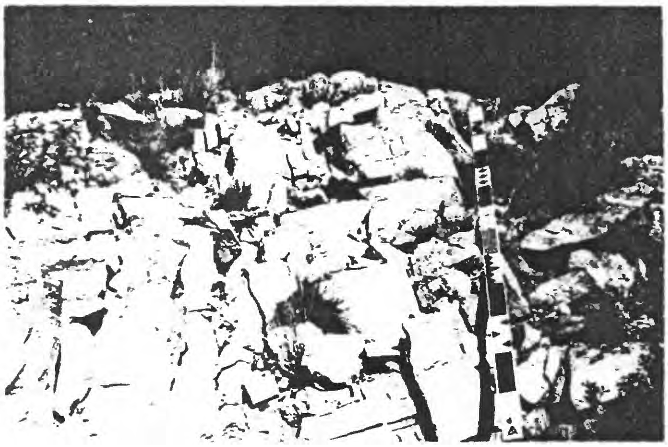


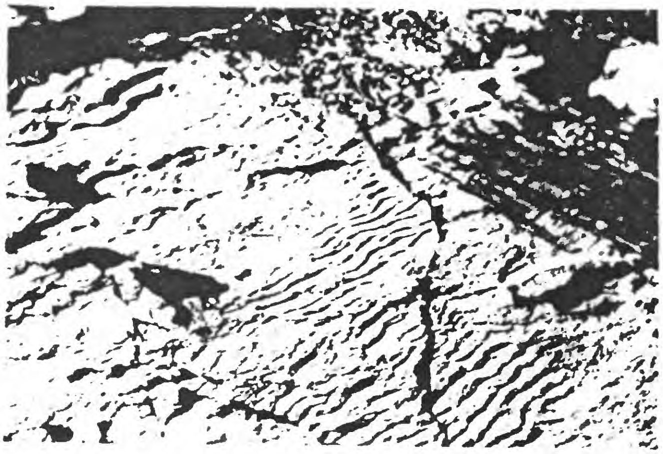
Plate 8

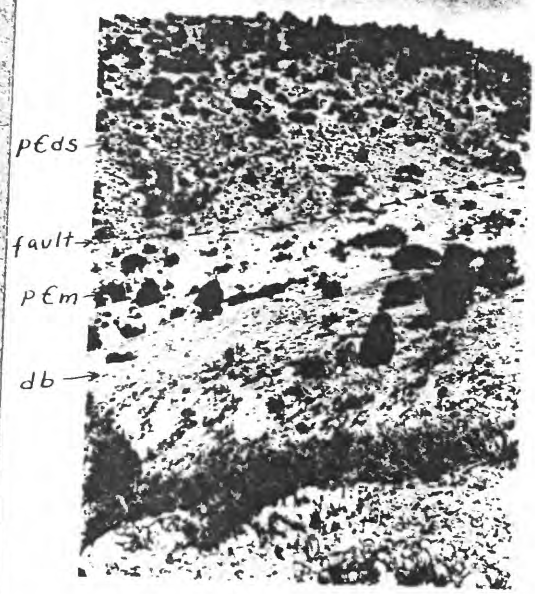












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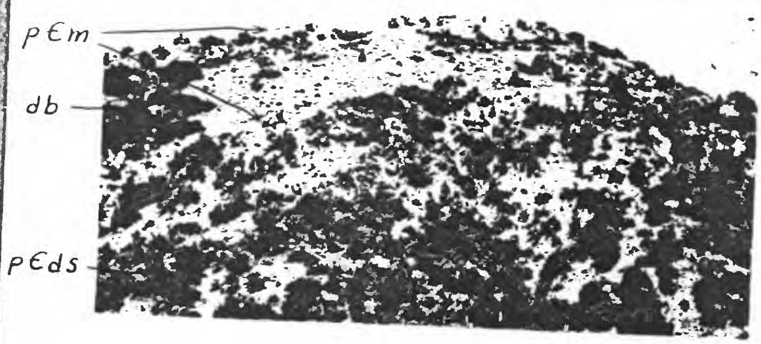

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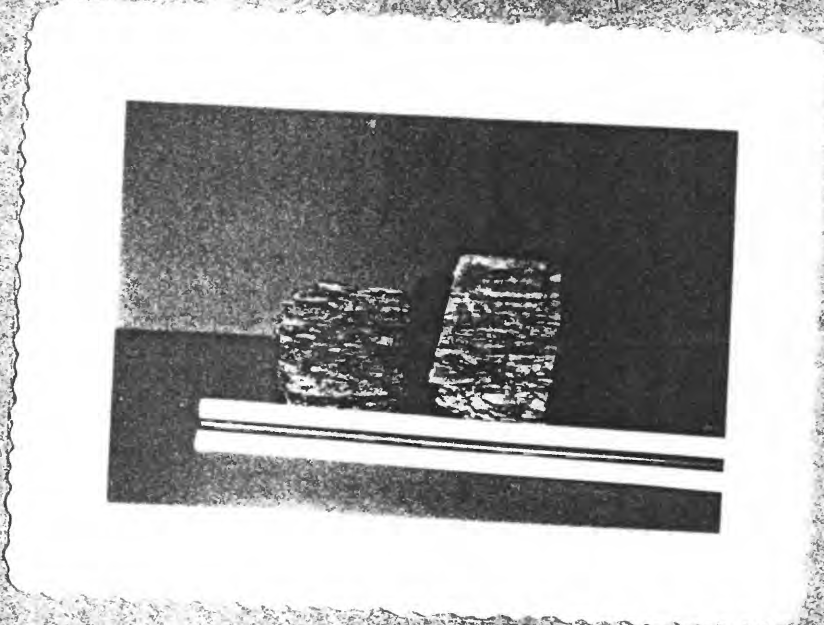
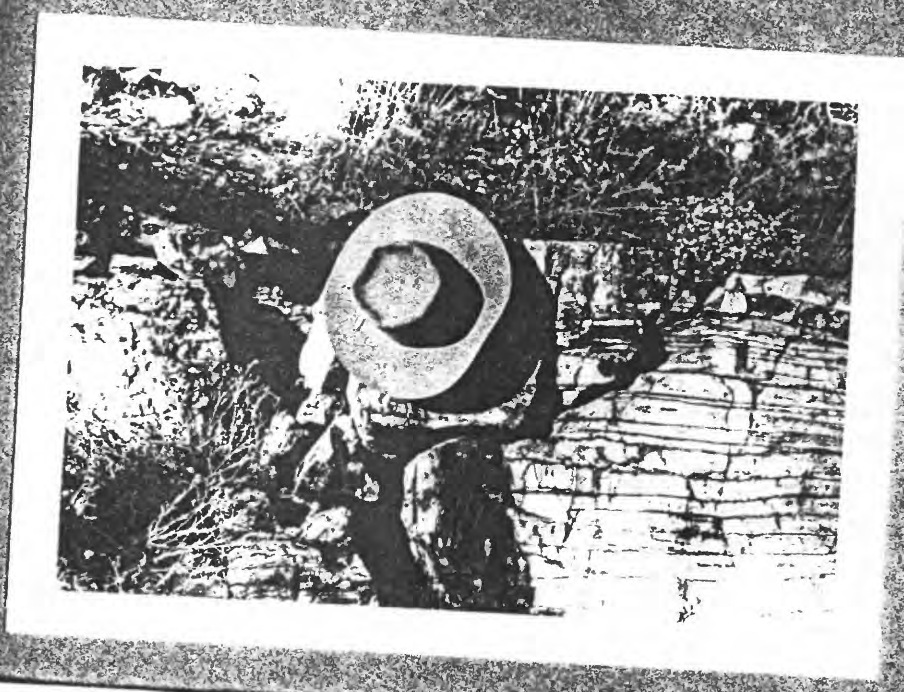
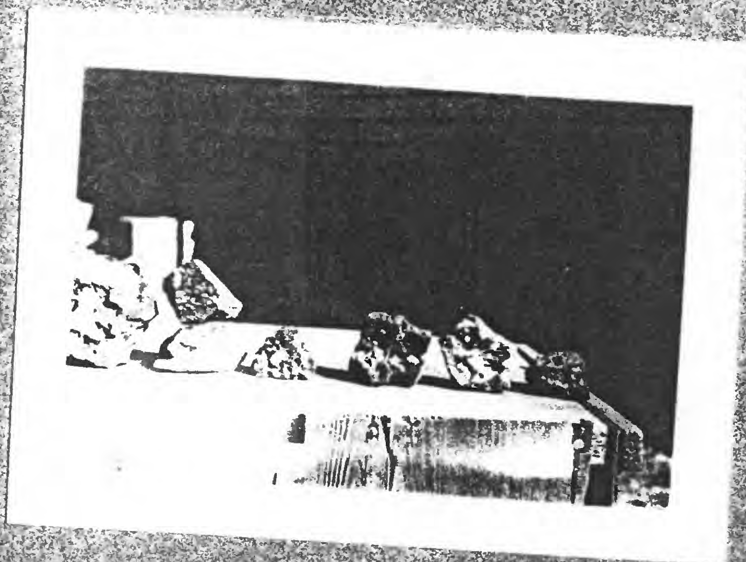
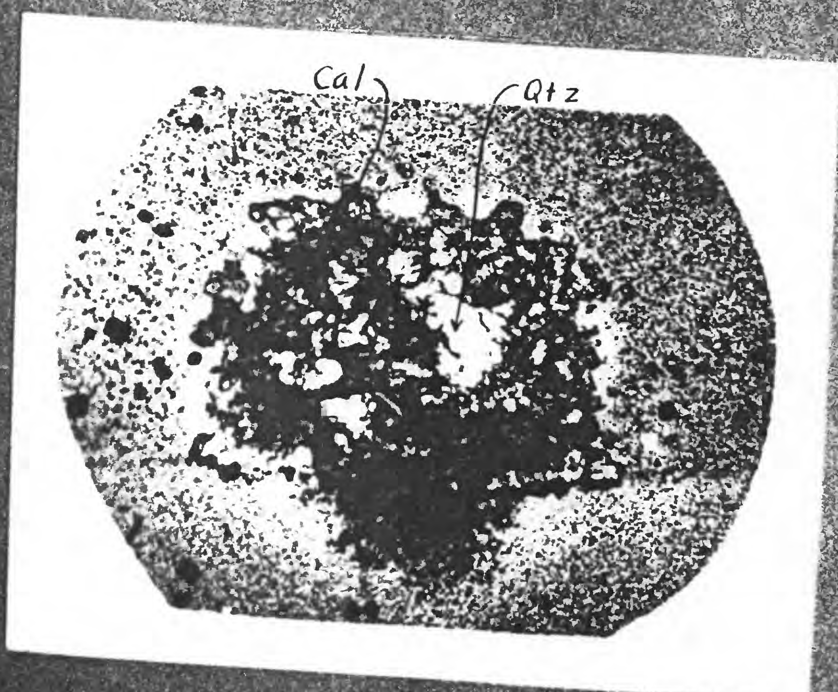
Plate 12





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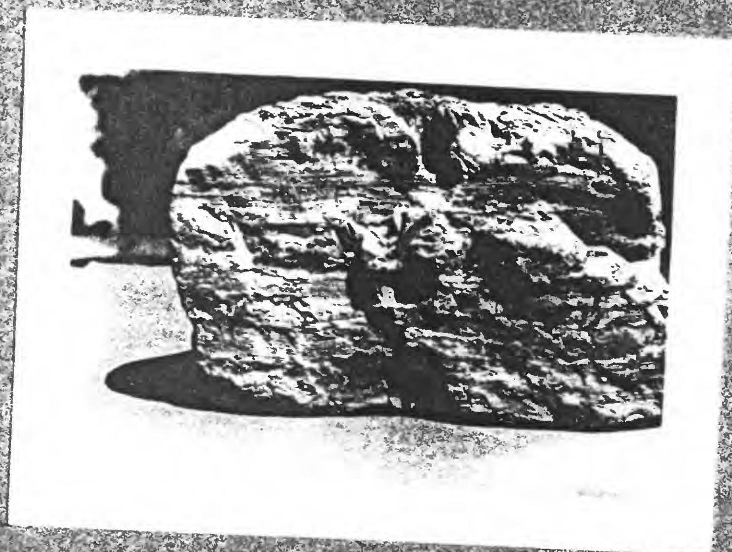
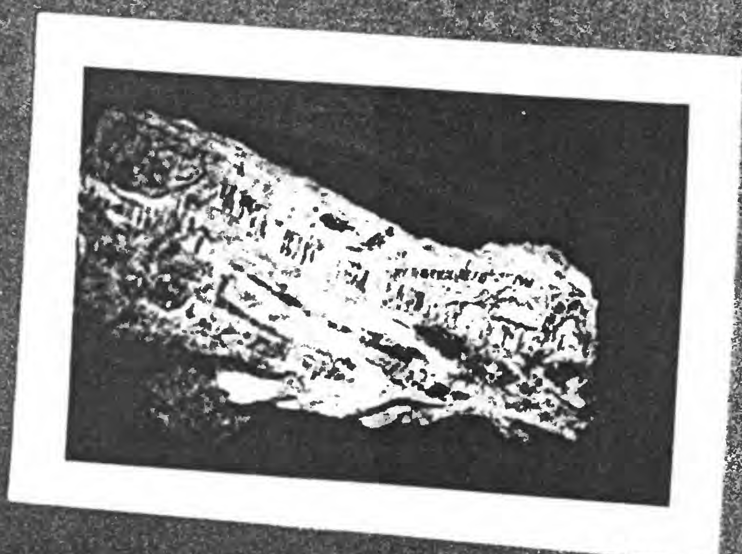




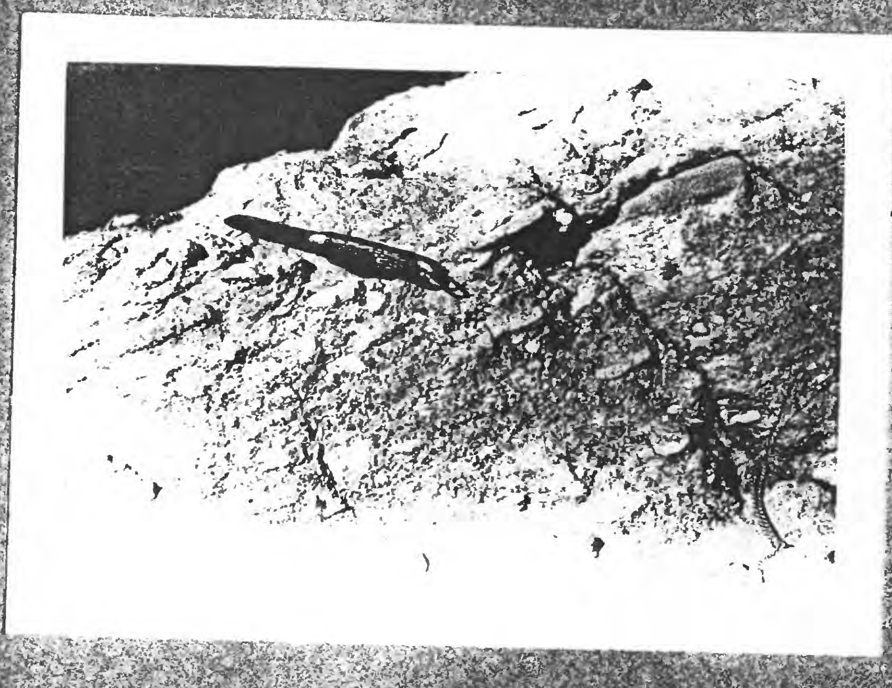
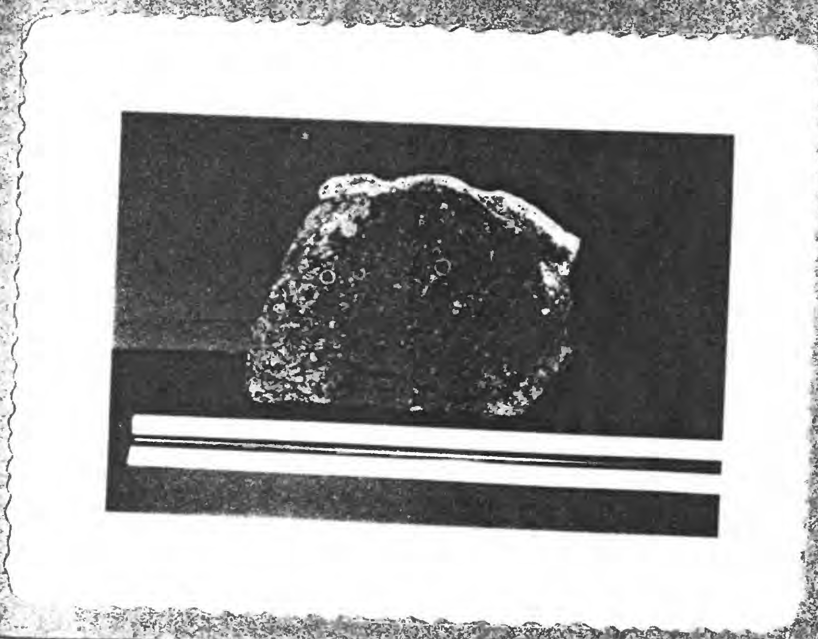
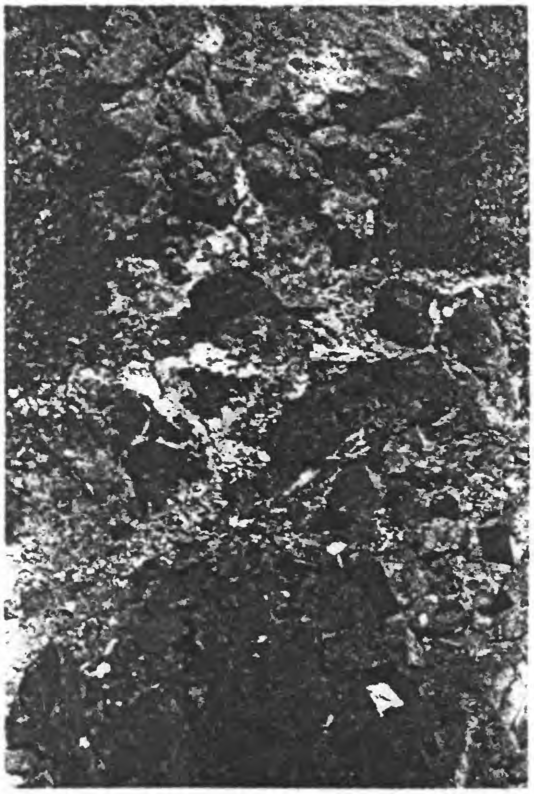
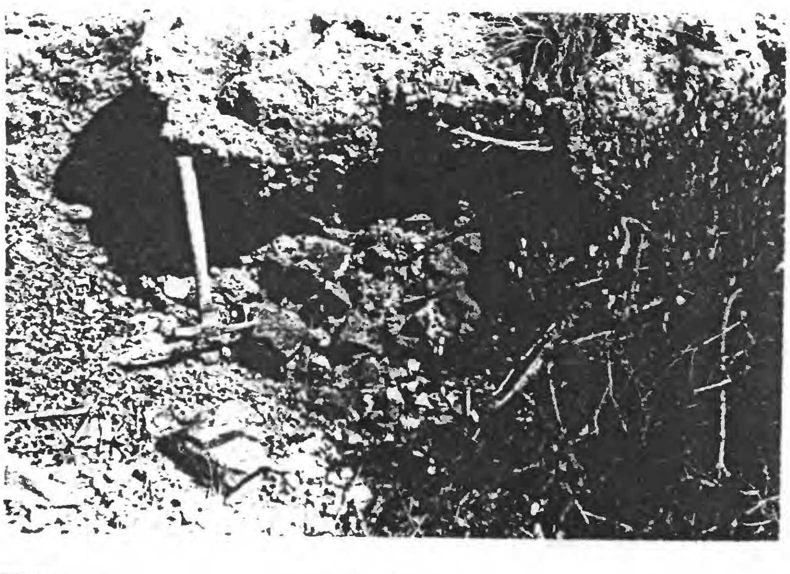
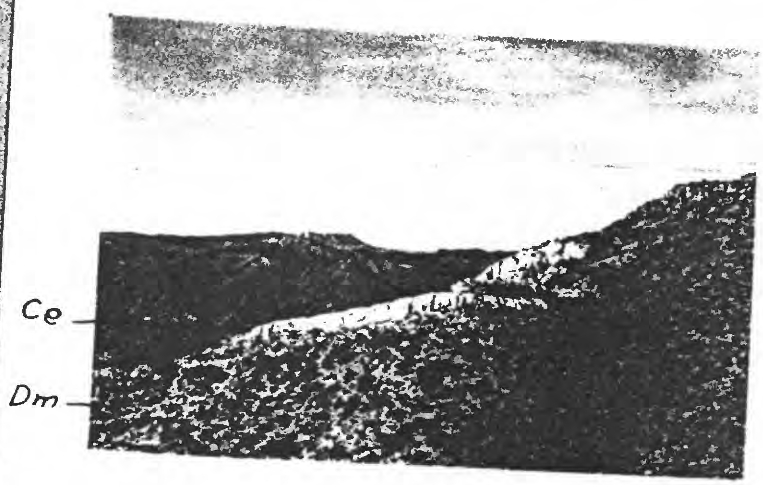


PLATE-16





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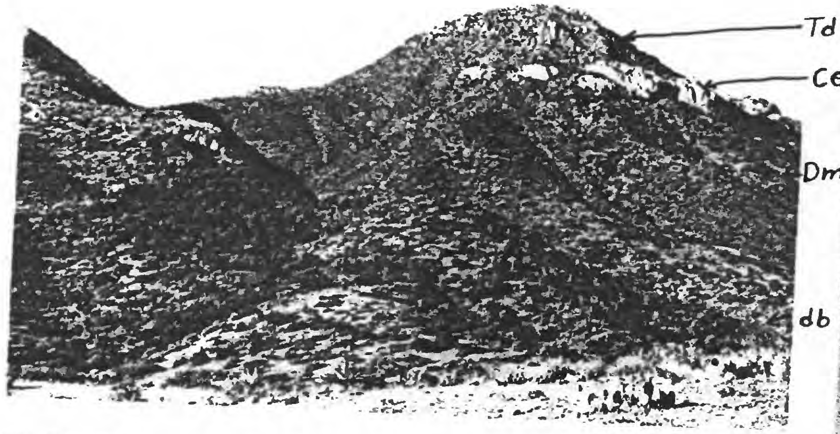
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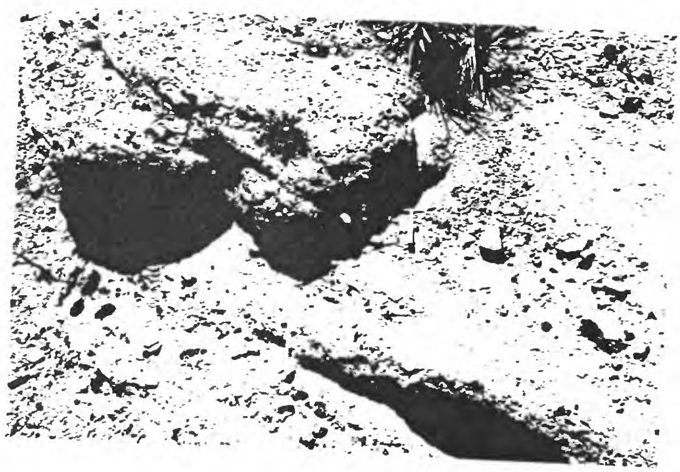

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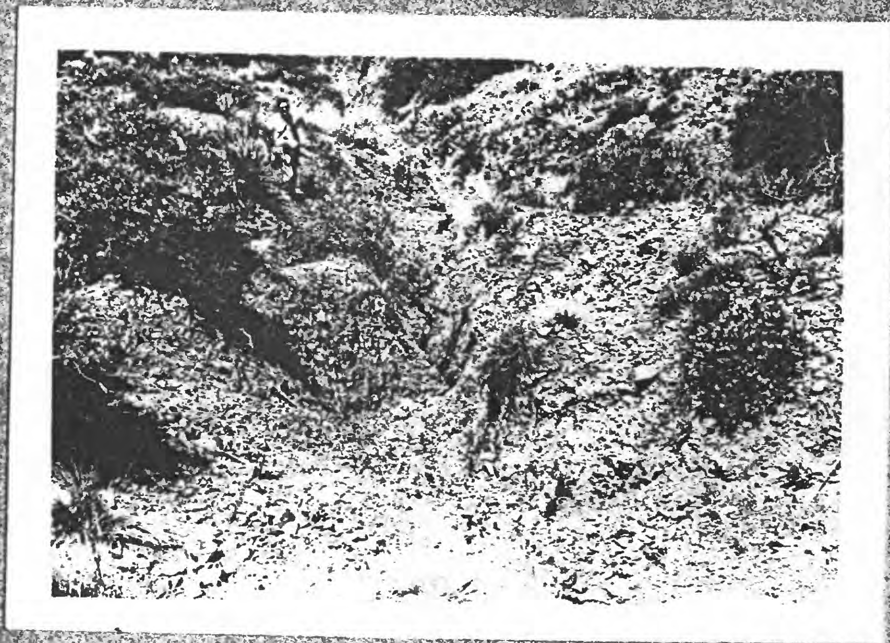


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Plate 23

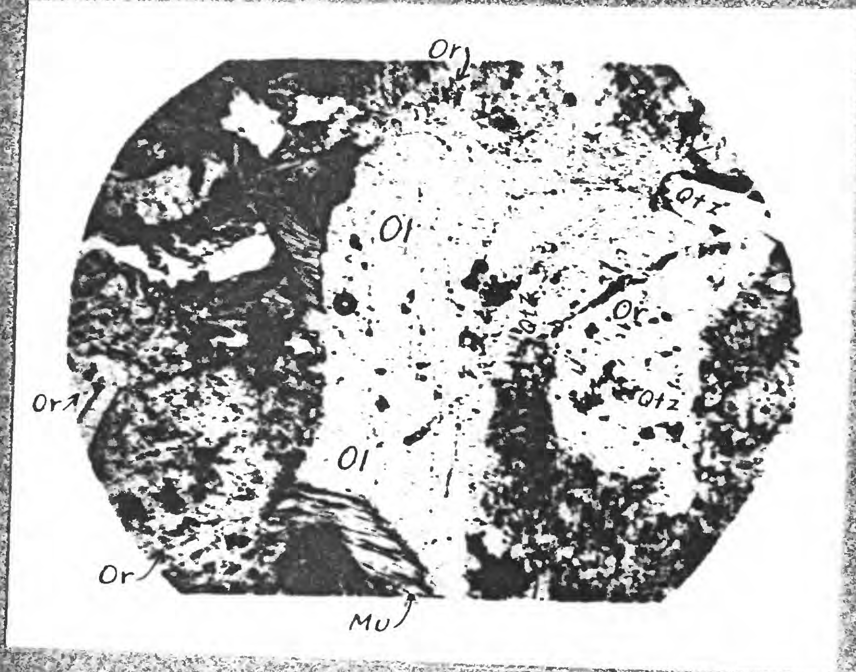

Plate 24


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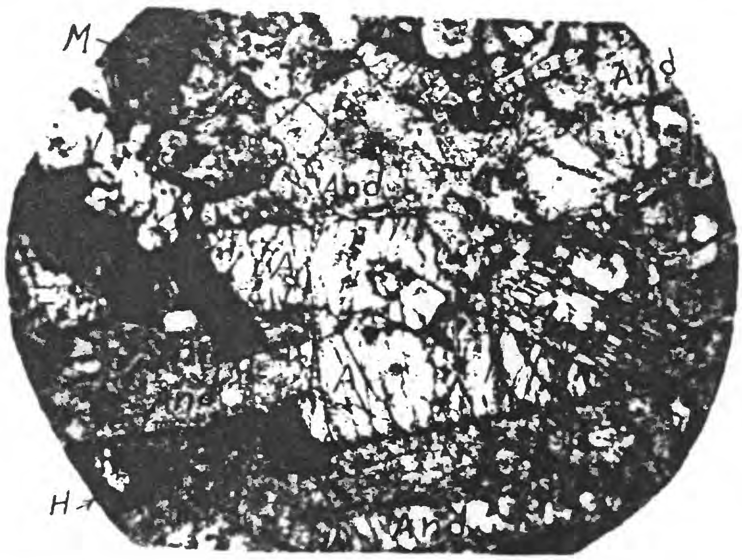
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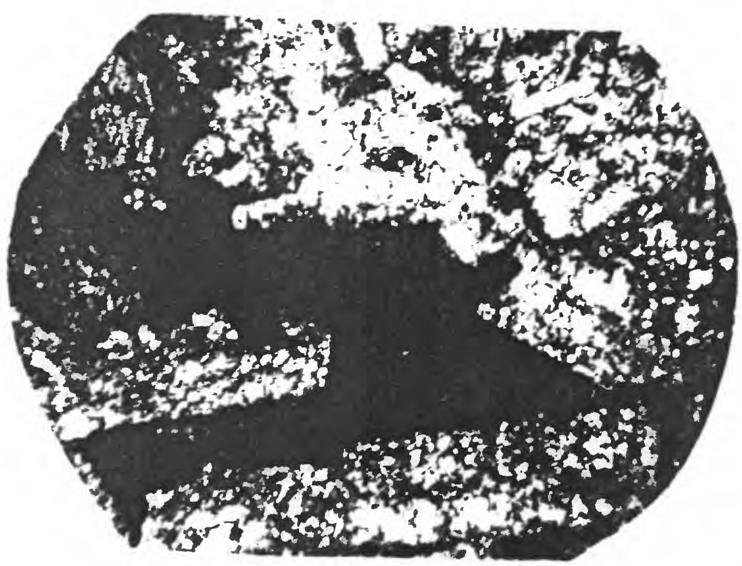

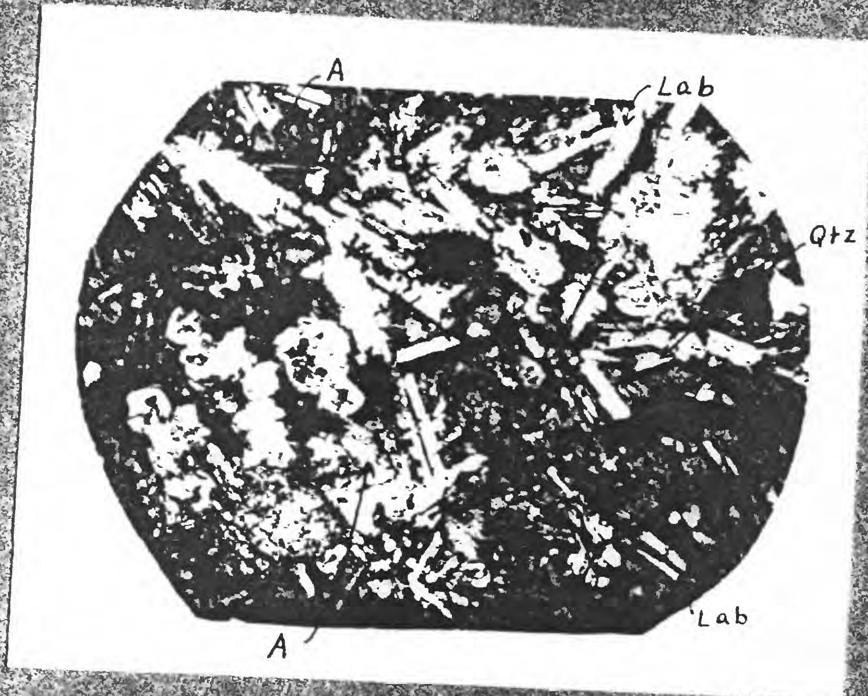
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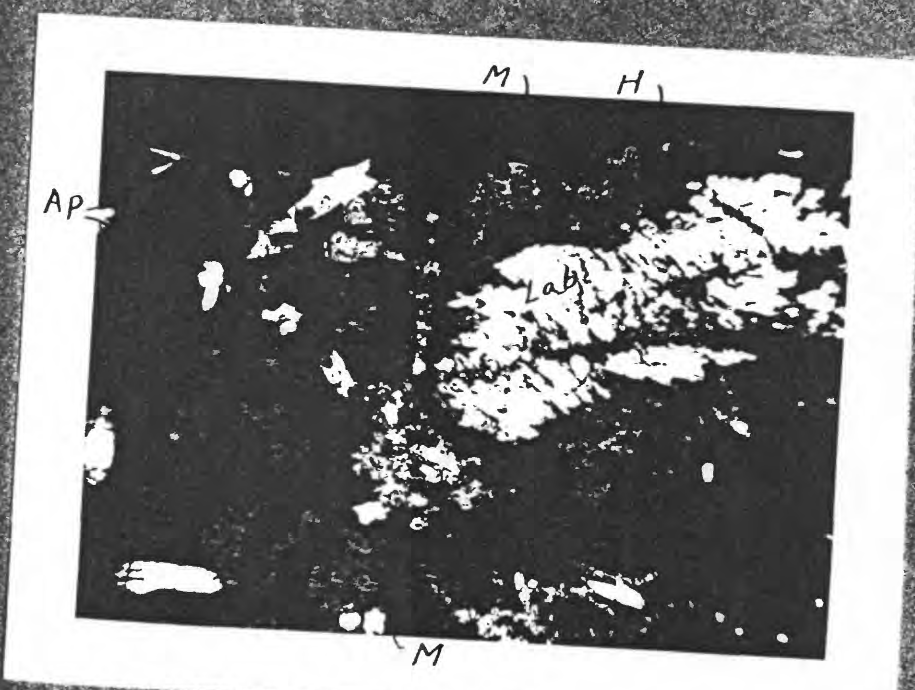
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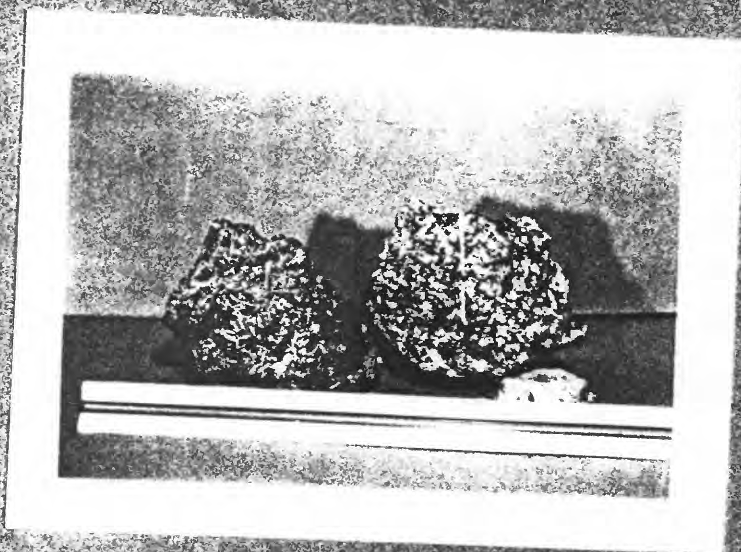

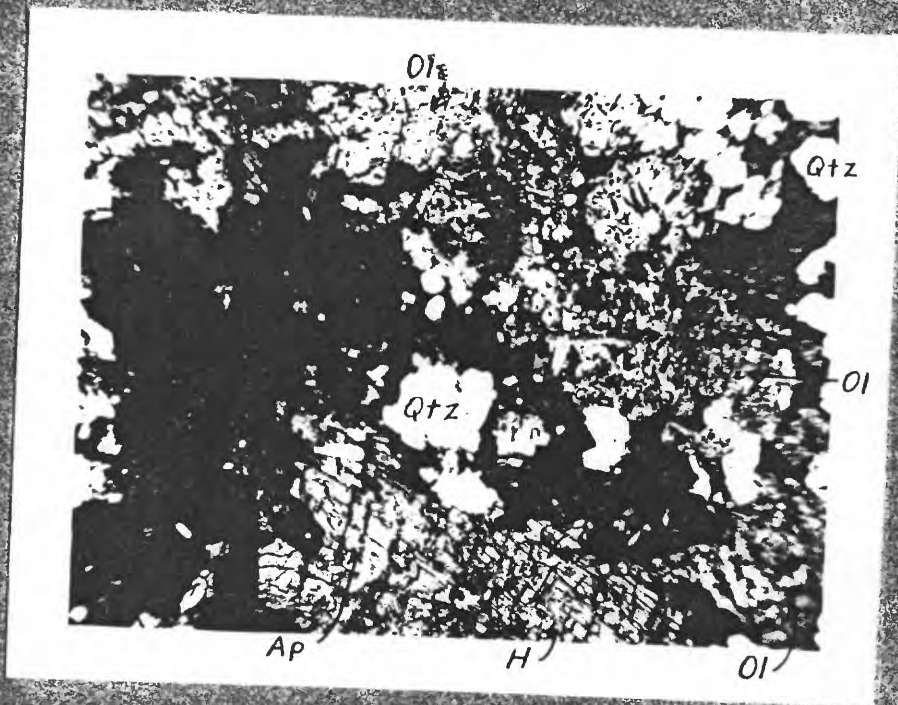
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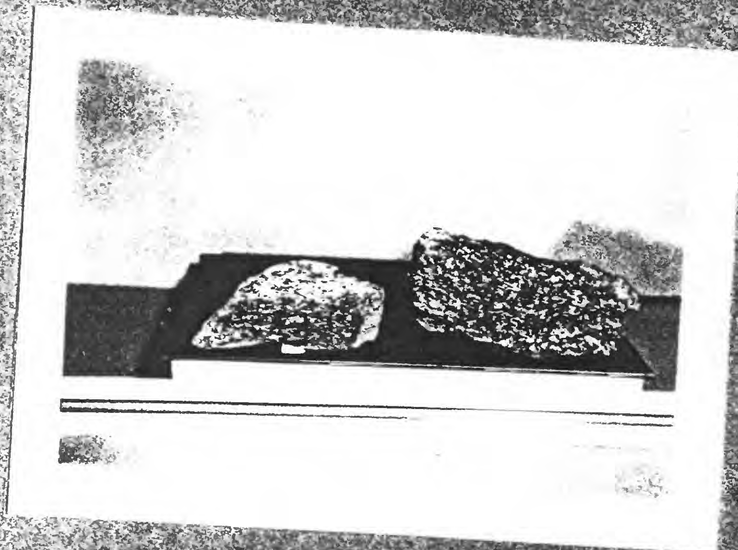

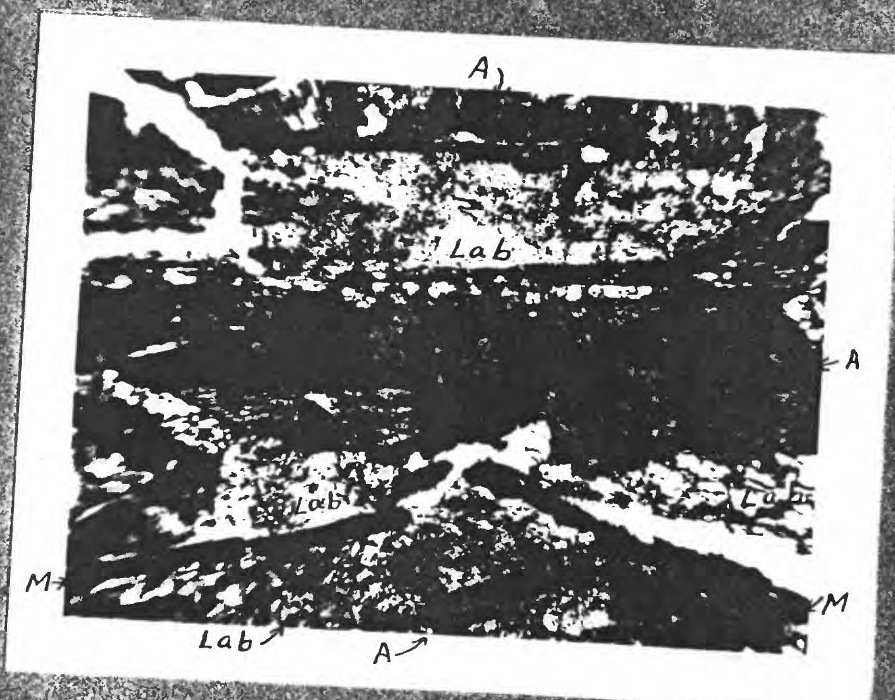
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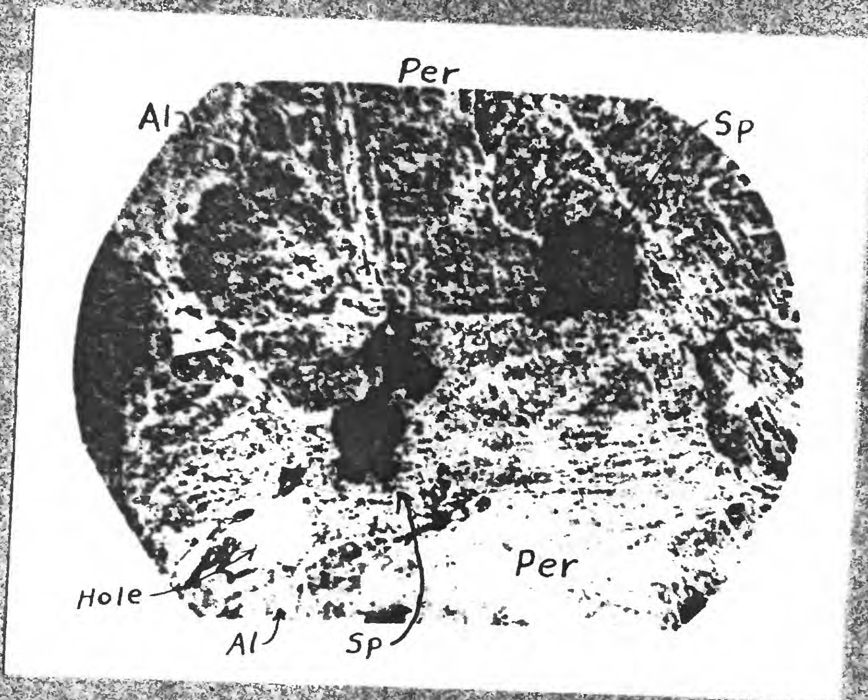
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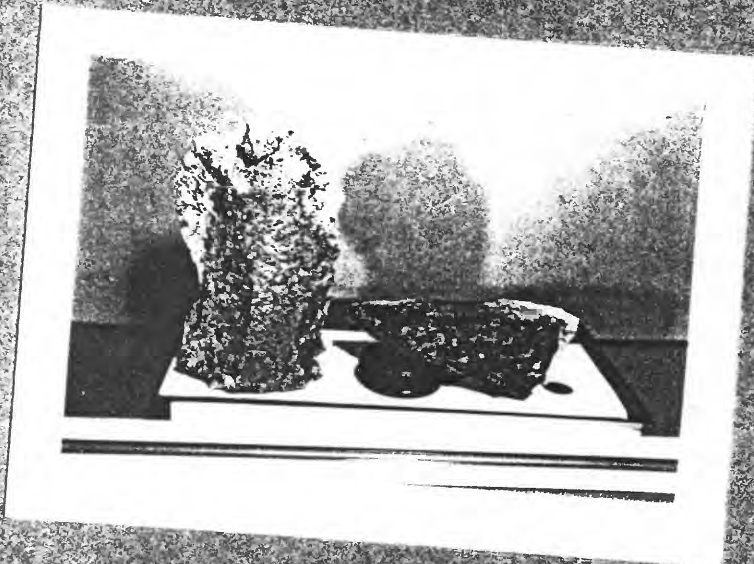

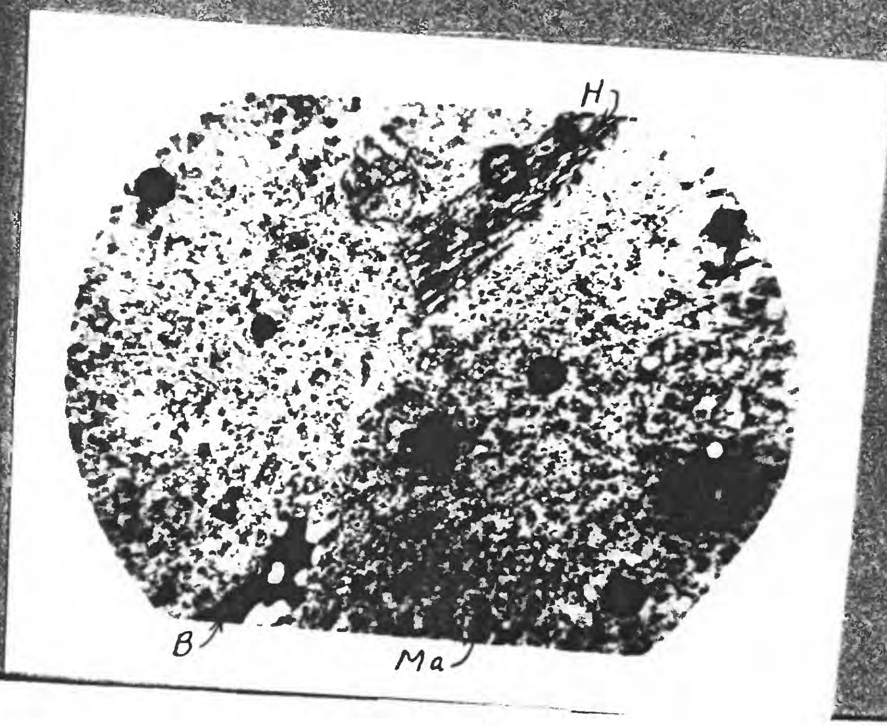
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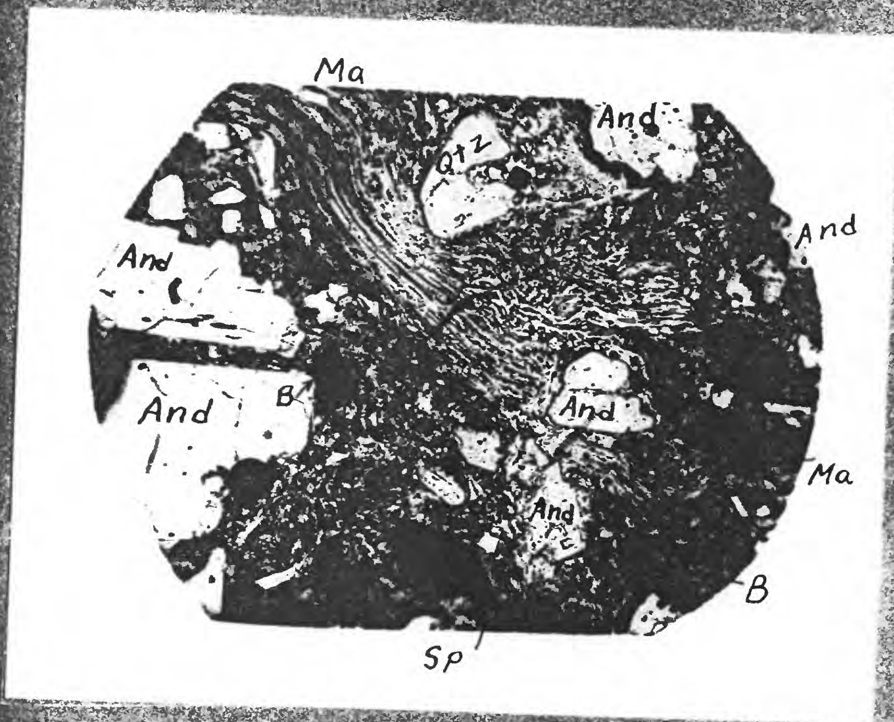
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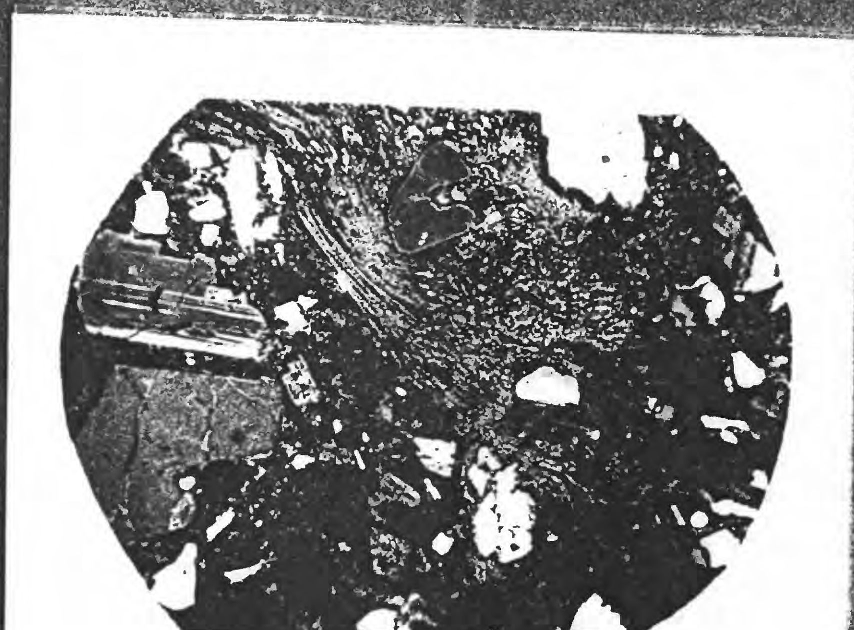

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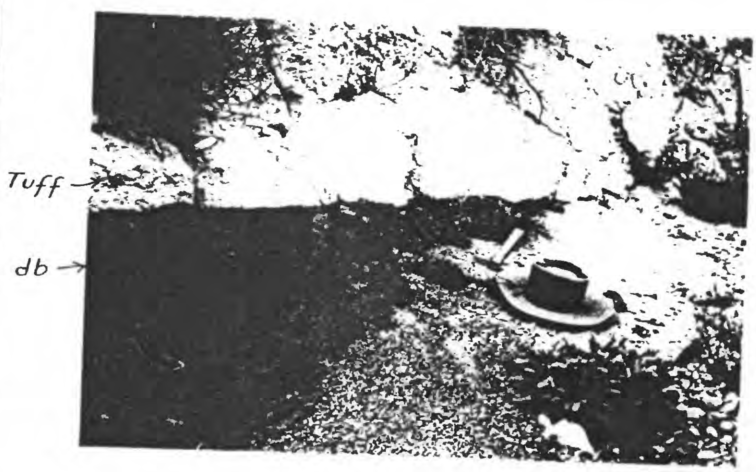

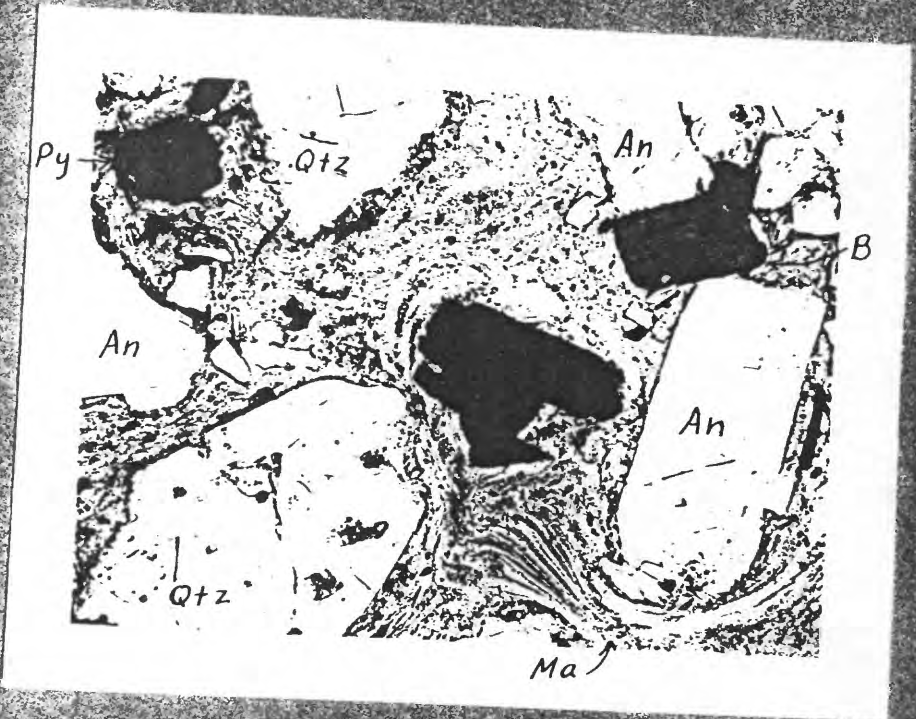
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