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GALIURO VOLCANICS, PINAL, GRAHAM, AND COCHISE COUNTIES, ARIZONA

By S. C. CREASEY and MEDORA H. KRIEGER, Menlo Park, Calif.

Abstract.— The Galiuro Volcanics occurs in the Galiuro, Winchester, and Little Dragoon Mountains, east and northeast of Tucson, Ariz. The sequence comprises lava flows and ash-flow tuffs ranging in composition from andesite to rhyolite. In general they can be subdivided into two parts separated by a major erosional unconformity. The lower part is predominantly lava flows ranging from andesite to rhyodacite but contains three ash-flow tuffs. The upper part is chiefly ash-flow tuff but also includes two areas of rhyolite-obsidian flows and domes and rhyolitic to andesitic flows. Conglomerate separates many if not all of the rock units in the upper part. The individual flows and tuffs are lenticular, and the stratigraphic relations are complex. Chemical variation diagrams suggest consanguinity among all the volcanic rocks, but the complex intercalation of rhyolite and andesite and of lava flows and ash-flow tuff indicates more than one magma chamber, different stages of differentiation in separate magma chambers, and several eruption centers. Chemical analyses indicate that the magmas were normal calc-alkaline. Eleven potassium-argon age determinations indicate that the Galiuro Volcanics accumulated from about 29 to 23 million years ago, which is in the middle of the mid-Tertiary volcanic and plutonic event in Arizona.

The Galiuro Volcanics occurs in the Galiuro, Winchester, and Little Dragoon Mountains, extending from a point about 64 kilometers east of Tucson northwestward for about 110 km (fig. 1). Most of the area underlain by the unit is shown on the geologic sketch map (fig. 2), but known or probable exposures of the formation crop out in and southeast of the gorge of the Gila River below San Carlos Lake (Creasey and others, 1961; Willden, 1964) and in the low pass between the Santa Teresa and Pinaleno (Graham) Mountains (fig. 1). Except in one small area (Krieger, 1968d), the Galiuro does not now extend southwest of the San Pedro valley, although it probably originally extended for some distance in that direction. Volcanic rocks of a similar age crop out in the Tucson (Damon and Bikerman, 1964), Santa Rita (Drewes, 1971a), and Patagonia Mountains (Simons, 1974; Drewes, 1971b), and slightly younger ash-flow tuffs and lavas occur west of Miami and between Miami and Ray (fig. 1) (Peterson, 1969; Creasey and others, 1975).

Plutonic rocks coeval with the Galiuro Volcanics crop out extensively in a northwest-trending zone defined by the Dragoon, Rincon, Santa Catalina, and Tortolita Mountains (fig. 1). No mid-Tertiary volcanic rocks occur within these ranges, only plutonic rocks. The contemporaneous volcanic rocks are confined to the flanking ranges to the southwest and northeast. Apparently this zone has been uplifted, and erosion since the mid-Tertiary has removed any preexisting mid-Teritary volcanic rocks and exposed the coeval plutonic rocks. These plutonic rocks do not extend southeast of Sulphur Spring Valley (fig. 1), and their extent to the northwest is not known to us.

The Galiuro Volcanics is gently deformed; dips uncommonly, if ever, exceed 20°. The rocks probably were tilted during the basin-and-range deformation of late Tertiary time. North of lat 32°45′, the Galiuro has been deformed into a broad, gentle downwarp, the axis of which trends east-west at the latitude of Aravaipa Creek. The elevation of the northern Galiuro Mountains probably is due to bounding normal faults on the northeast and southwest, although the faults are now largely covered by the basin fills of the San Pedro and Aravaipa valleys. South of lat 32°45′, the pile of Galiuro Volcanics forms a tilted fault block dipping gently to the east and southeast; only the western side of the mountains here is bounded by normal faults, which are well exposed around a butte near lat 32°42′, long 110°29′ (fig. 2). A parallel west-dipping normal fault extends for about 32 km through the center of the mountains (fig. 2). This fault has a vertical offset of 900–1200 meters and apparently was active during the accumulation of the Galiuro Volcanics.

PREVIOUS WORK

Early descriptions of the lithology and distribution of the Galiuro Vocanics are brief and generalized. As a part of the description of the wallrocks of a gold prospect in the central part of the Galiuro Mountains, Blake (1902) mentioned tuffs and lavas, and Darton

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The attention of geologists and of the mining public is now directed to the geological structure of the Galiuro Mountains, Arizona, of which little has hitherto been known, by the recent discovery of the "gold mountain lode" in its midst. This discovery is another example of the service rendered to geology by the mining prospector, stimulated and aided by enterprising capitalists.

The Galiuro Mountain range occupies a nearly central position between the Santa Catalina Mountains on the west and the Graham Mountains on the east. The district is about 50 miles north of Willcox on the Southern Pacific.

The Catalina Range and the Graham Mountains each have a crystalline granitic axis flanked by Archaean gneiss. The Catalinas on the east side have an overlying mass of Arizonian mica schists with superimposed Palæozoic beds in which a Devonian horizon is identified. Palæozoic limestones and quartzites are found at the north end of the Graham Range, but have not yet been recognized upon the line of the accompanying cross-section of the ranges.

The Galiuro Range consists of ancient rhyolites, which I name the "Galiuro rhyolite." The planes of flow instead of being nearly horizontal as usual are vertical over a large area and have a nearly uniform north and northwesterly trend to which the direction of the range and its chief valleys conform.

Over a considerable part of the range the rhyolite crops out in jagged peaks. But this topography is greatly modified by a later fragmentary deposit which covers the rough ancient croppings and fills ancient valleys. There are also horizontal beds of highly crystalline lava and of volcanic tufas and breccias, remnants of which are found in table mountain summits and in detached eroded masses filling some of the ancient valleys in the vertical rhyolites, but now cut through by erosion. These fragmentary deposits consist of the broken up masses of the subjacent rhyolite. The lower beds are formed of large angular masses firmly cemented together, and are seen to advantage along the upper portions of Rattlesnake Creek.

A diagrammatic sketch geological cross-section appended, Fig. 1, will serve to show at a glance the general structure of the Galiuro Range and its relations to the two great valleys of the San Pedro or Quiburis, and the Sulphur Spring Valley. Both of these valleys appear to have been in the condition of lakes or marine estuaries in comparatively recent geological time, and to have been drained by continental elevation.† The deep lacustrine sediments are overlaid near the mountains by the detrital accumulations forming the extended gradual slopes down to the center of the valley.

In the midst of the range there are two or more hard dykes of chocolate colored porphyry. A similar dyke is also found at the base of the range near Kielberg's Camp. With these exceptions and also that of the occurrence of crystalline lava, no crystalline rocks were observed. Neither granite nor limestones were found in place in the Galiuros nor in the detrital accumulations of the valleys.

The rhyolite intrusion may be assumed to have taken place along a longitudinal line or plane of break and faulting following the great syncline between the two uplifts of the Archæan granites, gneiss and schists of the Santa Catalinas and the Graham or Pinaleno Mountains. The peculiar and strongly marked vertical structure may be due to lateral pressure along the course of the break and not to lateral or original horizontal flowing.

In some places the rhyolites are finely lamillar and in others are coarsely orbicular with hollow cysts lined with quartz. Pitchstone and obsidian are also found.

The gold-bearing ledge forms a prominent outcrop standing out sharply above the general level of the adjoining rock, which also weathers into jagged outcrops. It conforms to the structure of the rhyolite and dips with it westwardly at an angle of about 72°. It is cut across at a right angle by a branch of Rattlesnake Creek, the chief feeder of the Araivaipa, which flows into the San Pedro valley. This natural cross-cut by erosion makes a good exposure of the ledge on both banks of the creek. The face on the south side rises to a height of about 90 feet and is illustrated by Fig. 2.

FIG. 1.—DIAGRAMMATIC CROSS-SECTION OF THE GALIURO MOUNTAINS AND THE BORD

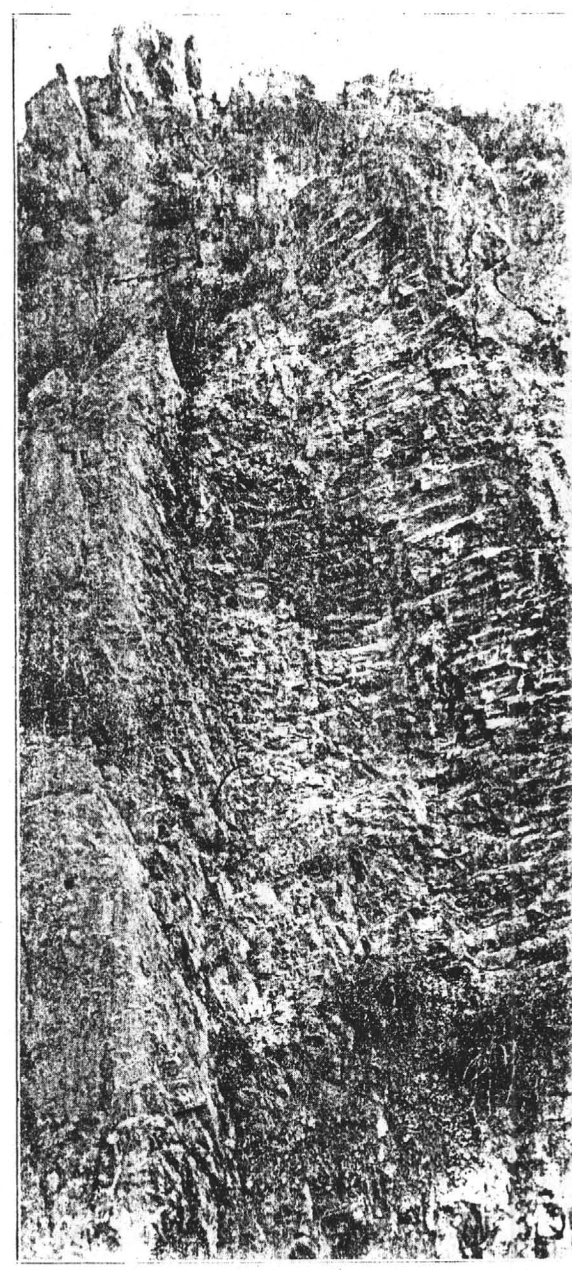

FIG. 2.—VIEW, SOUTH FACE OF LODE, WHERE IT IS (

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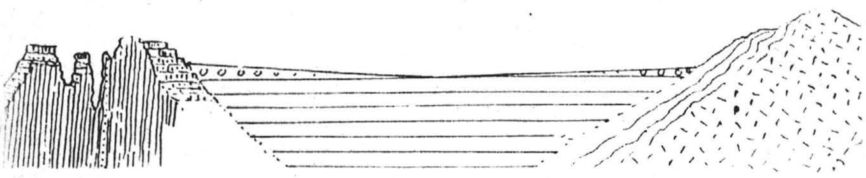

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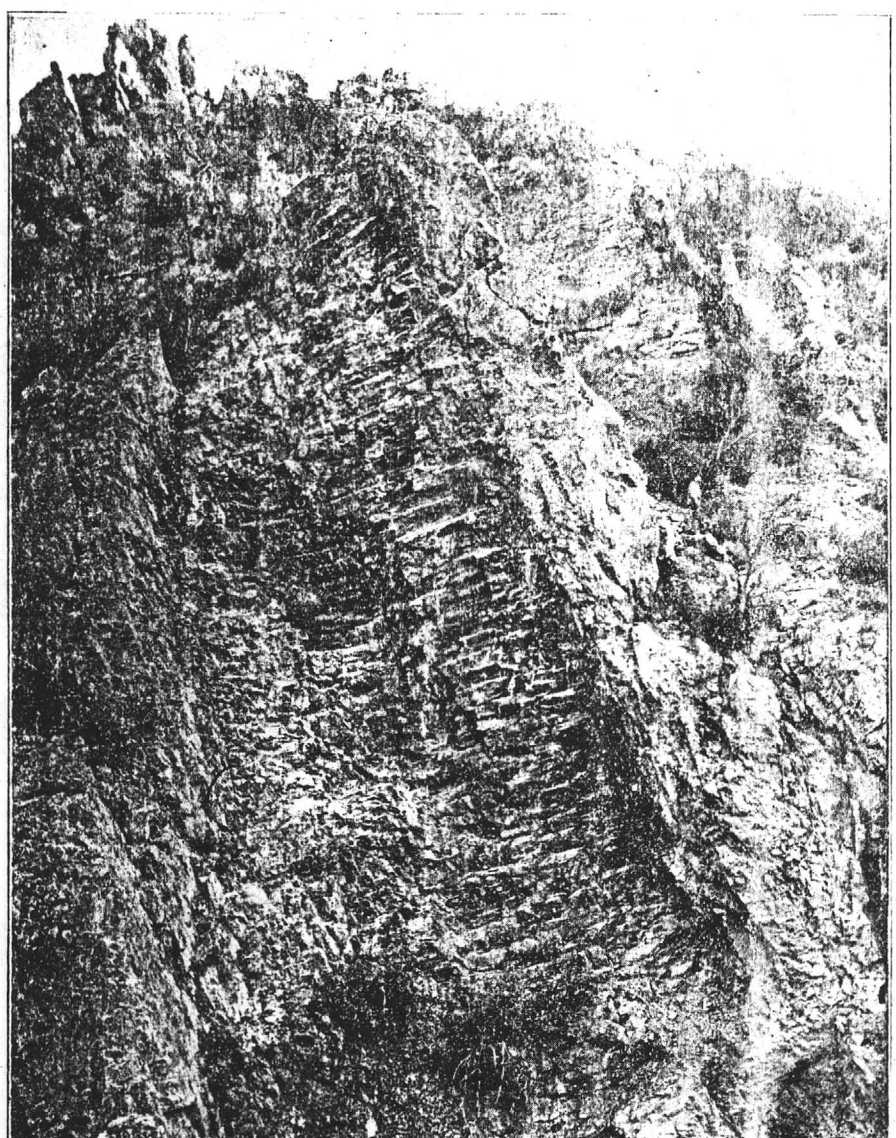

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gold is found in and about this lode on both f Rattlesnake Creek, especially in the loose n the bottom and sides of the croppings. The general gold-bearing character is thus established. When discovered by Jack Garden, gold had been traced by placer tests up the creek to this lode and he there found free gold upon the exposed surfaces of the ledge. Subsequent tests by blasting into the lode showed the gold to be present within it, in the substance of the rock. Specimens with free gold upon the surfaces can be had by breaking up the rock.

This gold-bearing lode is novel and unusual in its composition and structure. It differs from any gold-bearing lode I have seen and from any which has been described to my knowledge. While essentially siliceous, it does not have the character of a normal quartz lode. It is not distinctively quartz. It has rather the appearance of a quartzite, being granular in fracture, but not vitreous, though here and there it is traversed by thin veinlets of normal quartz, about ⅛ of an inch thick, but often not thicker than cardboard and of local extent and irregular in direction. These little veins are crystalline, and mineralized with iron pyrites and gold.

The gold becomes free when the grains of pyrite decay, and most of the pyrite, as far as developments have yet been made, is in the decayed oxidized state; the iron is in the form of hematite together with the gold. When the ledge matter is broken along the planes of the thin quartz seams, the cavities left

by the pyrite crystals usually contain a g of gold visible to the eye. The general p hematite from pyrites gives a brilliant most of the outcrops of the ledge and to th rocks. There is also a large body of quar known as the "blue quartz," in which matter is partly oxide of manganese.

The prevailing hematitic red color is g of general mineralization; so also is the g ence of gold in the soil around the outcr

The prominence above the surface o harder portions of quartzose rock migh as marking the limits of the ledge, bu tests show that the mineralization with gold extends beyond such limits, but at not possible to define the exact limits o eralization.

The evidences favor the conclusion th the general mass of nearly vertical rh there were planes of fracture or fissur which there was a permeation of the ro ous gold-bearing solutions accompanied phide deposited in the body of the lode, harder and more prominent quartzose le portions of the rhyolites, for some of grade ore retains some of the original st culiarities of the rhyolite, but has an exce The harder and more distinct outcrops, texture, are without lamination and resemb rather than quartz or rhyolite.

The general appearance and structure are best shown by the photographs of i

FIG. 3.—OUTCROP OF LEDGE—THIRTY F

on both sides of the creek which cuts th right angles. Only about one-half of the section of the lode is shown within the li picture, No. 2. The whole front face of t posed by blasting, measured horizontally, wide. The harder portions of the lode ar into two approximately parallel bodies by of rhyolite which retains its lamellar stru body of medial rock descends to the platfo the right or west side of the picture, and This rock is said to be found accompanyin in a similar position throughout its extent, south. The tunnel is cut in the foot-w lower quartzose ledge or foot-wall body. ing wall portion above the medial body is irregular in the form and breadth of the as seen in the illustration in the upper corner, but at the level of the platform it a large body of purplish gray quartzose led to the miners as "blue quartz." It meas 80 feet in thickness, making with the foot and the intermediate ground a total thi 90 feet.

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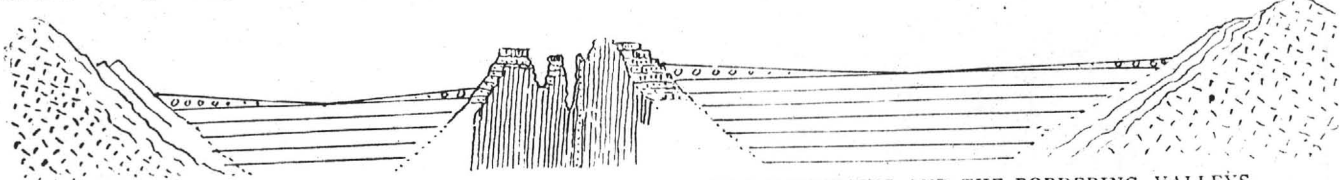

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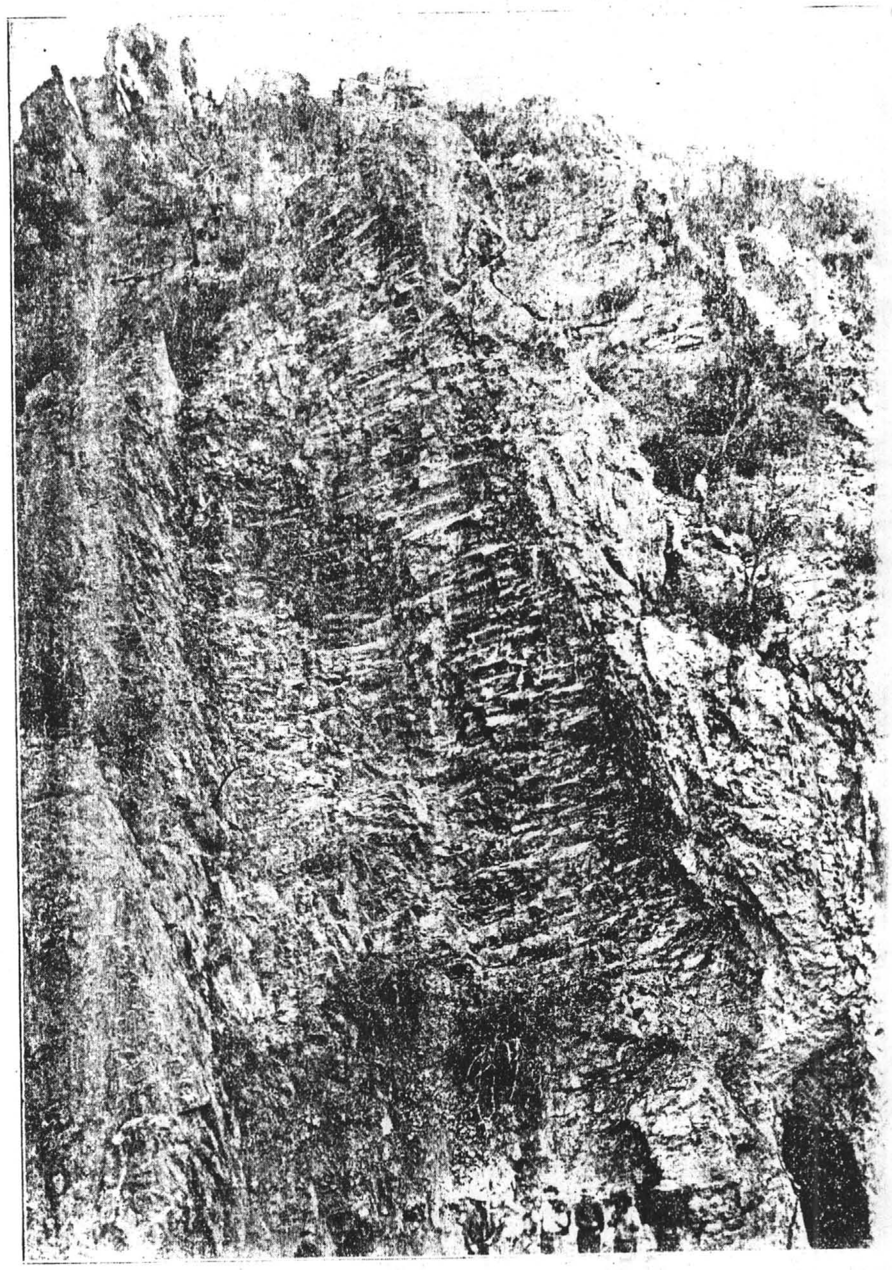

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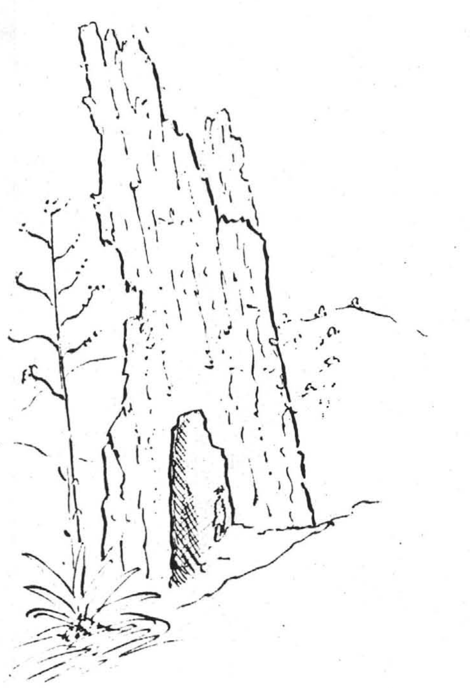

OUTCROP OF LEDGE—THIRTY FEET HIGH.

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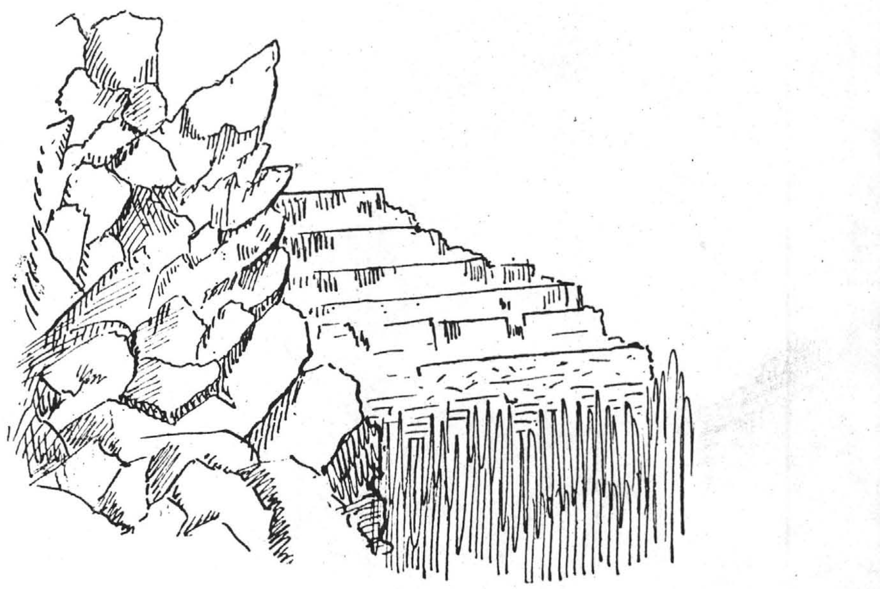

FIG. 4.—SECTION SHOWING CRAG-LIKE OUTCROPS OF LODE AND UNCONFORMITY OF RHYOLI WITH OVERLYING BRECCIAS AND TUFAS.

and the prevalence of iron oxide in small cavities are distinctly visible to the naked eye. This blue quartz merges into distinct rhyolite on the west, which rock forms the hanging wall of the lode.

A peculiar feature in connection with the ledge at once attracts the attention of the visitor. It is a very distinct columnar structure of the rock of the foot-wall side for a breadth of about 20 feet. This columnar or prismatic form of the rock is shown in the photograph and in the cross-section, Fig. 4. The structure is normal to the dip of the ledge. Traces of similar structure are also found on the other side of the medial plane.

This peculiarity at once suggests a porphyritic or dyke-like character of this rock, but its origin, or nature, is uncertain. The rock is all superficially colored a bright red by a coating of hematite, but is yellowish white within and has here and there crystals of quartz in the magma, justifying the name of quartz porphyry. The structure towards the east side gradually disappears and merges into a body of about 30 feet thickness of coarse-grained rhyolite much permeated with quartz similar to about the

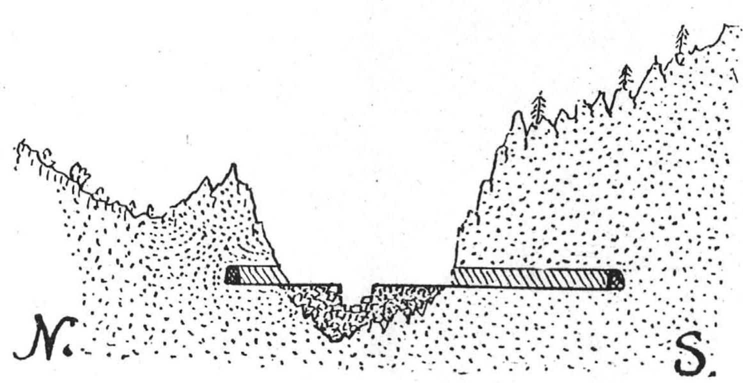

FIG. 5.—SECTION OF LODE AT OPENINGS ON RATTLESNAKE CREEK.

same thickness on the hanging wall side of the ledge. The outcrop of the main lode on the north side of the creek is similar in its structure but is not so high or so wide as the exposure on the south side.

On the extreme right or west side, and 50 feet distant from the main ledge, there is a second mineralized ledge some 8 or 10 feet in thickness, called the "Side Issue," where gold occurs. It is not regarded as connected with the main ledge, and has not as yet been prospected or tested beyond an opening bla out at the end.

Another plane of mineralization, or third ledg found about 250 feet to the eastward of the main l The ground between is hidden by debris from al and is not known to be gold-bearing.

Numerous tests by panning on the main l showed the general occurrence of gold in fine gra in dust and filaments, especially in all the l soil and dirt around the cliff. The gold is ea detached from its matrix by blasting, and brea up the ledge, and is found more abundantly in "fines" than in the coarse rocks as broken out.

The chief object of these tests was not to d mine the average value, but rather to ascertain distribution of the metal and its association. The is in close association with the hematite derived the pyrites.

The results of these preliminary tests were, h ever, sufficient to show that the whole mass of ledge, taken together in bulk without sorting or lection, forms what is known amongst miners a "low-grade proposition" in which the quan of ore compensates to a great degree for the comp tively small yield of metal per ton. This view is tained by the results of assaying different sam taken from time to time by the management by others.

What the general average is cannot just yet fairly determined as the work of cross-cutting ledge is still in progress and large samples must blasted out, crushed and averaged, to get a r which would represent what may be expected f milling the ore on a large scale. Mill tests are d able, but liberal sampling would show the gen average nearly as well.

Preliminary tests with a .03 per cent cyanide s tion indicate that the ore can be successfully trea with cyanide direct, after crushing, without amal mation.

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Another plane of mineralization, or third ledge, is found about 250 feet to the eastward of the main face. The ground between is hidden by debris from above and is not known to be gold-bearing.

Numerous tests by panning on the main ledge showed the general occurrence of gold in fine grains, in dust and filaments, especially in all the loose soil and dirt around the cliff. The gold is easily detached from its matrix by blasting, and breaking up the ledge, and is found more abundantly in the "fines" than in the coarse rocks as broken out.

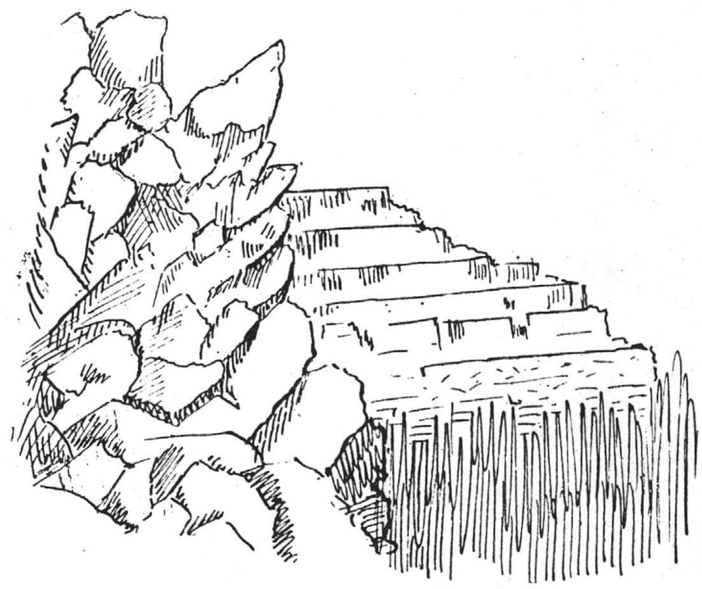

FIG. 4.—SECTION SHOWING CRAG-LIKE OUTCROPS OF LODE AND UNCONFORMITY OF RHYOLITE, WITH OVERLYING BRECCIAS AND TUFAS.

The chief object of these tests was not to determine the average value, but rather to ascertain the distribution of the metal and its association. The gold is in close association with the hematite derived from the pyrites.

The results of these preliminary tests were, however, sufficient to show that the whole mass of the ledge, taken together in bulk without sorting or selection, forms what is known amongst miners, as a "low-grade proposition" in which the quantity of ore compensates to a great degree for the comparatively small yield of metal per ton. This view is sustained by the results of assaying different samples taken from time to time by the management and by others.

What the general average is cannot just yet be fairly determined as the work of cross-cutting the ledge is still in progress and large samples must be blasted out, crushed and averaged, to get a result which would represent what may be expected from milling the ore on a large scale. Mill tests are desirable, but liberal sampling would show the general average nearly as well.

Preliminary tests with a .03 per cent cyanide solution indicate that the ore can be successfully treated with cyanide direct, after crushing, without amalgamation.

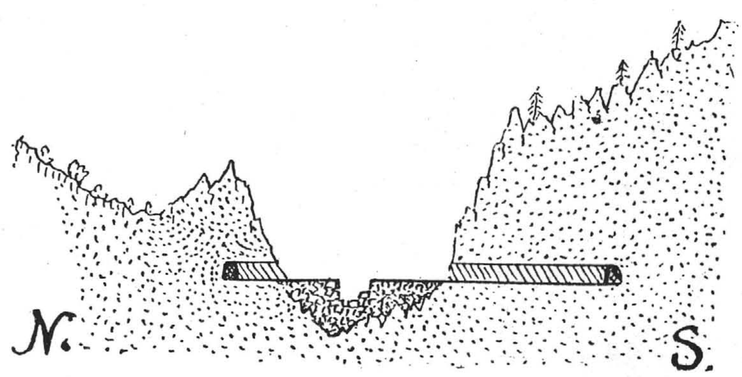

FIG. 5.—SECTION OF LODE AT OPENINGS ON RATTLESNAKE CREEK.

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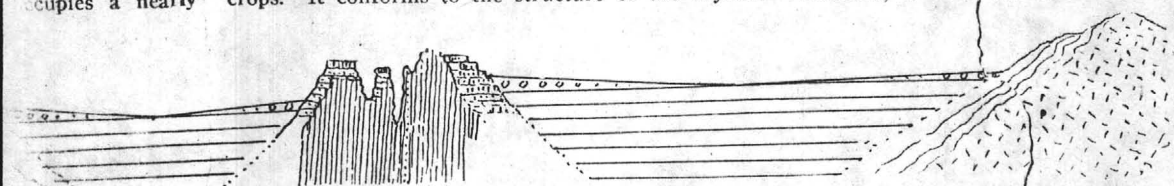
In some places the rhyolites are finely lamillar and in others are coarsely orbicular with hollow cysts lined with quartz. Pitchstone and obsidian are also found.

The gold-bearing ledge forms a prominent outcrop standing out sharply above the general level of the adjoining rock, which also weathers into jagged outcrops. It conforms to the structure of the rhyolite

general gold-bearing character is thus established. When discovered by Jack Garden, gold had been traced by placer tests up the creek to this lode and he there found free gold upon the exposed surfaces of the ledge. Subsequen tests by blasting into the lode showed the gold to be present within it, in the substance of the rock. Specimens with free gold upon the surfaces can b had by breaking up the rock.

This gold-bearing lode is novel and unusual in its composition and structure. It differs from any gold-bearing lode I have seen and from any which has been described to my knowledge. While essentially siliceous, it does not have the character of a nor-



DIAGRAMMATIC CROSS-SECTION OF THE GALIURO MOUNTAINS AND THE BORDERING VALLEYS.

and dips with it westwardly at an angle of about 72°. It is cut across at a right angle by a branch of Rattlesnake Creek, the chief feeder of the Araivaipa, which flows into the San Pedro valley. This natural cross-cut by erosion makes a good exposure of the ledge on both banks of the creek. The face on the south side rises to a height of about 90 feet and is illustrated by Fig. 2.

mal quartz lode. is not distinctively quartz. It has rather the appe ance of a quartzite, being granular in fracture, but n vitreous, though here and there it is traversed by thin veinlets of normal quartz, about ⅛ of an inch thick, but often not thicker than cardboard and of local extent and irregular in direction. These little veins are crystalline, and mineralized with iron pyrites and gold.

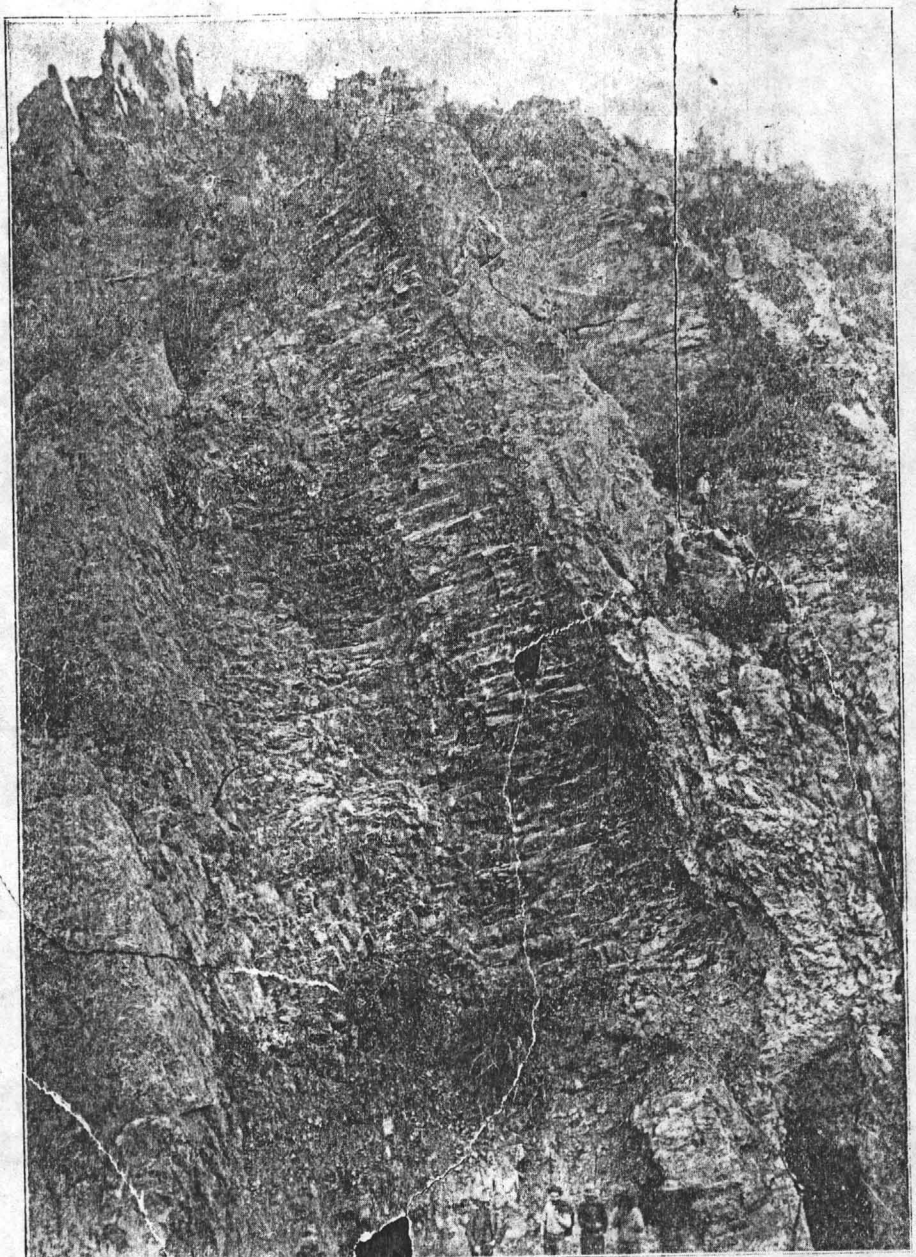


FIG. 2.—VIEW, SOUTH FACE O , WHERE IT IS CUT BY RATTLESNAKE CREEK.

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The gold becomes free when the grains of pyrite decay, and most of the pyrite, as far as developments have yet been made, is in the decayed oxidized state; the iron is in the form of hematite together with the gold. When the ledge matter is broken along the planes of the thin quartz seams, the cavities left by the pyrite crystals usually contain a grain or two of gold visible to the eye. The general prevalence of hematite from pyrites gives a brilliant red color to most of the outcrops of the ledge and to the adjoining rocks. There is also a large body of quartzose ledge, known as the "blue quartz," in which the coloring matter is partly oxide of manganese.

The prevailing hematitic red color is good evidence of general mineralization; so also is the general presence of gold in the soil around the outcrops.

The prominence above the surface of distinctly harder portions of quartzose rock might be taken as marking the limits of the ledge, but numerous tests show that the mineralization with pyrite and gold extends beyond such limits, but at present it is not possible to define the exact limits of such mineralization.

The evidences favor the conclusion that through the general mass of nearly vertical rhyolitic rock there were planes of fracture or fissure, bordering which there was a permeation of the rock by siliceous gold-bearing solutions accompanied by iron sulphide deposited in the body of the lode, not alone in harder and more prominent quartzose ledges, but in portions of the rhyolites, for some of the higher grade ore retains some of the original structural peculiarities of the rhyolite, but has an excess of quartz. The harder and more distinct outcrops, granular in texture, are without lamination and resemble quartzite rather than quartz or rhyolite.

The general appearance and structure of the lode are best shown by the photographs of its exposure

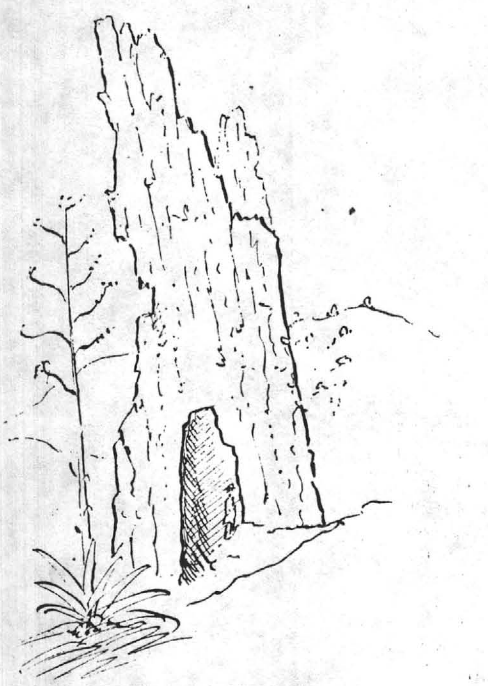

FIG. 3.—OUTCROP OF LEDGE—THIRTY FEET HIGH.

on both sides of the creek which cuts through it at right angles. Only about one-half of the face of the section of the lode is shown within the limits of the picture, No. 2. The whole front face of the cliff exposed by blasting, measured horizontally, is 168 feet wide. The harder portions of the lode are separated into two approximately parallel bodies by a thin body of rhyolite which retains its lamellar structure. This body of medial rock descends to the platform level on the right or west side of the picture, and beyond it. This rock is said to be found accompanying the lode in a similar position throughout its extent, north and south. The tunnel is cut in the foot-wall of the lower quartzose ledge or foot-wall body. The hanging wall portion above the medial body of rhyolite is irregular in the form and breadth of the croppings as seen in the illustration in the upper righthand corner, but at the level of the platform it appears as a large body of purplish gray quartzose ledge, known to the miners as "blue quartz." It measures about 30 feet in thickness, making with the foot-wall body and the intermediate ground a total thickness of 50 feet.

This blue rock is finely granular, with a prismatic blocky fracture, dull in luster, but under the microscope in thin edges is vitreous and distinctly quartz. The coloring is due, largely, to manganese oxide which coats the seams and often shows in characteristic dendritic forms. Iron protoxide is also present. Under the microscope, small, irregular cavities appear between the siliceous grains and are lined with hematite. The degree of the mineralization is variable. In some places the porous nature of the rock,

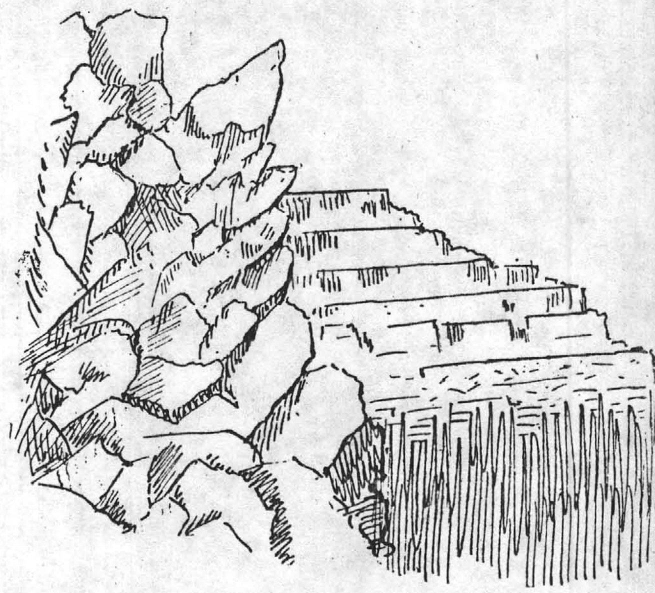

FIG. 4.—SECTION SHOWING CRAG-LIKE OUTCROPS OF LODE AND UNCONFOR[MITY] WITH OVERLYING BRECCIAS AND TUFAS.

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This peculiarity at once suggests a porphyritic or dyke-like character of this rock, but its origin, or nature, is uncertain. The rock is all superficially colored a bright red by a coating of hematite, but is yellowish white within and has here and there crystals of quartz in the magma, justifying the name of quartz porphyry. The structure towards the east side gradually disappears and merges into a body of about 30 feet thickness of coarse-grained rhyolite much permeated with quartz similar to about the same thickness on the hanging wall side of the ledge. The outcrop of the main lode on the north side of the creek is similar in its structure but is not so high or so wide as the exposure on the south side.

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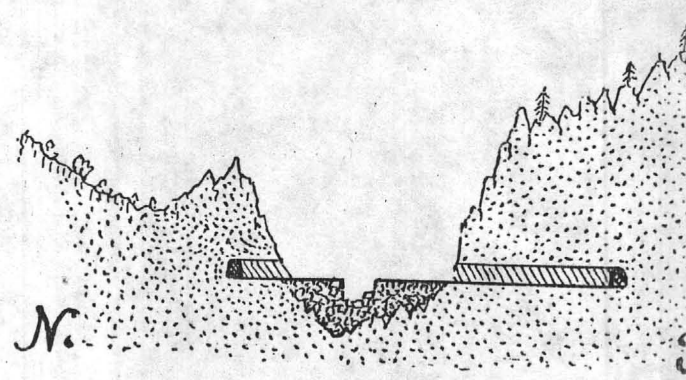

FIG. 5.—SECTION OF LODE AT OPENINGS ON RATTLESNAKE C[REEK]

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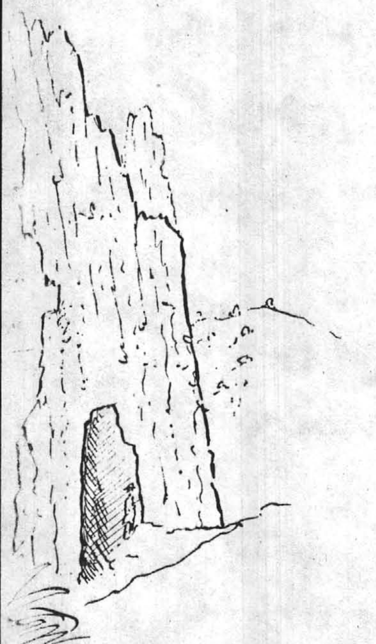

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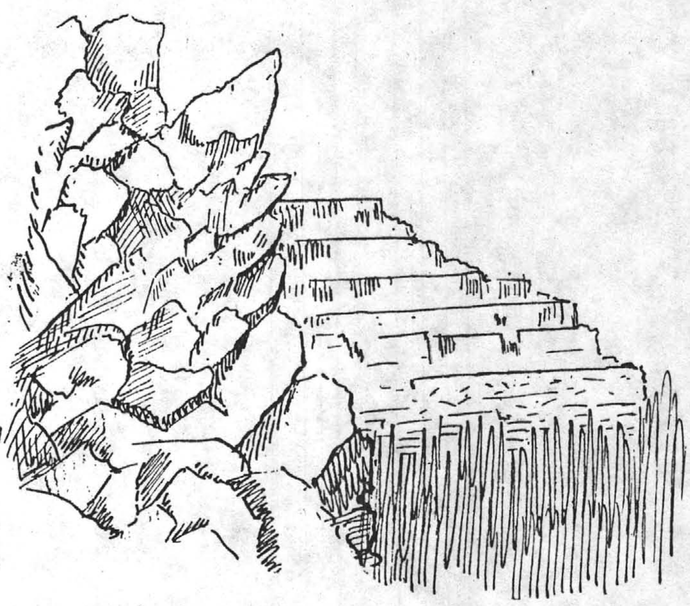

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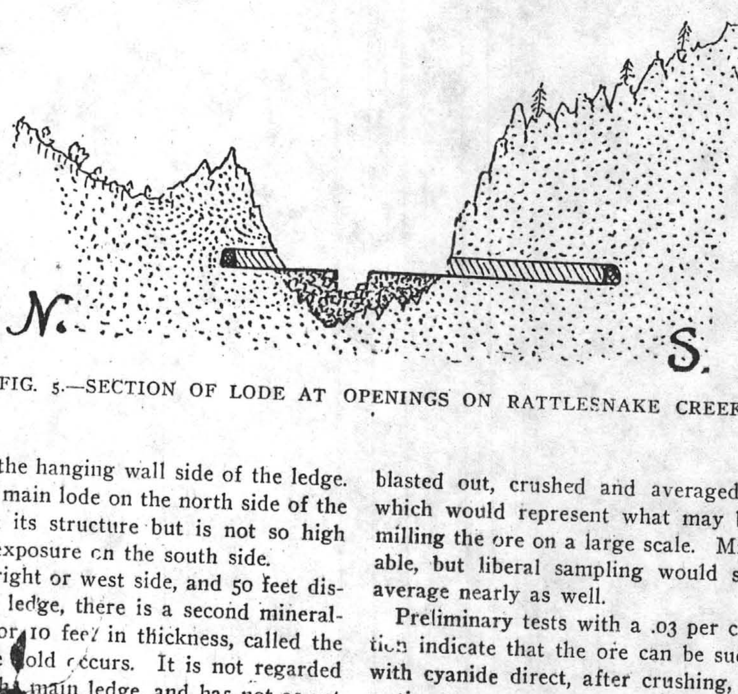

FIG. 5.—SECTION OF LODE AT OPENINGS ON RATTLESNAKE CREEK.

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Preliminary tests with a .03 per cent cyanide solution indicate that the ore can be successfully treated with cyanide direct, after crushing, without amalgamation.

THE GEOLOGY OF THE GALIURO MOUNTAINS, ARIZONA, AND OF THE GOLD-BEARING LEDGE KNOWN AS GOLD MOUNTAIN.*

By WILLIAM P. BLAKE, Geologist of Arizona.

The attention of geologists and of the mining public is now directed to the geological structure of the Galiuro Mountains, Arizona, of which little has hitherto been known, by the recent discovery of the "gold mountain lode" in its midst. This discovery is another example of the service rendered to geology by the mining prospector, stimulated and aided by enterprising capitalists.

The Galiuro Mountain range occupies a nearly

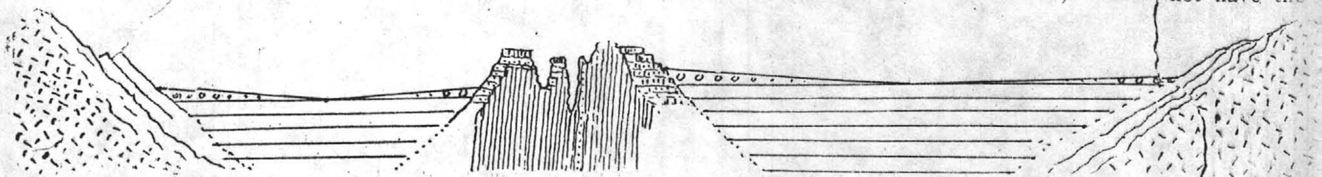

FIG. 1.—DIAGRAMMATIC CROSS-SECTION OF THE GALIURO MOUNTAINS AND THE BORDERING VALLEYS.

central position between the Santa Catalina Mountains on the west and the Graham Mountains on the east. The district is about 50 miles north of Willcox on the Southern Pacific.

The Catalina Range and the Graham Mountains each have a crystalline granitic axis flanked by Archæan gneiss. The Catalinas on the east side have an overlying mass of Arizonian mica schists with superimposed Palæozoic beds in which a Devonian horizon is dentified. Palæozoic limestones and quartzites are found at the north end of the Graham Range, but have not yet been recognized upon the ne of the accompanying cross-section of the ranges.

The Galiuro Range consists of ancient rhyolites, which I name the "Galiuro rhyolite." The planes of ow instead of being nearly horizontal as usual re vertical over a large area and have a nearly uniorm north and northwesterly trend to which the irection of the range and its chief valleys conform.

Over a considerable part of the range the rhyolite crops out in jagged peaks. But this topography is atly modified by a later fragmentary deposit which vers the rough ancient croppings and fills ancient lleys. There are also horizontal beds of highly ystalline lava and of volcanic tufas and breccias, emnants of which are found in table mountain summits and in detached eroded masses filling some of the ancient valleys in the vertical rhyolites, but now cut through by erosion. These fragmentary deposits consist of the broken up masses of the subjacent rhyolite. The lower beds are formed of large angular masses firmly cemented together, and are seen to advantage along the upper portions of Rattlesnake Creek.

A diagrammatic sketch geological cross-section appended, Fig. 1, will serve to show at a glance the general structure of the Galiuro Range and its relations to the two great valleys of the San Pedro or Quiburis, and the Sulphur Spring Valley. Both of these valleys appear to have been in the condition of lakes or marine estuaries in comparatively recent geological time, and to have been drained by continental elevation.† The deep lacustrine sediments are overlaid near the mountains by the detrital accumulations forming the extended gradual slopes down to the center of the valley.

In the midst of the range there are two or more hard dykes of chocolate colored porphyry. A similar dyke is also found at the base of the range near Kielberg's Camp. With these exceptions and also that of the occurrence of crystalline lava, no crystalline rocks were observed. Neither granite nor limestones were found in place in the Galiuros nor in the detrital accumulations of the valleys.

The rhyolite intrusion may be assumed to have taken place along a longitudinal line or plane of k and faulting following the great syncline between the two uplifts of the Archæan granites, gneiss and schists of the Santa Catalinas and the Graham or Pinaleno Mountains. The peculiar and strongly marked vertical structure may be due to lateral pressure along the course of the break and not to lateral or original horizontal flowing.

In some places the rhyolites are finely lamillar and in others are coarsely orbicular with hollow cysts lined with quartz. Pitchstone and obsidian are also found.

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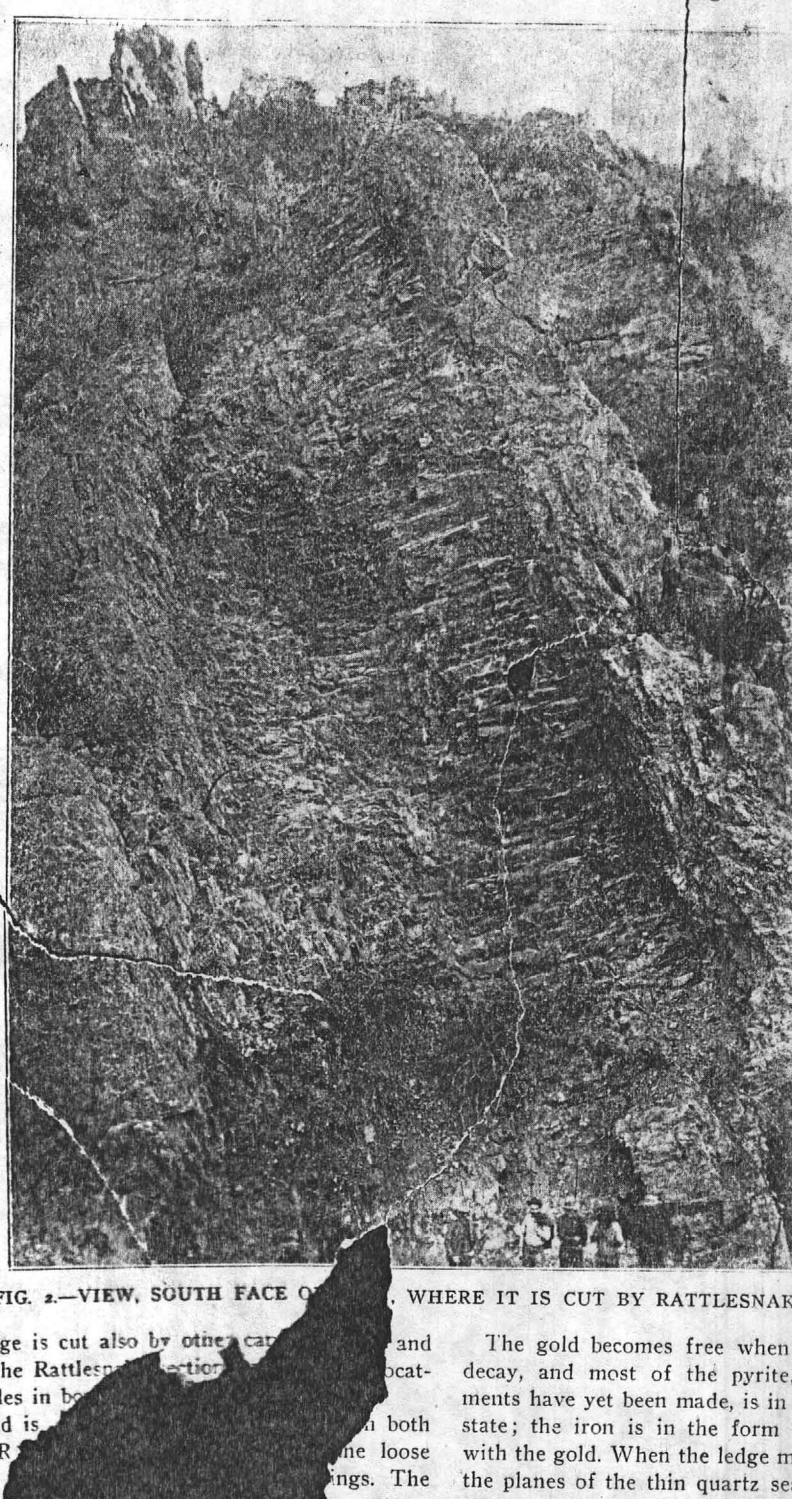

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*Abstract of a report made to the Consolidated Gold Mountain Mining Company, Tucson, Arizona, March, 1902.

†See a paper on Lake Quiburis, an Ancient Pliocene Lake in Arizona, by W. P. Blake, read by invitation at the meeting of the Cordilleran Section of the the Geological Society of America, San Francisco, Cal., January, 1902, and published in the February number of the University of Arizona Monthly.