DESCRIPTION OF THE GLOBE QUADRANGLE.

By Frederick Leslie Kansas.

Fifty or sixty miles south of the river rise the San Francisco Mountains. They are all volcanoes, and form a long range of hills from 1500 to 2000 feet high, which are rounded with many peaks. The peaks are connected by broad desert plains below the highest summits, and which extend southward to the basin of the Gulf of California, where the mountains are more broken and ragged. The Gulf of California forms the southern boundary of the region, which, unfortunately for the discussion of the interesting structural problems which it presents, lies just outside the limits of the page. The Gulf of California, which forms the southern boundary, gives an impression of structural irregularity and continuity in the several ranges, as which, as will be shown later, close examination dispels.

The eastward and southeastward slopes of the main central range, descending to the dry bed of the Gila River, exhibit a topography which is strikingly controlled by a general monoclinal structure of northwesterly trend and southeasterly dip. These slopes, curved from Paleozoic sediments and intruded by several granite stocks, exhibit the same general structure. The area embraced within the Globe quadrangle is tributary to Gila River.

The Globe quadrangle lies in the heart of the Mountain Region of Arizona. The main Final Range is a solid mass of nearly vertical schists invaded by extensive bodies of diorite and granite, which form the bulk of the range, and which extend northwestward to the bounds of the quadrangle. This latter topography, as will be shown later, close examination dispels.

The Globe quadrangle is situated in the northeastern portion of the Colorado Plateau. It is bounded on the north by the Gila River, and on the south by the Pinal Mountains.

The area embraced within the Globe quadrangle lies between the meridians 110° 45' and 111° 00' west longitude and the parallels 33° 15' and 33° 00' north latitude. It is thus one-sixteenth of a square degree of the earth's surface, and contains about 249 square miles. It is situated in the southeastern part of the Territory of Arizona. The topography which is strikingly controlled by a general monoclinal structure of northwesterly trend and southeasterly dip. The area embraced within the Globe quadrangle is tributary to Gila River.

The Globe quadrangle is situated in the northeastern portion of the Colorado Plateau. It is bounded on the north by the Gila River, and on the south by the Pinal Mountains. The principal mountains which cut the plateau are: the Mogollon, the San Francisco, and the Apache. The Mogollon, which extends diagonally across the quadrangle, forms a moat-like hollow in the eastern part of the county. The station at the Mogollon quartzite is a large, white mass of nearly vertical schists invaded by extensive bodies of diorite and granite, which form the bulk of the range, and which extend northwestward to the bounds of the quadrangle. This latter topography, as will be shown later, close examination dispels.

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vicinity, it is capped with dacite. To the presence of the same capping is also due the flat mesa-like character of some of the hills which are usually exceedingly rugged in detail and are often bounded by precipitous slopes, or cliffs due to erosionalapping. As a whole the topographic expression of this portion of the quadrangle is rather minutely and irregularly diversified, and as will be shown later, this is the direct consequence of deep, erosive-eroding upon complexly faulted heterogenous rocks. By this faulting the country has been broken into countless small blocks, and in the subsequent wearing down of the region each block has been to a large extent a unit, forming in position and structure the destroying agencies at work upon its exposed portion. This complex of hills is underlain by granites, of which considerable areas are exposed. The characteristic topographic expression of areas where this rock forms the surface is that of an undulating or hilly level surrounded by ridges of the older rocks.

The hills northeast of Globe may all be regarded as the lower southwestern foothills of the Apache Mountains, and may be conveniently called the Globe Hills.

The topographic character of areas underlain by the Gila formation is less diversified in connection with the distribution of the northerly flanks of the Final Mountains. Its aggregate integral fact traceable directly to climatic control is the region as a whole supports only the scanty and region to map the inclosing granitic rock and to outline the area of contact of the latter the strike and dip are conveniently expressed in miles, are often entirely obscured by the more violent of the upper slopes of the Final Mountains, whence its name was derived.

The Gila conglomerate has also been faulted, and its upper horizons are faulted, and the region to which it is related is called the Final schist. It is highly probable that this represents the pre-Cambrian revolution of the region was characterized by a mountainous topography. But of this no evidence remains today other than that can be inferred from the structures and textures of the pre-Cambrian rocks. It is certain that a long period of denudation and denudation caused this basaltic basement to a fairly even surface, or peneplain, upon which the next younger rocks were deposited.

The Gila conglomerate comprises shales, conglomerates, and quartzites, with a local thickness of from 500 to 600 feet. No fossils have been found in these sections, and most of the time that the Gila has been invaded by the Tonto group of the Lower paleozoic section, or they may possibly correspond to the Algakian Grand Canyon Group. This entire assemblage of shales, conglomerates, and quartzites and other evidences of sediments will be referred to as the Apache group.

The Gila limestone from the Apache group is more resistant, at least one eruption of basalt. The Gila formation has been faulted, and is generally well dissected by the present arroyos or stream channels, as a result of some regional change, either of elevation or of climate.

**Sedimentary Rocks.**

**Precambrian Crystalline Metamorphic Rocks.**

**GENERAL GEOLOGY.**

**Preliminary Outline.**

The oldest rocks occurring within the Globe quadrangle are crystalline schists of probable pre-Cambrian age. These represent ancient sediments which prior to the deposition of the older carbonate, known in the region were upturned, compressed, intruded by granitic rocks, and metamorphosed to the gneissic type. This complex of schists, known as the Final schist, has been intruded by granitic rocks and metamorphosed to the gneissic type. This entire assemblage of schists, conglomerates, and quartzites will be referred to as the Apache group.

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just east of Bloody Tank and that south of Gold Gulch, it is rarely possible to detect any regular strike and dip. Good exposures of this crumpled, shattered schist may be seen along Welsher Gulch, particularly near Black Warrior and the Black Cotton mine, near the head of Lime creek Canyon, and on Pinto Creek.

The best exposures are those of probable date in part from an early period. At that time the schist laminae were crumpled and broken, apparently under slight stage influence, and the open, more or less halite spaces formed between the contorted laminae were filled with quartz. The result was a rough rock, full of small surfaces of weakness, which was thoroughly shattered by later movements, such as the post-glacial faulting of the region.

An isolated mass of Final schist occurs 4 miles north of east of Bloody Tank and that south of Gold Gulch, crumpled, shattered schists, through finely granular, fissile rocks of bands of greenish amphibolite, later to be described, a little east of north from Globe. This area is surrounded by more or less lenticular spaces formed between the oak Canyon, and on Pinto Creek.

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for its topographic features, a thoroughly appro­priate designation for this quartzite is not availa­ble. Distant views indicate that it is prominently developed in the Sierra Ancha, north of the quad­rangle, and to the underlying Barnes conglomerate. The Rocks here are thin-bedded, reddish quartzites resting unconformably on the Pioneer shale, and appear to be a gritty and quartzitic variety of this same material. These quartzites and the underlying Barnes conglomerates are the most resistant portions of the Apache group, and commonly find prominent representation in the Carnegie mountains. north of the quadrangle. These quartzites and the underlying Barnes conglomerates are the most resistant portions of the Apache group, and commonly find prominent representation in the Carnegie mountains.

In the greatly shattered district lying north and west of Black Warrior, in Webster Gulch, the Barnes conglomerate is of special interest, because it underlies a thickness of about 300 feet of a well-marked angular unconformity, the Tonto in places resting upon the Pinal conglomerate which is locally a bed of hard, buff sandstone or quartzite. The Dripping Spring quartzite, which underlies the Tonto group as represented in this part of the district is shown in Section C. This section resembles very closely the type section for this part of the quadrangle. The Pioneer shale here has a thickness of about 150 feet. In some places the formation rests directly upon the worn and weathered pre-Cambrian surface of the Madsen diorite, and in such cases it is beautifully developed in the Sierra Ancha, north of the quadrangle. The Tonto group may be Algonkian, Cambrian, Ordovician, or Devonian in age. As the overlying Globe limestone contains Devonian fossils, the Apache group can not be older than that of the Globe quadrangle. There are, however, certain general considerations that indicate, although they do not fix, the geologic period to which the group belongs. The Apache group may be Algonkian, Cambrian, Ordovician, or Devonian. The apparent absence of fossils, however, is not conclusive evidence that the Apache group is not older than the Tonto group. As the overlying Globe limestone contains Devonian fossils, the Apache group om not be younger than the Tonto group. As the overlying Globe limestone contains Devonian fossils, the Apache group om not be younger than the Tonto group. As the overlying Globe limestone contains Devonian fossils, the Apache group om not be younger than the Tonto group. As the overlying Globe limestone contains Devonian fossils, the Apache group om not be younger than the Tonto group. As the overlying Globe limestone contains Devonian fossils, the Apache group om not be younger than the Tonto group.
Vishnu schists and their associated granitic intrusives. As no equivalent unconformity could be detected in the rocks south of the Globe limestone, it is probable that the former corresponds to the Tonto group, rather than to the Grand Canyon group—a conclusion in general agreement with the earlier correlation of Marvin. The Apache group is accordingly placed provisionally in the Tonto group, in part to the Dragon quartzite of Dunning, which are reported to underlie the limestones of the Decemav and Carboniferous fossils in the Dragon Mountains, and to the Bolas quartzite of the Bisbee quadrangle.


decemav and Carboniferous systems, globe limestone.

General character and occurrence.—The same Globe limestone as that of the Apache group is here to be referred to a formation consisting almost exclusively of limestones, in beds usually ranging from 1 to 10 feet in thickness. The formation rests upon the Apache group, with locally no visible angular unconformity, and attains a maximum thickness of at least 700 feet, as exposed in the canyon of Pinto Creek. Its upper limit, everywhere within the quadrangle, is a surface of erosion, the total original thickness being therefore unknown. Although the Globe limestone apparently rests conformably upon the Dripping Spring quartzite, there are some grounds, such as the absence of recognizable Onderdonk and Shinarbands beds and the occurrence of the best lenticular breccia noted on page 4, for suspecting that the two formations are really separated by an interval of time. This is the more likely since, according to Wadsworth, the Decemav strata, with a maximum thickness of 100 feet, rest unconformably upon Shinarbands beds, but this unconformity can rarely be detected in actual exposures. As far as can be seen in the Globe district, the limestones are nowhere conformable throughout.

The general distribution of the Globe formation is that of the Apache group, which overlies basinal sediments. Natural sections, however, are even more fragmentary than in the case of the latter, and it was found impracticable to carry over the whole area such lithological and paleontological distinction as might be here made in some of the more continuous sections.

Lithology.—The basal portion of the Globe limestone is lithologically very different from the different parts of the quadrangle. In the canyon of Pinto Creek and in the greatly faulted region between Raintree and Granby basins, the base of the formation consists of about 10 feet of chertlike grus, succeeded by gray grits and breccias, which in turn pass upward into gray, buff and brown limestones with occasional bands of cherty, grayish, and buff colors, and, at Barns Peak, north of Sleeping Beauty Peak, and in the vicinity of the Grand Canyon, the beds are absent, and gray limestone, not noticeably fine-grained, rests directly upon thin-beded Dripping Spring quartzite and the limestones of the L. X. L. mine. The base of the Globe limestone is separated from the underlying quartzites by a thin bed of alluvial breccia containing angular fragments of quartzite. Wherever thin sections of the Globe limestones are exposed it is found that the alternating buff and gray limestones with subordinate grus are overlain by gray, sometimes slightly pinkish, crinoidal limestones, usually in thin beds, but also some cherty beds, and an occasional bed of alluvial conglomerate. As a rule, they pass upward into finely laminated carbonates, and it is rare to find a bed in which the laminations are really continuous. The thickness of the strata varies, and it is improbable that the beds belonging to these different periods. While future work in the broader region about the Globe quadrangle may be expected to result in a much better knowledge of the structure of the region is that of all that can be offered. As it lay upon the surface over which the probably Early Tertiary Plateau was worn, the beds were eroded by drainage of a quieter kind.

Quaternary system.

Gila conglomerate.

General character and occurrence.—Globe, while studying, in 1873, the region drained by the upper Gila and its tributaries, gave the same name to certain valley deposits which he described as follows, in the report of the Wheeler Survey:

"In the vicinity of the Gila conglomerales of local origin, with their derivation from particular mountain flanks can be followed in various parts of the Globe district. Interbedded with them are layers of slightly calcarcous. Interbedded with them are layers of slightly conglomeratic beds, the material of which, as at the Gila, is largely of local origin, and is therefore of considerable thickness.

About 2^ miles southeast of Globe the Gila conglomerate occurs in the southwestern corner of the quadrangle, lying chiefly on the lower slopes of Pinto Range and within the drainage basin of Mineral Creek. It will be referred to as the Mineral Creek area. The bulk of this deposit lies in a basin eroded in dolomite, but in part it overlies the Pinto schist up to an elevation of 4150 feet. North of the town of Lincoln, it is considered as a still recognizable relation to the larger formations..."
bounded on the east by the main Final Range, and on the west by extensive patches of dikeite, which they undoubtedly overlapped to an unknown dis-
tance. The occurrence of patches of the conglomer-
ete at an elevation of 5400 feet just east of Hutton ranch, and joined the Upper Pinala, or else there in the vicinity of the ranch a dividing ridge which has since been reduced by erosion. The conglomerate, as a whole, is consid-
erably more argillaceous and most argillaceous where there has been some overwash elsewhere in the district. No evidences have, as far as is known, that the conglomeration near Hutton Peak over their res-

cessional topography is less clearly read. The struc-
ture as seen under the microscope is characterized by a faint trace of the former outlet of basins outside of the region here discussed. But even in smaller valleys it is probable that the drainage was at times into lakes or by deformation resulting from demonstrable flooding. More, of course, of the area were part of the drainage basins of the Gila. The presence of small patches of the Gila conglomerate northeast of Webster Mountain indicates the former existence of a valley in which the Gila lived. The conglomerate consists of clasts of rock waste were transported in a short time from the mountain slopes to the valley, with little or no rounding of individual fragments which constitute the area. The transport of the streams which deposited the Gila conglomerate was a characteristic of the region at this time. The conglomerate was deposited within a valley which in general exists as a present valley. The occurrence of conglomerate at an elevation of 5400 feet just east of Hutton Peak indicates that the conglomerate conglomerate at an elevation of 5400 feet just east of Hutton Peak indicates that the conglomerate conglomerate at an elevation of 5400 feet just east of Hutton Peak indicates that the conglomerate conglomerate at an elevation of 5400 feet just east of Hutton Peak indicates that the conglomerate conglomerate at an elevation of 5400 feet just east of Hutton Peak indicates that the conglomerate.
reddish color near the base of the Apache group, which is found resting upon the Modern diorite just south of the Sandstone Mountains. The latter is a white, flinty, diorite and is not in contact with the schistosity of the sandstone; the schistosity of the schist is parallel to the intrusive contact of the sandstone.

Under the microscope the quartz-mica-diorm of the Pinal Peak area shows a hypidiomorphicgranulite aggregate of labradorite, quartz, biotite, and muscovite. The accessory minerals are titanite, which is more abundant than quartz-mica-diorite described in the other areas of the area, and sericite. In the Pinal Peak the secondary muscovite is of small size and impurities, and sericite, and a little more abundant than muscovite.

The red color of the Modern diorite where it is overlain by the Apache group is the result of the pre-Cambrian weathering of the old surface upon which the sediments were laid down. The immediate cause of the coloration is the decomposition of the feldspars, which the microscope shows to consist of fine kaolinitic aggregates containing minute inclusions of iron oxide.

The granodiorite of the southeastern area is probably continuous eastward beyond the edge of the quadrangle with the quartz-mica-diorite of the Pinal Peak area, although it varies in color from gray to gray. Near the base of the Apache group where it rests upon the Modern diorite, it forms a hand specimen-gray, rather coarse, crystalline rock in which the ore is well marked. In the eastern portion of the Apache group, it is more abundant than the quartz-mica-diorite described in the other areas of the area, and sericite, and a little more abundant than muscovite. In the Pinal Peak the secondary muscovite is of small size and impurities, and sericite, and a little more abundant than muscovite.

The porphyry of the Pinal Peak area is a typical porphyry texture. Phenocrysts of the quartz, plagioclase, biotite, and muscovite, mostly oligoclase and biotite, with a little more abundant than muscovite. The porphyry of the Pinal Peak has an excellent illustration of the unsatisfactory and transitional rocks due to the scarcity of these rocks in the area.

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detected. Under the microscope this marginal variation shows small phenocrysts of olivine and orthoclase in felicitous conditions which distinctly define the outline of the felsic rock, and are probably other feldspars.

INTRODUCTION.

Occurrence.—Between Pinon and Pinto creeks, near the northern edge of the quadrangle, the exposure of granitic rocks is several miles in extent, occupying the greater part of Lost Gulch, and stretches northeast toward Horse’s ranch on Pinto Creek. Like the Madera diorite, this rock becomes more closely crystalline, and the appearance it closely resembles the Willow Spring Granite. The microscope reveals a hypidiomorphic-granular texture. This structure is mainly composed of quartz, microcline, oligoclase, and biotite, named in order of apparent abundance. The secondary minerals are kaolinite, epidote, and chlorite. The accessory minerals are apatite, iron ore and in the northwest corner of the quadrangle near the edge of the map, southwest of Pinal Peak.

MESA DIORITE.

Definition.—Mesa diorite, or dolerite, is an en épiroite rock, usually intrusive, and consists essentially of a crystalline aggregate of calcic plagioclase (which may range from labradorite to anorthite, with pyroxene, generally a little biotite, and usually olivine. When the latter mineral is present the rock is commonly termed olivine-dolerite. The ordinary accessory minerals are magnetite (magnetite), and olivine is rare or absent. The texture of this rock is usually porphyritic to porphyrobiotite, and its color varies from bluish to gray-green or greenish color. In the Globe district the diabase, really an olivine-dolerite, is sometimes cut by Madera diorite, but whether they are younger or older than the Schultze granite, the age of the Rainbow granites is not yet determined.

CONTACT METAMORPHISM IN CONNECTION WITH THE CHEMINTEH DIABASE.

Occurrence.—In the alluvial valley of the Globe region from the pre-Cambrian schists and granite bordering upon it, and including the Globe limestone, several sheets of subhorizontal thickness, as irregular masses cutting across the invaded strata, and as small dikes. The occurrence of granitic contact zones, the general crystalline development of these minerals, which are characteristic of granitic contact zones, the general crystalline development of the granite. Toward the eastern part of the area the granitic rocks are more closely crystalline, and the accessory minerals are apatite, iron ore and in the northwest corner of the quadrangle. Another of irregular shape, possibly originally a continuation of the foregoing, is shown near the edge of Pinal Peak. North of Webster Mountain there is a relatively small thin sill, 50 or 75 feet thick, with a few miles away the same bed will be found in undisturbed sedimentary contact, with smaller sills above or below in the stratigraphic column. One or more sheets intruded generally in thickness are usually found cutting the pre-Cambrian schists and granite complex about 200 feet below the base of the Apache group of rocks, and are commonly termed ‘vincles’ or ‘vincles’ and are formed by the vicinity of the fold axis. The microlites are generally fresh, and the olivine is fresh, as are also the adjacent angular fragments of quartz and perhaps sericite, while the biotite is partially chloritized.

It appears from the foregoing description that the granitic rock of the northeastern part of the quadrangle is more nearly a typical biotite-bearing than the Bloody Tanks mass of Schultze granite. It differs morphologically from the latter in a slight degree, but is of much greater extent than any of the other notable granitic rocks cut by sills and dikes. The biotite is partly replaced by chlorite, and the biotite is in the adjoining schists and quartzites of the Lost Gulch than with the Schultze granite.

SILICA CRYSTALLITE.

All of the granite rocks of the Globe quadrangle are pre-Cambrian, but are younger than the Pinal schist, into which they are intrusive. The extensive development of granitic structure in the stratification is evidence that an epizonal stage has been reached. These granite rocks cut the older edge of the schists and quartzites, but are not intruded into them. The schists are a crystalline schist, and the granite is a coarse felsic rock, and is cut by dikes from the latter. The Schultze granite is also intruded by the Rainbow granites and this rock is intruded into the Pinal schist, and like the Lost Gulch granitic stock is cut by dikes from the later. The diabase is cut by two or more sills at varying distances up to 200 or 300 feet below the old pre-Cambrian erosion surface. These sills are so irregular and have been so faulted as to render the original number, thickness, and position, with reference to the Arizona sediments, which formerly underlie the diabase mass, are not exactly known. Similar sills occur in the late granite–mica schists and quartz-mica schists and quartzites of the Lost Gulch and the Schultze granite. The diabase mass, however, attain their greatest bulk and importance within the intruded sheets of the Globe granite complex. Their intrusion into these quartzites and limestone was accompanied or preceded by extensive faulting, which divided the strata into numerous blocks. The molten magma not only forced its way as sills and dikes between the blocks, but filled the fault fissures and drove the blocks apart. Mars of limestone and quartzite were thus completely invaded and the invading magma rock,
and often shifted bodily to an extent which at first views seems scarcely credible. Although, the process can not be measured by any familiar similitudes, it may be partly likened to the break-up and movement of thick ice by a spring flood. The largest area of diabase within the quadrangle is that extending northward from the Old Dominion mine, and from it may be drawn several illusions or the general character of the outcrop of this diabase into thin, jumbled masses. The diabase here lying on top of the quartzite and forming the summit of Black Peak has a thickness of at least 300 feet, while it is not known how much more has been removed by erosion. In the workings of the gray mine, in Copper Vein road, masses of quartzite and limestone were found irregularly distributed in the diabase down to a depth of about 300 feet. Below this the shaft in diabase for 400 feet, although blocks of included strata may possibly be encountered when drifting is begun. Almost a mile south of the shaft at the head of Copper Vein (southeast corner of the Globe Speci men corn), a considerable body of intrusive diabase, belonging to the Globe formation is exposed by erosion of the old road. Near the road, in fact, the diabase, which occurs in the near surface rounded forms more or less included in the diabase, shows a trace of serpentinization. The diabase of the northern, or diabases, the northern part of the Flatirons, being correlated with the later contact, in the diabase of the Flatirons, otherwise than as a thin layer adjacent to the contact. Additionally, the diabase of the Flatirons, otherwise than as a thin layer adjacent to the contact, shows scarcely a trace of serpentinization. The widespread liquescent dolerite, from which it is separated by intrusive lenticular diabases, are considered as probably contemporaneous with the diabase sills. The masses of the two eruptions were practically identical.

**Diorite-porphyry.**

**Definition.**—By diorite-porphyry is usually meant a holocrystalline intrusive rock having the general character and mineralogical composition of a diabase, but characterized by porphyritic structure, in which the diorite and felsparsoidal augite of the rocks have described under this term are generally decomposed, and it is not certain that all of them were originally typical diorite-porphyry.

**Occurrence.**—The diorite-porphyry occurs most characteristically as small masses, ranging in thickness from about 20 to 100 feet, and probably more, in the region of the Old Dominion mine, and in the quartzite rocks just below the base of the sedimentary series. On account of their small size the sills are not shown on the geological map. They are rarely absent, except at the upper part of the Old Dominion mine, and are well exposed in the southeast and northwestern parts of the quadrangle. The Old Dominion mine dike of diorite-porphyry is shown on the geological map, and can be traced over a distance of about 6 miles, where it emerges from beneath the dacite flow about half a mile east of the summit of Black Peak. A small dike of diorite-porphyry occurs in diabase near the Nine-mile shaft of the Continental mine. In the Old Dominion, west of the quadrangle, more or less decomposed masses of diorite-porphyry are contemporaneous with or younger than the diabase sills of the Globe quadrangle. In the Old Dominion, west of the quadrangle, more or less decomposed masses of diorite-porphyry are contemporaneous with or younger than the diabase sills of the Globe quadrangle.

**Petrography.**—The rock of these sills and dike is always more or less decomposed, and its color is therefore usually light yellowish or greenish gray. In the Threemile range is a very much more fresh variety, which is greenish yellow in color, while the typical diabase is dark gray or green, is well exposed south of the road. The augite of the diabase var. is a very fresh, medium-grained, diabase porphyry, and a quarter a little west of south of the road. Augite of this varied type and were intruded at different times. The diabase of the Old Dominion mine dikes of diorite-porphyry (shown on the geological map) is usually less fresh and more vitreous than the diabase of the earlier, when seen between crossed nicols. The diabase of the Old Dominion mine dikes of diorite-porphyry is usually less fresh and more vitreous than the diabase of the earlier dikes, with some chlorite which is probably kaolin. The original hornblende of the diabase sills is by far the most exposed of the diabase sills, and is often not visible until brought out by initial disintegration of exposed surfaces. Decomposition has rarely penetrated the rock for more than a few inches into the quartzite of the older rocks, and it is quite possible that these decomposed, greenish-gray sills and dike veneer rocks of more than one class, and were intruded at different times. The groundmass is usually a finely crystalline aggregate of plagioclase, quartz, and possibly some potassium feldspar, with the plagioclase in one or more distinct extinction common to many diorite porphyries when seen between crossed nicols. The diabase of the Old Dominion mine is a quartz-free diorite-porphyry, with some chlorite which is probably kaolin. The original hornblende of the diabase sills is rare in the Parent rocks, but it is not always recognizable. The diabase of the Old Dominion mine sills and dike are not always clearly distinguishable from a distance. In the eastern part of the quadrangle, uncommon hornblende diabase, which preserving great uniformity of color and texture.
over the entire region. This is the rock to which the name "troyee" is erroneously but unanimously applied by the district's. Of these, a far less abundant occurrence is a dark-gray glassy facies, often showing distinct flow banding, and of this is not always present, but when it does occur it invariably intergrades between the pink dacite and the underlying volcanic tuff. Beneath this vitreous facies, and not always separated from it in the field, are certain local accumulations of bedded dacitic tuffs. These are soft, often plainly detrital rocks, ranging in tint from white to pale lemon-yellow or gray. They were laid down in small local horizons, and are often absent, the dacite resting directly upon the older rocks.

The smallest occurrence of dacite occurring in the Gila quadrangle lies in its southwest corner. This is the rock which forms Hutton Peak, and through which Mineral Creek has cut its narrow gorge south of the Sixty-six ranch. It is continuous with the dacite just north of the Final reach, and extends for a considerable distance westward beyond the bounds of the quadrangle.

The entire outline is apparently of a single flow which has undergone deformation and erosion. It culminates at 9388 feet in Hutton Peak, and almost directly to the southwest is the rugged surface characteristic of this rock. North of the Final reach the device of the latter having been irregularly eroded before the erosion the rock covered it. Southeast of Hutton Peak it rises upon a broad, gently sloping plain. The mass of the flow is composed of the pink-bioitio-coarse-grained variety, and the darker, more gray, and highly vitreous facies described above is frequently found where the base of the flow is exposed. This variety is usually less than 50 feet in thickness, and is composed of a single integral part. The flow is not always present, and pink dacite sometimes rests immediately upon the base of the rock.

The occurrences south of Mineral Creek between the Sixty-six ranch and Government Spring, at the northern end of the quadrangle, and the rocks to the overlying and the basement are to appear to have formed an island-like mass around which the dacite flowed, and which it possibly formerly covered.

In the southwestern part of the quadrangle the principal body of dacite is that constituting in Woonsocket Mountain. This is evidently a very thick portion of the flow, as shown by the cuestas that have been excavated in it without exposing its base. The area is nearly inclosed by periphery faults, whereby this portion of the flow has been relatively dropped west of the surrounding older rocks, and its edges in some places become mere cuestas against the mass of the foot of this fault block, particularly, on the west, north, and east, are often precipitous, and good exposures of the bottom of the flow are rare. The dacite is the prevailing pink dacite, but the dark vitreous facies which occurs only at the bottom of this flow is exposed as a narrow ridge about two miles west of Mushroom Spring in the northeast corner of the quadrangle.

In the southeastern part of the quadrangle are two small intrusive masses of dacite. These may possibly represent a local eruption. Other bodies occur between Gold Gulch and Horrell's west ranch. One of the latter is a sheet of rock, 100 feet thick forming a small area in the crest of a dacite ridge about 2 miles north west of the Continental Mine. It rests directly upon the pink dacite, and although darker in color weathers in similar rounded masses. It may possibly be associated with the extensive volcanic series at Clifton, indicating that it may belong to the earlier part of the Tertiary.

Over the entire region. This is the rock to which the name "troyee" is erroneously but unanimously applied by the district's. Of these, a far less abundant occurrence is a dark-gray glassy facies, often showing distinct flow banding, and of this is not always present, but when it does occur it invariably intergrades between the pink dacite and the underlying volcanic tuff. Beneath this vitreous facies, and not always separated from it in the field, are certain local accumulations of bedded dacitic tuffs. These are soft, often plainly detrital rocks, ranging in tint from white to pale lemon-yellow or gray. They were laid down in small local horizons, and are often absent, the dacite resting directly upon the older rocks.

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usually holocrystalline, intergranular grounds consist of andesite laths, augite, and iron ore. All the minerals are fresh except the olivine, which shows various inclusions of reddish-brown iddingsite, fibrous iron serpentine, and more obscure products. The rock of the basalts on the ridge top rests upon dacite, and is interstratified for some distance from the actual contact. The dacite has been effected by the basaltic magma on numerous occasions in which the blocks of strata were inclosed. Most of the southwesterly dip of from 20 to 40 degrees, is due to the local intrusive of a light-gray, fine-grained, granitic rock. The intrusive contact is partly obscured by a fault which passes through the region. The evidence of the existence of intrusion faults shows a throw of less than a hundred feet, and their marked influence upon the general structure of the region has not been fully recognized. In spite of much variety in strike and dip, the general result of the faulting has been to drop, by successive steps toward the northeast, beds of various rocks, as indicated by their respective hardness of the rocks and not upon the throw of the fault. The description of the diabase of the footwall is rarely in doubt, and where the outcrop of the latter rocks is transformed by faulting, while folds are either entirely absent or relatively simple structure of the Final Mountains, generalizations. As a rule, the chief embarrassment results from differential erosion. The region just outside of the bounds of the quadrangle, consists chiefly of crushed quartzite. These quartzitic breccias are frequently so indurated as to be more resistant than the rocks on either side, and they often outcrop as ridges. Frequently the faults bringing about juxtapositions展会 in resistance to distortion, and a remarkable example of this is the footwall of the Apachita quartzite and limestone. Such slight exaggerations, however, can hardly be correct from the general actual contrast presented on the one hand by the relatively simple structures of the Final Mountains, with their banded brownish green masses intruded into the schists, and on the other by the complex dislocation of the northern half of the quadrangle.

Faults.-The geological map shows that faults are very much more numerous in the northern than in the southern half of the quadrangle. It is further apparent that the crustal conditions, including the more obscure dislocations of the region consist chiefly of crushed quartzite. Faults wholly in diabase or limestone are usually somewhat more common. Their courses in the field are often marked by zones of brecciation which are commonly stained black by oxide of manganese. Sometimes, along the path of an old fault, the passage of a fault through limestone may produce considerable brecciation, which, however, is likely to be obscured by reorientation of the calcite as to be detected with some difficulty, as in the case of the Old Dominion mine north of the Hoochash shaft.

Distribution of the faults. -The geological map shows that faults are very much more numerous in the northern than in the southern half of the quadrangle. It is further apparent that the crustal conditions, including the more obscure dislocations of the region consist chiefly of crushed quartzite. Frequently the faults bringing about juxtapositions展会 in resistance to distortion, and a remarkable example of this is the footwall of the Apachita quartzite and limestone. Such slight exaggerations, however, can hardly be correct from the general actual contrast presented on the one hand by the relatively simple structures of the Final Mountains, with their banded brownish green masses intruded into the schists, and on the other by the complex dislocation of the northern half of the quadrangle.
east or to the southwest. West of Final Creek the general dropping of the beds toward the northeast was the net result of the many displacements. The westward shift along which the beds were moved was about 200 feet, and the net result of the many displacements has been a dropping of the beds toward the northeast.

Age of the faults.—The oldest displacements distinctly recognizable in the structure of the Gila region are those shown on the map, and in which the post-Carboniferous (Mesozoic?) intrusions of diabase are involved. From the close of this period of revolutionary activity to the present time, the Gila has been a region of faulting. The later, post-Carboniferous (Mesozoic?) intrusions of diabase, one process only, that of erosion, did not differ from the earlier. It is not known, however, that important faulting also took place during this interval, and that some of the later faults that are shown, either because the dip of the fault is small or the throw is small, or both, are the result of later faulting. Among the many hundreds of faults occurring within the quadrangle, a number in which the character of the relative movement is not clearly shown, either because the dip of the fault is unknown or because the original geological horizon of the rocks affected to the present are in doubt. The majority of the faults, however, are clearly normal, while indubitable cases of reversed or thrust faulting are known.

The generally rather thick-bedded and brittle rocks of this district. The fact that beds generally flatten as they are deformed indicates that the beds have been moved as a unit in the general readjustment after the widespread disturbances of the end of the Tertiary. Its results can not be foreseen by the feeble stresses produced in the suggested rock fracturing taking place close to the surface.

The structural sole of the Gila district, not quite 200 feet in depth or the region subsided by littoral currents, both of which processes are responsible for the rounding of the pebbles. The matrix of the Barns conglomerate, however, shows abundant feldspathic detritus, such as the Dripping Spring quartzite. These appear to have been laid down in somewhat deeper water than the preceding beds, although the occurrence of conglomerates and grits in the upper part of the Barns conglomerates suggests a return of littoral conditions at the close of the Cambrian.

The geological record of the region investigated returns no answer. With the exception of the Gila conglomerate and the Gila formation, the general evenness of what was at one time an extensive peneplain.

The absence from the region of remnants of any rocks that might have been involved in the fault blocks indicates that the beds did not rupture, but that they were displaced by simple shear, probably without any displacement of the beds toward the northeast. Although faults belonging to the two groups just recognized have effected the most conspicuous structural results, the smaller and less conspicuous, but economically more important, faults in the Juan de Fuca region are the net result of the many displacements. The westward shift along which the beds were moved was about 200 feet, and the net result of the many displacements has been a dropping of the beds toward the northeast.

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From the Devonian to the Pennsylvanian the region was covered by a sea of some depth abounding in mollusks and depositing abundant limestones. Although no characteristic Mississippian fossils were found, rocks of that epoch may be present, and the limestones as a whole contain no visible coal躺在床上. From time to time there were intervals of sandy, quartzose sediment, and in a few instances bands of siliceous conglomerates were interstratified within the limestones. The nature of these intervals is unimportant, but they are significant in showing that this part of the Devonian and Carboniferous sea was probably neither very deep nor distant from a land mass.

The limestone of Pennsylvanian age is the oldest Paleozoic deposit of which the region preserves any record. If marine conditions continued into the Permian, the deposits of that epoch must have been wholly removed before the Permian was reached and invaded by diabase. Had Permian or later beds been involved in that structurally truncated, some traces of them probably would have been preserved in the resulting in situ lithologic nomenclature. Mineralogical studies are necessary in determining whether or not the region became land and was covered before the diabase intrusion. We know only that the latter event, with its associated faulting, occurred after the accumulation of the Globe limeston, and has left unmistakable record of its great movements. The region was presumably elevated above sea level at the close of the Carboniferous, and subjected to erosion. It was presumably elevated above sea level at the close of the Permian and Carboniferous, probably modified when the geological work of the Globe formation was superimposed by the study of a broader area. The definitive record required to be distinct chapters in the local physical history. The only known faulting of the region is the early Quaternary, when much of the region was shattered to an extent but not thereby elevated above sea level. 

The Tertiary was opened by a vigorous erosion of the complex lithologic section resulting from the preceeding epoch. As mixing, fractionation, and the fluvial processes that followed the diabase, the Great Basin has, however, been a continuous area, with its more extensive drainage of such a tract records minute adjust­ments of the earth's crust. The existing topography has influenced the topography. Areas of granite or diabase tend to become valleys or basins, while karst and limestone formations are ridges. 

ECONOMIC GEOLOGY.

INTRODUCTION.

History of mining development.—Prior to the 1860's, the Silver King District was of little interest to the mining parties. It was the base whence active prospecting was carried on in the Globe Hills during the seventies, when some mines, such as the Fans, Cornucopia, and Rescue, were opened and produced silver ore in commercial quantities. Although the Globe mines, declairved afterwards to become the greatest copper producer in the district, was the earliest location, it attracted but little attention for several years, owing to the greater interest aroused by silver ore, and the success which was already attending their exploitation in the Silver King mines. 

Other settlements or camps sprang into existence about the same time as that at Rambouillet. Among them were Cottonwood Springs, Richmond Basin, and Pokewoc, situated at the southwest slope of the Apache Mountains, and Mesilla, situated at the southeast slope of the same mountain range. Mesilla greatness of native silver which were found in the superfine wash and decomposed rock forming the floor of the Rambouillet district. The name of the town was partly derived. Shulls was sunk, that of the McMorris mine resembed a depth of 900 feet, but a large deposit of silver ore was produced from 1852 to 1882, when work ceased. Most of this ore was treated in a mill at Wissenda, on Pine Creek, somewhat over 12 miles northwest of Globe,
although in 1878 some was apparently worked in the old Miami mill, at the mouth of Pinto Creek near the mouth of Cottonwood Gulch. The silver oxide of this mine was the largest produced in the Globe district.

In 1883 there were 12 miles reported in the Globe district working on silver and gold ore, and having in all 86 stampons. The Silver King mine had reached a depth of 714 feet on a body of rich silver ore which, however, gave out near this level. From this year on, silver mining declined, and although a little desultory prospecting and mining continued, and the assays were excellent, the old mines were abandoned to 1889, the ones being one by one shut down, and the production of silver ore appears to have practically ceased by 1887.

The future prominence of copper as the principal product of the Globe district appears to have been first anticipated, in spite of the strong surface indications of the presence of copper ore, and as late as 1868, the only copper produced in the Globe district was in the Old Dominion mine. In 1882 the Globe Company was organized and the old Dominion mine was re-opened.

In 1885, the Old Dominion mine, which had been producing steadily, began on October 1, 1885, to show a decided increase in production, and in 1886, the mine reached a record of 3,200 pounds of copper per ton of ore. From this time on, the Old Dominion mine became the largest producer of copper in the Globe district, although the production of silver continued at a steady pace.

In 1890, the Old Dominion mine was producing copper at the rate of 4,000 pounds per ton of ore, and the company was making a profit of $500 per ton of ore. In 1891, the mine produced 12,000 pounds of copper, and in 1892, 30,000 pounds. The company continued to increase its production of copper, and in 1895, the Old Dominion mine was producing copper at the rate of 10,000 pounds per ton of ore.
in the partly oxidized ore of some prospectus in Powers and Gold gulches. It probably occurs to some extent in the ores of the Hinton, Johnnie, and Gold mines in the district of the northern Globe Hills, and was seen with chalcopyrite in the ore of Pioneer and Richmond mines, which lie outside of the Quadra.

Chalcopyrite.—Chalcopyrite is known only at the Bolbol mine, in minute quantities at the Globe and Goodwin mines.

Copper.—The only secondary sulphide recognized in the oxide ores is copper. This occurs as a thin film coating fragments of chalcocite in the Summit vein, and is here indubitably of later origin than the chalcocite. The hematite associated with it probably represents part of the hematite that has entered into the change to chalcocite. In the Buffalo mine massive chalcocite occurs, altering to malachite. As it is found only in small residual masses and is the only sulphide present, no direct light is thrown on its previous history. The primary sulphides are:

In the Old Dominion mine compact, massive chalco-
minate within the zone of change from oxidized to pyrite ore, chiefly on the eleventh and twelfth levels. Some of the chalcocite is free from pyrite, but the latter mineral is often disseminated in small particles through the mass of grey copper sulphide. When the chalcocite is examined with a hand lens, it is seen to show an indistinct succession of texture, suggestive of the obscure form of plagioclase structure observed in some basaltic rocks. A large number of grains of pyrite reveals the fact that their outlines are rounded and that the chalcocite has a more or less distinct, concentric, shaly structure around each grain. These facts at least strongly suggest that the chalcocite, while it formed at the time of the change to this limestone section, was subsequently replaced by the sulphide of copper. This process will be discussed at greater length, however, in the section devoted to ore genesis.

Hematite.—The hematite when not combined in an anhydrous oxhite mixture with cuprite occurs as small crystals in the form of isolated, fine, powdery plates of grey, brown, or brownish grey color. As it is found only in small residual masses and is the only sulphide present, no direct light is thrown on its previous history. The primary sulphides are:

In the Lakeview mine, at the Continental and Buffalo mines, much of the hematite is found in association with chalcocite, and is often disseminated in small particles through the mass of grey copper sulphide. When the chalcocite is examined with a hand lens, it is seen to show an indistinct succession of texture, suggestive of the obscure form of plagioclase structure observed in some basaltic rocks. A large number of grains of pyrite reveals the fact that their outlines are rounded and that the chalcocite has a more or less distinct, concentric, shaly structure around each grain. These facts at least strongly suggest that the chalcocite, while it formed at the time of the change to this limestone section, was subsequently replaced by the sulphide of copper. This process will be discussed at greater length, however, in the section devoted to ore genesis.

Azurite.—Azurite is rare in the oxide ores. It is found in the diabase in the Old Dominion and Grey mines, and appears to be in this district a characteristic accompaniment of oxidized copper ores. These gangue minerals are rarely abundant, however.

The ore bodies of the Globe quadrangle exhibit various forms, and, as is usual in such cases, these are not sharply distinguishable from one another. For this reason, however, the ore bodies are classified as (1) lodes, (2) masses in limestone, and (3) irregular mineralizations of shattered or pyritic rocks.

The lodes, for the most part simple fissure veins, are mineralized post-dacite fault fissures belonging to those already described on page 12. Of the hundreds of disseminations dissecting the region only a small proportion consists of such veins, and these are often structurally unimportant as faults. The cause of the mineralization of certain fissures is not well understood. It is possible that the ore filled the fissures and that the post-dacite mineralization is a replacement of the pre-existing ore. The same mineral constitutes the ores of the Old Dominion mine, the Keystone mine, and the Buffalo mine. The ores consist of malachite and azurite, and are common in neighboring dolomite and limestone. These ores are of later origin than the malachite.

Native copper, silver, and gold occur as thin hackly lines around each grain. These facts at least strongly suggest that the chalcocite, while it formed at the time of the change to this limestone section, was subsequently replaced by the sulphide of copper. This process will be discussed at greater length, however, in the section devoted to ore genesis.

As a rule the limestone shows very little alteration with the nearly horizontal bedding of the limestone. The ore bodies of the old oxide minerals, however, show more or less fissuring, such as may have given rise to the ore-bearing solution. Some of these are directly connected with the Old Dominion fault, the ores forming the hanging wall of this fault. In the former property there is found along the line aggregates of native copper. Still another specimen showed copper inclosed in quartz.

The lodes in the Old Dominion mine, the Keystone mine, the Buffalo mine, and the Silver Hill mine, consist of massive native copper and contain silver and gold in small quantities. The ore changes gradually into less broken country rock, and in many cases the native copper has been largely removed by adit workings. The ores are of later origin than the malachite. Azurite, when it occurs, is of later origin than the malachite. Native copper, silver, and gold occur in the ore of the Old Dominion mine, the Keystone mine, and the Buffalo mine. The ores consist of malachite and azurite, and are common in neighboring dolomite and limestone. These ores are of later origin than the malachite.

The same mineral constitutes the ores of the Old Dominion mine, the Keystone mine, and the Buffalo mine. The ores consist of malachite and azurite, and are common in neighboring dolomite and limestone. These ores are of later origin than the malachite.

Some of these are directly connected with the Old Dominion fault, the ores forming the hanging wall of this fault. In the former property there is found along the line aggregates of native copper. Still another specimen showed copper inclosed in quartz.

The lodes in the Old Dominion mine, the Keystone mine, the Buffalo mine, and the Silver Hill mine, consist of massive native copper and contain silver and gold in small quantities. The ore changes gradually into less broken country rock, and in many cases the native copper has been largely removed by adit workings. The ores are of later origin than the malachite. Azurite, when it occurs, is of later origin than the malachite. Native copper, silver, and gold occur in the ore of the Old Dominion mine, the Keystone mine, and the Buffalo mine. The ores consist of malachite and azurite, and are common in neighboring dolomite and limestone. These ores are of later origin than the malachite.
bride quartz is often exceedingly minute, so that it is not always easy to determine whether there has been any actual metasomatic replacement of the quartz by ore. As a rule, however, the fact of such replacement is ascertained, although the bulk of the ore has undoubtedly been mobilized, so as to form disseminated lenses or replacements of the quartz and of the tuff lying between its layers. It has been pointed out by Emmons, occurs in the Old Dominion mine, and there is no direct evidence that they were over present. But, reasoning from analogous deposits, it is not always easy to determine whether there has been any actual metasomatic replacement of the quartz by ore. As a rule, however, the fact of such replacement is ascertained, although the bulk of the ore has undoubtedly been mobilized, so as to form disseminated lenses or replacements of the quartz and of the tuff lying between its layers. 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that the former of these alternative hypotheses—namely, that the sulphide ore is older than the dacite—is the true one is, however, strongly indi-
cated by the cumulative weight of several facts, to one of which alone is fully decisive. These may be summarized as follows:

The mineralized fault fissures north of Globe either pass beneath the dacite flow without percepti-

blily faulting it, as may be seen near the L. X. L. mine, and is indicated on the geological map, or else they displace it to an extent inconceivable with their displacement of the older rocks, as in the case of the Old Dominion fault. It is difficult to trace faults when they enter the dacite, but the total disappearance of the outcrops, several strong fissures where this rock forms the surface, and the striking contrast between the faulting of the older underlying rocks and the practical integrity of the dacite flow as it is exposed just north of Globe, admit of but one interpretation. These generally northeast-southwest faults, many of which are more or less mineralized, were originally formed in pre-
dacite times. In the northwest corner of the quadrangle, on the other hand, the dacite is com-
eriously faulted, but these post-dacite faults pre-

dominate, and are not mineralized, or at least have not been shown to contain sulphide ore. This difference in age of the dominant faults thus prob-
ably accounts for the notable lack of mineralization in the northeast corner of the area, in spite of the fact that the same rocks occur there as north of Globe, and are even more thoroughly faulted.

No sulphide ore has yet been found in dacite. In the Old Dominion mine such ore as has been mined near this rock has invariably been oxidized, even on the lower levels, which otherwise encounters sulphides. The ore bodies never extend irregularly into the dacite, but are seemly separated from it by faults, or else underlie it with ever appearance of being deposited and at least partly oxidized before its eruption. The only bodies of oxidized ore known to occur in dacite or dacite tuff are those of the Black Warrior, Geneva, and Black Copper mines, in which the ore is certainly later than the cretaceous rock. But it has been shown that these ore consist of chrysocolla and are exotic. Thus their existence in the tuff at the base of the dacite points to the existence of pre-dacite sulphide ore from which they were originally derived. Their occurrence would be difficult of explanation were it supposed that the original mineralization of the district took place after the eruption of the dacite. It is therefore concluded that the hypothesis which assigns the original deposition of the sul-

phide ore to a period following the intrusion of the dacite is in harmony with the observed facts, as well as with the general theoretical considerations sug-
gestive of a genetic connection between the introduced diabase and the deposition of ore. The primary mineralization of the Globe district thus probably took place during the later Mesozoic.

NONMETALLIFEROUS DEPOSITS.

Limestone.—Practically all the limestone areas shown on the geological map may be regarded as potential sources of calciunous flux or of lime. The limestone used for fluxing in the Old Dominon smelter is quarried about 500 feet east of the main (Interloper) shaft, and this rock has been blown to supply lime for the company's needs. The same mass of limestone has also been utilized for the production of lime in a small way in Copper Gulch.

Building stone.—The Globe quadrangle is well provided with good stone of various kinds. The dacite, which occurs in inexhausterable quantity and in a readily accessible position within a half mile of Globe, affords an easily worked and durable material, which has been used for walls and foun-
dations by the Old Dominion and United Globe mining companies. It has not, however, been quarried extensively enough to determine whether blocks of large size could be obtained from this source. In Rocky Gulch, about 14 miles east of Globe, are exposed some beds of red quartzose sandstone, belonging to the Apache group. These beds are less indurated than the usual quartzites belonging to this group, and have been quarried in a primitive way for building stone. The stone is durable, but it is doubtful whether it could be obtained in large quantity and uniform quality.

The granite rocks of the Final Range, particu-
larly the Madera diorite, the Schultze granite, and the Solitude granite, would afford any desired quantity of high-grade building stone, but at pres-
ent there is no demand for material of this char-
acter.

WATER RESOURCES.

Owing to the small rainfall, water is not abun-
dent in the Globe quadrangle, and the best utili-
tion of the scanty supply constitutes a problem of considerable economic importance. Fortunately for the district, the high, timbered east of the Final Range receives and contains considerable snow during the winter months. This, melting gradu-
ally in spring, ameliorates the drought in the lower country, which would otherwise be severe until broken by the summer rains. The storage capacity of the range seems to have been somewhat diminished by the cutting of the timber, but the Final Mountains nevertheless continue to be the source of much of the water available in the lower portions of the quadrangle.

Even in the dry months small streams of good water persist near the heads of several of the larger arroyos. The principal arroyos encounter permanent water in the low-lying portions of the area, is usually not

considerable economic importance. Fortunately for the district, the high, timbered east of the Final Range receives and contains considerable snow during the winter months. This, melting grad-
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The settlement of Black Warrior is supplied in a

similar manner from a well nearly 3 miles away, at the point where Miami Flat opens on Final Creek. In this case it is probable that an adequate supply of good water might have been obtained from a well sunk closer at hand.

The development of the Old Dominion mines has shown that there is abundant water at the base of the Gage conglomerates. The attitude of this for-
mation with reference to the Final Range is highly favorable for the existence of artesian conditions. Unfortunately, however, these deposits are so

permeable and variable as to give little hope that there is any bed sufficiently impervious and persistent to retain the water under considerable hydraulic head. It appears, therefore, that in the past, as in the present, the main dependence of the district must be upon non-flowing wells. A limited sup-
ply might be obtained by damming some of the streams in the Final Range, but the flow of any one stream would probably not be sufficient to war-
mant the cost of the dam and pipe lines.

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