INTRODUCTION.

LOCATION.—The Bradshaw Mountains quadrangle lies between parallels 34° and 34° 30' north latitude and meridians 112° and 112° 30' west longitude. It measures approximately 34.5 miles from north to south and 18 miles from east to west, and covers 986 square miles. The quadrangle is in the southeastern part of Yavapai County, Arizona, and includes a small part of Maricopa County in its extreme southeastern corner; a portion of the Prescott Forest Reserve occupies the northwestern half—a mountainous region including all the higher summits of the Bradshaw Range. The city of Prescott is 2 miles north of the northeast corner of the quadrangle, and Jerome, a mining town, is 17 miles north of the northeast corner. The only settlements at the time of the survey were small mining camps and scattered ranches.

Drainage.—The Bradshaw Mountains form a natural divide through the quadrangle from north to south, culminating in Mount Union, which rises 7971 feet above sea level. Several peaks on the east and northwest rise nearly 5000 feet, and southwest and the higher summits range from 6000 to 7000 feet. The peak of Agua Fria Valley and basin, the headwaters of the New River, rise to heights of 3000 feet, but north of them the flat-topped mesa and desert wasteland from Surprise to Squaw Creek average only 6000 feet, and the general aspect of the country is relatively low and flat. The lowest part of the quadrangle is in the northeast corner, with an altitude above sea level of 1000 feet. This area is almost flat, with the surface of the plateau.

DESCRIPTION OF BRADSHAW MOUNTAINS QUADRANGLE.

According to the present usage of American geologists, formations that lie unformably above the older and consist of stratified sedimentary rocks are assigned to the Algonkian. Owing to the fact that in some regions scattered rocks of approximately the same age have been found in Archaean rocks otherwise the same, there is some confusion in the nomenclature of the ancient schists. The schists of the Bradshaw Mountains are considered by the authors to be (1) pre-Cambrian, (2) Pro-Algonkian, (3) in great part sedimentary, for the following reasons:

1. The Paleozoic section is exposed at Jerome, 17 miles northeast of the northeastern corner of the quadrangle. The rocks are three fleshy felty sandstones, shales, and limestones, and the limestones are outliers of the great mass of horizontal Paleozoic and Mesozoic sediments which form the high plateau region of northern Arizona and New Mexico, and in which the schists are cut off near the surface of the plateau. The schists are therefore considered pre-Cambrian and largely sedimentary; hence they are assigned to the Algonkian.

2. The name of a great, series of schists rests upon field and laboratory evidence. Field exploration shows what rock types in the series are most abundant, and microscopical work determines whether those types contain water-worn pebbles and boulders. The type rock most widespread in the schist belts of the Bradshaw Mountains is a sericitic phyllite with occasional rounded quartz grains. From the great abundance of this rock and of variations, one might infer that these were hand true clay slates and on the other shaly slates and conglomerates, the authors conclude that the schist series is the main sedimentary. Confirmation of this conclusion is found in the sequence at certain points from course to fine to fine slates and fine sandstones; the authors conclude that the schist series is the main sedimentary. 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of phyllaceous conglomerate occurs very sparsely mingled with the quartz in most specimens, and calcite, epidote, albite, and quartz are often found in scattered grains. The present structure of these rocks is almost wholly the result of a process of recrystallization and deformation, however, that which later formed the conglomerate and its matrix is often seen in the form of an extensive lens of quartzite which is conformed in attitude with the schist and differs from it in composition solely in that the latter is more prominent in quartzite.

On the other hand, the facies of the schist series are noted which in general conform to the above description, but show abundance of fossils, paratively in the mosaic groundmass, partly in relatively large crystals with poorly preserved crystal form. The conglomerate is in most microcline and albite, and is sufficient in amount and of such a form as to indicate that the schists containing it were probably derived from acid igneous rocks, such as granitoid-parorphyses or the like. The fact that such fossils failingly of the schists are rare may strengthen the conviction gained in the field that the great bulk of the phyllite formation is of schist origin.

The following section across the Yavapai formation illustrates the variety of nature of its constituents. In this section, the nature of the surface exposures are given, rather than thicknesses, because the whole series varies in thickness throughout the section and occurs in closely appressed folds, so that actual thicknesses may be readily determined.

**Generalized section for teasing from east to west, from Mount Tritle to Copper Mountain.**

**Rigging Creek.**
- Dark and argillaceous green schist, 1.1 miles. Width of exposure 1 mile.
- Amphibolite; 15 miles.
- Mouth of Burch creek, in part, 1.1 mile.
- Laminated, trend: north-south, 1.1 mile.

**Grapevine Creek.**
- Dark grey, phyllitic, N. 45° E., dip west 45° at the boundary of the townsite, 1.3 miles.
- Dark grey, phyllitic, 1.3 miles.
- Quartzite ledges, 1.3 miles.
- North of Mayer.
- Ferrugious and sillicous schist with white quartz veins and hematite parallel to the hand joins, 50 feet. The material is extremely compact, 1.5 miles.
- Highly altered metamorphic schist—hornblende, schist, biotite, sericite, epidote, 1 mile.
- Dark grey, phyllitic, trend N. 45° E., dip west 40°, 1.5 miles.
- Sinalee schist exposure disconformable on eastern, granite, 1.5 miles. Width of exposure 1 mile.
- Boulders of schist and quartzite, 1 mile.
- Black schist and quartzite, in part, 1 mile.
- Quartzite lenses, 1 mile.
- Sericitic and argillaceous schists, trend N. 45° E., dip north 45° at the boundary of the townsite, 1 mile.

**Thicknes**—The changes of dip in this section indicate an antiformal structure on the west, in the vicinity of Grapevine Creek, and a synclinal structure in the region west of Copper Mountain. If these folds are projected southward along the strike, they match some similar ones indicated north of Brady Butte and in Cedar Canyon. Assuming that the structure is essentially vertical, the apparent changes in the nature of the Yavapai formation above the conglomerate on Bear Creek may be estimated by taking one-half the distance between the two areas of two folds of like kind (see section C-C on section-structure sheet). Measured in this way the Yavapai schist above the conglomerate-and-sandstone series has a thickness of from 6000 to 7000 feet. In structure section C-C the attitude of the conglomerate on either side of Brady Butte is hypothesized. The schists between the granite and the conglomerate may have a synclinal structure because the conglomerate represents the base of a formation unconformable on other schists. The synclinal or horizontal formation east in the region is indicated by the fact that pebbles of schist and quartzite occur within the conglomerate and such fossils as described above occur in the conglomerate.

Along the road from Battle Flat to Bear Creek the conglomerate outcrops in the Yavapai schist in widely scattered localities. They contain well-rounded pebbles in some places, more angular ones in others, and are intermixed with sandstones and siltstones. The conglomerate and quartzite are most prominent in the schist belt south of Mount Tritle, and to the west of this belt a wide series of slates and schists occurs beyond the conglomerate outcrops in contact with granite; the sedimentary origin of the greater part of the schists, the conglomerate and quartzite ledges, and the schist and quartzite of the Yellow Mountain range suggests that there were more considerable conglomerates and quartzite lenses in the Yavapai schist in widely scattered localities.

**Width of exposure**
- From 10 to 60, strike N. 55° E., white, 0.5 miles.
- Dark grey, phyllitic, N. 15° W., dip west at an angle of 70°, 0.5 miles.
- Dark grey, phyllitic, N. 45° E., dip west at an angle of 45°, 0.5 miles.

**Outcrops of quartzite occur throughout the Bigg district, near Bear Creek, west of Mount Tritle, north of Corda, and south of Silver Mountain, in addition to the localities already mentioned.**

**Hornblende-schist phase of Yavapai formation.**

The hornblende-schist phase is characterized by the development of hornblende and other distinctive minerals, here collectively referred to as hornblende-schist. The hornblende-schist phase is distinguished in different places in coarseness, schistosity, mineral composition, and origin. The boulders shown on the geologic map occur principally in contact with granite or quartzite and are highly metamorphosed bodies. The rock of the metamorphosed bodies varies from 1 mile, but it becomes greater in places where igneous bodies occur on opposite sides of a side-ruptant belt, as in Silver Mountain or Spruce Mountains. The topographic relief of those schists is great, but it is accompanied by the development of hornblende-granite; thus the greater part of Spruce Mountain, Mount Tonto, Mount Charleston, and Silver Mountain are formed of three hornblende phases and metamorphosed bodies. The hornblende-schist phases are influenced by fossiliferous belts to the normal Yavapai schist and are believed to be definite in all cases, and the contacts of these bodies or dike-like bodies do not always show pronounced
metamorphism. Thus the schists on the flanks of the Mount Elliott and Bynoe Granite masses do not show, as a rule, the characteristic hornblende schist belt on their flanks. Moreover, the changes wrought in the hornblende schists are probably not wholly due to contact action of intrusive phionic magmas. There are many local occurrences of highly metamorphosed rock which are not near igneous contacts. The case cited below, of the transition in the zone surrounding the great southern Bland granite stock, appears to be a definite case of "contact metamorphism." The continuity of one of these zones, however, is interrupted in two places, and it is remarkable that the long discordant belt bordering the granite of Bland Hill, and parallel to the eastern contact of the southern Bland stock across Black Canyon, has apparently exerted very little metamorphosis on the schists. Further exploration is necessary before these problems in this complex field can be solved.

A characteristic sector of the hornblende-schist phase is shown on the west flank of Synnai Mountain, where, east of the quartarid-nepheline Greens Creek basin, is a region of massive hornblende epidote hornblende characterized by football and eutaxitic texture, as distinct from the plains of the flat land of the quartarid-feldspar. Further east, in the vicinity of the Black Canyon, the schists are common in many places throughout the Tertiary magmatism. In this part of the country the pegmatitic lenses are found in the vicinity of granite contacts.

Along Crazy Basin Creek, northeast from Blasco Spring basin, is a region of prominent hornfels parallel to and near the granitic contact as is follows:

**Valparaiso Creek.**


The changes of hornblende-schists conform to a steady facies, well illustrated in the eastern spur of the conical hill of metamorphic schists which rise near Crazy Basin Creek, and are distinguished from the plains by the quartarid-nepheline-feldspar complex. The dip from relatively low angles (55°) where the schists are buckled about the northern end of the granite, show a gradual change as one approaches the granite, the schists dipping parallel to the rock face, and the dip increases to more than half a mile broad, to a depth which varies in places with the valley of the creek. In the vicinity of the creek the schists are foliated and generally fine-grained, and the amphibolitic zones more profuse, derived from basic igneous rocks. The environment is inescapable. The change is brought about by the horizontal schistosity in the quartarid-nepheline-feldspar complex, in which the quartz is commonly wrapped about the miarolitic cavities. Accessory minerals in small quantities are green hornblende, and the amphibolite schists are magnetic. They are highly puzzolanic rocks; the quartz occurs in prismatic 10° or more, and the hornblende is green or greenish-brown, and a little biotite. Euhedral hornblende and foliated muscovite and biotite are characteristic.

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(2) The amphibolites differ from the rocks above in the deutero-epidote, and quartz. The hornblende is green or greenish-brown, and the amphibolite schists are magnetic. They are highly puzzolanic rocks; the quartz occurs in prismatic 10° or more, and the hornblende is green or greenish-brown, and a little biotite. Euhedral hornblende and foliated muscovite and biotite are characteristic. These occurrence of these schists is in the zone surrounding the great southern Bland stock of Bland Creek, from Silver Mountain on the southwest, near toward Crazy Basin creek, and thence southward, along the eastern boundary of the granite, nearly to the southern limit of the quadrangle. The schists appear a gradual change as one approaches the granite contact, and near the schist and as independent masses. They are foliated and generally fine-grained, and the amphibolitic zones more profuse, derived from basic igneous rocks. The environment is inescapable. The change is brought about by the horizontal schistosity in the quartarid-nepheline-feldspar complex, in which the quartz is commonly wrapped about the miarolitic cavities. Accessory minerals in small quantities are green hornblende, and the amphibolite schists are magnetic. They are highly puzzolanic rocks; the quartz occurs in prismatic 10° or more, and the hornblende is green or greenish-brown, and a little biotite. Euhedral hornblende and foliated muscovite and biotite are characteristic.

(3) The mica-schists include coarsely crystalline quartz-mica, hornblende-mica, and tourmaline-schists; (4) epidote-, zoisite-, garnet-, and tourmaline-schists; (5) hornfels; (6) uralite-schists. The schists are buckled about the northern end of the granite, to the more normal higher angles (68°); the dip increases to more than half a mile broad, to a depth which varies in places with the valley of the creek. The schists are foliated and generally fine-grained, and the amphibolitic zones more profuse, derived from basic igneous rocks. The environment is inescapable. The change is brought about by the horizontal schistosity in the quartarid-nepheline-feldspar complex, in which the quartz is commonly wrapped about the miarolitic cavities. Accessory minerals in small quantities are green hornblende, and the amphibolite schists are magnetic. They are highly puzzolanic rocks; the quartz occurs in prismatic 10° or more, and the hornblende is green or greenish-brown, and a little biotite. Euhedral hornblende and foliated muscovite and biotite are characteristic.

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**Granite Country.**

The oldest surficial deposits in this region are gravels, associated with the lavas. In some cases these have been removed by recent washes, but in all such deposits are here included under volcanic agglomerates (see page 6). The only Quaternary deposits shown on the map are the larger alluvial. The oldest surficial deposits in this region are gravels, associated with the lavas. In some cases these have been removed by recent washes, but in all such deposits are here included under volcanic agglomerates (see page 6). The only Quaternary deposits shown on the map are the larger alluvial. The oldest surficial deposits in this region are gravels, associated with the lavas. In some cases these have been removed by recent washes, but in all such deposits are here included under volcanic agglomerates (see page 6). The only Quaternary deposits shown on the map are the larger alluvial.
The granite has the normal granite structure at the headwaters of Cohos Canyon on the southern base of Mount Union, in the high mountain east of Cushing, in the extreme western corner of the quadrangle on Indian Creek, and at many other places. A specimen from the head of Cohos Canyon was made the basis of a partial analysis which resulted as follows:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na₂O</td>
<td>9.00</td>
</tr>
<tr>
<td>CaO</td>
<td>3.90</td>
</tr>
<tr>
<td>K₂O</td>
<td>3.18</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>19.45</td>
</tr>
<tr>
<td>FeO</td>
<td>4.05</td>
</tr>
<tr>
<td>MgO</td>
<td>2.80</td>
</tr>
</tbody>
</table>

The molecular alkali-silica ratio calculated from these figures is 0.605, and corresponds to that of granite or tonose, which contains the equivalent of granite.

The granite forms the higher mountain summits, including the southern Bradshaw Range, the south-western range, the Mount Union group of peaks, Bradstreet Peak, and the heights of differentiates of Bradstreet Peak, the granites on the north and diorite on the west. In the latter part of the band of the Bradshaw Mountains the granite on the north and diorite on the west. The granite in the region of the band of the Bradshaw Mountains is one of the most common igneous rocks in the world. The granite is present in all of the bands, and extends in an almost continuous thickness of granite, in which the granite is not differentiable in origin and represents another period of intrusion, but evidence was not available for satisfying the authors on this point.

The diorite of the southwestern stocks is much more basic rocks. At the Bland mine and the summit breccias of Mount Tritle they are heavy blue-gray, and are essentially defined by porphyritic feldspar development. The hornblende is green in color and sometimes is found in the diorite, which is composed of green hornblende and greenish white feldspar with inclusions.

Table of analysis of diorite-perthite (No. 306) gives the following results:

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The mineral composition, calculated on the basis of this analysis, was found to be:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>63.3</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>25.4</td>
</tr>
<tr>
<td>Albite</td>
<td>4.4</td>
</tr>
<tr>
<td>Diopside</td>
<td>4.4</td>
</tr>
<tr>
<td>Hypersthene</td>
<td>3.5</td>
</tr>
<tr>
<td>Magnesite</td>
<td>3.5</td>
</tr>
<tr>
<td>Arfvedsonite</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The rock, as may be seen from this analysis with over 2 percent of CaO, is felsic and fresh, and this was expected from the appearance in this section, although so large an amount of calcite was not in evidence. The calculation of the norm gives the following:

Mineral composition of monzonite-porphyry:

<table>
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<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>60.0</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>25.3</td>
</tr>
<tr>
<td>Albite</td>
<td>4.2</td>
</tr>
<tr>
<td>Diopside</td>
<td>3.9</td>
</tr>
<tr>
<td>Hypersthene</td>
<td>3.2</td>
</tr>
<tr>
<td>Magnesite</td>
<td>3.3</td>
</tr>
<tr>
<td>Arfvedsonite</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The quartz-diorite is known to be the youngest of the Baseline monzonite-porphyry and its name was not assigned to it. The rocks are rock of striking appearance, with black hornblende in the large scale and biotite in the groundmass. Under the microscope the hornblende presents a remarkable character due to partial alteration, and the biotite is present in the first-mentioned rock alone some olivine, much aegirine. Magnesite is abundant in all.

The other variation is found in parts of the stock near the Mountains, on the east with a fine-grained granite-porphyry, frequently quite flinty in texture. The second dike mentioned is not topographically as conspicuous, varies in thickness from 30 to 300 feet, and crosswise various formations, is at a distance of 25 miles, a striking parallelism in the western context of schist and the larger southern stock of Baseline granite. The dike rock here is a monzonite-porphyry and parallels it in all other dikes.

The rock of the great dike in the New River Mountains is dense and flinty looking, with glasy-amblesite phenocrysts in a microgranphyric groundmass of quartz and feldspar. It is less basic, but little from the schistose flow of the same region.

The rock of the long dike described is typical of a large number of smaller rhyolite-porphyry dikes throughout the quadrangle. It is a fine-grained, with quartz and feldspar phenocrysts up to half an inch across, and a small amount of carbonate, which is a bisealit to carbonate and sericite to be determinable. The groundmass is a fine agglutinated granophyre in part, of quartz, feldspar, and sericite plates. Apatite and zircon were noted occasionally.

Similar dikes were found in the basin of Lynn Creek, in the Willow tunnel at Middleton’s, and in Rockwall Gulch. Syenite- and monzonite-porphyry dikes were found in Peck Canyon, on Lynn Creek, in Pine Flat, south of Tuckers Flat, a much, abundantly on the Mayo and, above Crow Creek, and west of Hornet’s Flat. They are gray rocks speckled with pink and greenish and algal particles.

The field of the monzonite is less shaped, and almost wholly altered to sericite and olivine. It appeared to consist of a single band of basaltic, and a soda-lime feldspar, probably aplite, and was about equal in amount to the biotite.

A chemical analysis of this rock was made which confirmed the determination above given, but so much alteration was revealed that it seemed necessary to reproduce the figures of the analysis.
clerite patches are pseudomorph after both biotite and hornblende, both of which occur rarely unaltered. The groundmass is generally microgranular, consisting of some quartz, feldspar, and abundant feldspar, both orthoclase and plagioclase, the latter being largely subequant with granite horns.

Streams have transported on their beds much coarse tectonically all of the fragments are of pitchstone, a material from the New River Mountains, and partly of the Crooks Canyon and Sheep Mountain, which represent condensate for the basaltic rocks and are therefore than the rhyolite-porphyrty.

Volcanic rocks

The oldest volcanic rocks known within the Bradshaw Mountains quadrangle are certain light-colored, fine-grained, porphyritic tuffs, consisting of glassy feldspar. The filamentous feldspar is uniform, varying chiefly in its content of fine-grained phenocrysts, which are mostly plagioclase.

ular basalt 350 feet thick occurs in upright colu-

highly vesicular orange-red glass containing minute

ine, and magnetite grains, either very finely gran-

is of feldspar laths (labradorite) with augite, oliv-

ite period closed.

The plagioclase crystals are white and glassy, and of a

perfect and transparency of form very true in Na.

Side feldspar. The crystals are complex twinn on the olivs, Carlsbad, and Mancos beds and

the common feldspar. The felspar grains are somewhat dulled by weathering, but are still suf-

ficiently perfect to give distinct readings on the

refractometer. The augite crystals are on the common prismatic facies, terminated by the nega-

tive pyramidal. In some cases the crystals of

both olivine and augite are covered with a coating of

a white scutile determined by chemical tests to be

water.

In this section the rock is formed of plagioclase feldspar, orthoclase, nepheline, augite, oliv-

ite, olivine, magnesite, and apatite, with a

structure varying from coarse granular to ophitic.

The plagioclase constitutes more than half the mass

and is dolerite (AbjAng), in the absence of orthoclase,

probably represents a locally differentiated facies

of a3girine, olivine, magnetite, and apatite, with a

average of 200 feet and in the neighborhood, that this intrusion did

outside the quadrangle. It seems highly probable,

clearly intrusive. It is a very coarse-grained gran-

type hessose, an equivalent of basalt.

Partial analysis of typical basalt from near Richinbar.

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaO</td>
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<tr>
<td>SiO2</td>
<td>59.36</td>
</tr>
<tr>
<td>Al2O3</td>
<td>7.64</td>
</tr>
<tr>
<td>FeO</td>
<td>5.58</td>
</tr>
<tr>
<td>MgO</td>
<td>1.59</td>
</tr>
<tr>
<td>Fe2O3</td>
<td>1.56</td>
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<tr>
<td>Na2O</td>
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<tr>
<td>K2O</td>
<td>1.04</td>
</tr>
<tr>
<td>Total</td>
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</tr>
</tbody>
</table>

RELATIVE SIZES OF VOLCANIC ROCKS.

The rhyolite tuff is apparently the oldest of the volcanic rocks, as it occurs at the base of the oth-

er agglomerates. The presence of a rhyolite near Preseit and of rhyolite-porphyr dolerites and rhy-

olite pods within flow structures on New River Mountain indicates that silicous lavas are not

wanting, and it is probable that they are the oldest lives in the region.

The basalts of the great basaltic period of volcanic activity followed the outgoing of sills, and the basaltic andesites

were not preserved under the basalt on the eastern side.

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part of the quadrangle, is marked by no definite boundaries in the field. In such a place it is highly probable that the banding of the igneous members of the complex was induced by splitting apart spaltenstein, and hence that the various bands represent the filling of intervals originally marked by various compositions in different epochs of the period of intrusion of the magma as a whole. The outcrop of Crooks complex along Squaw Creek and some of these outcrops of contact dikes in the Crooks complex show bands parallel to Yavapai schists, but the banding is transverse to and discordant with the trend of adjacent schists. The Crooks complex as a whole is an intricate manifestation of the intrusive nature of the granite and its relation to the schists and the areas mapped as this formation may be considered exemplified on a scale too small to map of all the contact features of granite, diorite, and schist shown elsewhere on a larger scale.

The evidence bearing upon the problem of contact metamorphism is as follows: The schists are shown on the map to develop a metamorphic zone, bearing distinctive contact minerals, along the borders of the great Bradshaw stock and along portions of the contact of the elongate group of igneous formations from Briggs to Mount Union, including granite, Crooks complex, and diorite, all of which are banded with a faint banding of the same magnitude. Included strike or belts of schist within these igneous masses usually show the same transition from metasomatic or contact schist to the adjacent schist at places where no plutonic masses are visible. The greater part of the evidence, however, shows a connection between individual formations of the schists and the proximity of the plutonic contacts. Hornblende is not always present in the contact zones, but it is there in the Crooks complex and along the borders of the Crooks complex. The evidence, therefore, for an extensive metasomatic zone in the contact schists is nearly as complete as that for the exomargin zone in the schist. It is quite certain, however, as stated above (1) that the contact schists were adjacent to the contact with granite, and in these cases, if the diorite is considered a phase of the granite, the question arises, Why is the diorite more basic along the contact than it is in the interior of the stock? This question has been raised repeatedly over the Bradshaw Mountains, where a large granite stock on the other hand has inclosed a large belt of diorite which contains some granite and schists which are partly altered to amphibolite, and which are more metamorphic varieties of the granite. A stock of quartz-diorite in the northwestern part of the quadrangle shows an associated granite stock in the northwestern part of the quadrangle. In the latter area from Lynx Creek to the northwest corner of the quadrangle, to Cellar basin, on the western side, where the schists are well exposed toward the Hackberry basin, east of Bigbug Mesa, at Valverde, and at Stoddard, at Myer's deposit of quartz, into contact with granite and schists, the schists were already basic; in such a case the location of basic material in those places where the diorite侵入, there can be no doubt that the schists are generally altered and replaced within the granite bodies. In these respects the Crooks complex is an excellent type for studying the problem of contact metamorphism. The above statement of the facts and of the</p>
patches serve to connect the wide alluvial area of Collar basin with the southern exposure, showing that the volcanic lavas were once continuous through the region. South of Smokey Creek the stream flows through a fertile bottom land. Under the basalt and granite flows occur. The series of ancient crystaline rocks which form the old land under the lavas, from west to east, is as follows: Gran­ite, gneiss, schist, schistose gneiss, quartzite. The whole series is given place to diorite, and toward the east granite being segregated along the contact zone, or intrusive plu­teous. The oldest rocks known in the Bradshaw Mountains are quartz-diorite and granite, with small schist bands which are often stained with chrysocolla; this has given rise to copper prospecting in this vicinity. 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in the Minnehaha complex they are almost entirely wanting. The cross-cutting veins, which are largely aluminous and contain 10 to 20 per cent quartz, do not appear to have been so largely altered at the surface to chrysocolla as elsewhere. The typical silver veins of the Minnehaha complex to the west, are several gold mines, of which the Fortune is said to have been a large producer. The Bear mine is working a large vein of pyrite-chalcopyrite with less important outlying veins which will be considered. These are siliceous schists pitted and copper-stained with films of native copper and sometimes of cuprite. The surface brilliant with chrysocolla. Chalcocite appears to be the principal sulphide mineral in these veins. In some instances bournonite, with a gangue of quartz, is present. At one mine, the surface brilliancy is due to a layer of 20 to 30 feet of quartzite with a false coloration. The veins may be classified, according to the character, the metallic contents being largely divided into gold and silver veins, and those of the Crook mine, having been worked with considerable success in the past, and the Richinbar mine is a development of the last. The Crook mine is very similar in character of ore. The vein is an ore shoot several feet wide in the Homestake, and is characterized by comb and banded structure, the center of the vein being generally open and lined with beautiful crystals of all the vein minerals. A rich body of free gold was found in this mine at a depth of 200 feet from the surface. The ore is predominantly of chalcopyrite, and contains some tetrahedrite in quartz and galena. The croppings are rich in silver. The Tiger mine was the first of the rich silver veins to be developed and is the only one of them that is still open, but it is not larger producer. The vein, which passes from the quartz-diorite into a schist and sulfide belt, is nearly a mile wide at the surface and averages about 2 feet thick. The productive part of the vein is an ore shoot several hundred feet wide, with flat pitch to the north. The ore shoot is developed by the usual adit workings. The pyrite and sphalerite are the most abundant, and are accompanied by more or less silicification. The Blue Mountain mine, which shows a zone of impregnation up to 30 feet wide, which has been followed down to a depth of 300 feet, the width increasing with depth. Beside copper the ore carries small gold values.

The Blue Bell mine is the only property in the area which the geologists of the Survey did not examine. The information concerning it, therefore, based on what could be seen at the surface and on statements as to conditions underground which were not verified.

A similar but even less defined and less explored series of copper veins appears in the narrow belt of schist which follows the edge of the Crown King stock. The vein lay next to a huge quartzite ledge with a foot or less of about 400 feet wide, and averages about 2 feet thick. The productive part of the vein is an ore shoot several hundred feet wide, with flat pitch to the north. The ore shoot is developed by an adit entrance. The pyrite and sphalerite are the most abundant, and are accompanied by more or less silicification. The Blue Mountain mine, which shows a zone of impregnation up to 30 feet wide, which has been followed down to a depth of 300 feet, the width increasing with depth. Beside copper the ore carries small gold values.

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defined and narrow, and composed of coarse quartz containing pyrite, galena, and sphalerite; the values are found chiefly in irregular vertical shoots. The ore is free milling.

VALUE OF THE ORE.

It is difficult to give average values for the ore produced in this region, both because of the lack of reliable data and because of the extreme variability of the tenor and character of the ore. The free-milling gold ores now being worked probably average about twenty dollars gold and from 1 to 2 ounces silver to the ton; values of less than twelve dollars per ton will rarely pay under present conditions of working. An idea of the character of some of the smaller ores produced is given by the average value of five shipments of selected ore from a mine now active, which yielded 35 ounces of gold, 165 ounces of silver, and 4 per cent of copper to the ton. Reliable data for the value of the rich silver ores formerly worked are not at hand. The ores appear to have run as high as 200 ounces, and probably much more, to the ton.

placer.

Rice placer deposits formerly existed along most of the streams of the quadrangle, and it is estimated that not less than 100,000 dollars was obtained by placer mining up to 1881. Most of this value was won from Lynx, Bigbug, and Hasbyung Creek in the north and from Turkey Creek, Black Canyon, and Castle Creek in the south of the quadrangle. At the present time the river placer is almost exhausted, but a little work is still being done on Lynx Creek and along Oak and Cherry creeks in the western part of the quadrangle.

It has been found that some of the gravelly beds in the western belt of volcanic agglomerate are auriferous, and just beyond the western boundary of the quadrangle, on Slate and Milk creeks, some hydraulic prospecting has been done on placer deposits belonging to this formation. To what extent this auriferous character prevails in the large deposits of the formation within the quadrangle is not yet determined. At the time of survey a dredging plant was about to begin operations upon an alluvial deposit which caps a flat ridge near Mayer and in which a small gold content has been proved. The success of the experiment is not known, but even if profitable the amount of auriferous alluvium available for such operations appears to be very limited.

Iron Ore.

No iron ores of proved value are known in the quadrangle. Iron ores of possible value were, however, noted at one point. On the ridge at the head of Blind Elindus Creek, about 2 miles southeast of Bueno, is a body of schist rich in magnetite. Microscopic study shows it to have a small phase of the Yavapai schist; here the schist is nearly devoid of soil. The basalt weathers into black ash, and the resultant glacial outwash is designated as building stone. So far as known the only stone used in the region is the green rhyolite tuff found abundantly in the Bradshaw Mountains.

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