

which is crossed by the road from Gold Creek to Burner. The range may be regarded as a northward extension of the Cortez Range, but the two are separated by a relatively low saddle between the headwaters of Soldier Creek and Independence Valley. Several of the highest mountains reach elevations from 9,000 to 10,000 feet above the sea, or about 4,000 feet above the level of Independence Valley.

As shown in the atlas of the Fortieth Parallel Survey, the range is made up mainly of thick rhyolite flows which here and there are eroded away to expose large outcrops of sedimentary rocks, chiefly the Weber quartzite. The rhyolite extends westward a great distance from Tuscarora and covers a large area surrounding Squaw Valley, including Gold Circle and other camps near by. At Tuscarora, Cornucopia, Good Hope, and Falcon the rhyolite is cut by large bodies of intrusive andesite. A body of granodiorite occurs near the headwaters of Willow Creek.

The mining camps situated in the Independence Range are Tuscarora, Cornucopia, Good Hope, and Falcon. The ore deposits are silver-bearing fissure veins of the Tertiary group and are in andesite or in rhyolite near intruding andesite. No deposits have yet been discovered in the sedimentary rocks or associated with the granodiorite intrusive rock.

#### TUSCARORA.

##### HISTORY.

Tuscarora is situated on the southeastern slope of Mount Blitzen, at an elevation of about 6,200 feet above sea level. It is near the west margin of Independence Valley, a broad area of flat hay land drained by Owyhee River, and is about 50 miles northwest of Elko, with which it is connected by a daily stage that also connects at Tuscarora with stages for Edgemont, Aura, Mountain City, and other northern points.

Placer deposits were found at Tuscarora in 1867, and several years later rich silver veins were discovered. In the seventies and eighties a number of silver mines were opened and a large production was sustained for a number of years. Most of the ore was milled at Tuscarora; only the very high grade ore was shipped to smelters. The six silver mills which were in operation employed the Reese River process, by which the ore was dried, stamped, roasted with salt, and amalgamated in silver pans. The Grand Prize mill employed a combination process, the ore being concentrated over vanners and the concentrates roasted and subsequently amalgamated in pans with the raw tailings. The silver mills had an aggregate of 80 stamps and are said to have given a satisfactory extraction.

The Dexter mine, which is a large deposit of low-grade gold ore, was discovered after the silver mines had been producing for several years. This mine was worked until 1898, when operations were discontinued

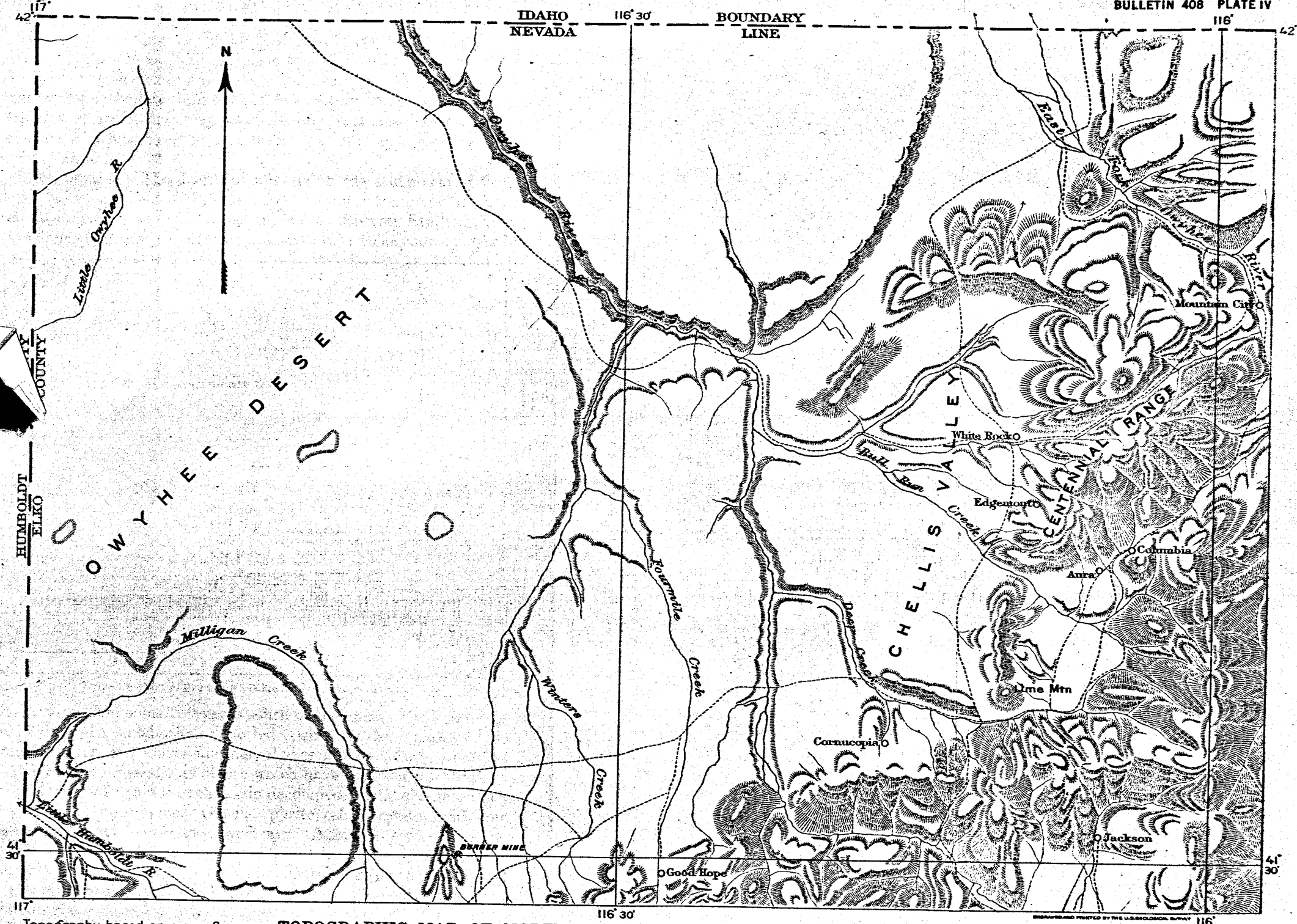
on account of the great volume of water which was encountered. The Dexter ore was treated in the Dexter mill, originally a 40-stamp amalgamating mill operated by electric power. Subsequently four Ellis tables and fourteen cyanide tanks with a capacity of about 450 tons were added to treat the tailings. In 1908 a second cyanide plant was installed.

Since 1898 there has been some leasing on the upper levels of the old silver mine, but extensive mining operations have been discontinued. In 1907 Arthur A. Brownlee obtained options on nearly all the mines and organized the Tuscarora Nevada Mines Company. This company spent considerable money sampling the mines and dumps, and is said to have found a large tonnage of low-grade ore in the old workings of the Dexter mine. The company plans to unwater the mine, to build a large cyanide plant, and to undertake many other improvements.

Accurate figures for the production of Tuscarora are not at hand. Various estimates range from \$25,000,000 to \$40,000,000. Most of this was obtained between 1872 and 1886 and the larger portion is silver. The gold placers are reported to have yielded \$7,000,000 and the Dexter mine \$5,000,000 in gold, the various silver mines being credited with the remainder.

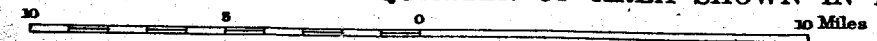
When the camp was visited in 1908, practically all the mines were inaccessible. At the Dexter, which is situated at the lower edge of the mineralized area, the water table was within 20 feet of the surface and only some shallow workings and open pits could be entered. In the silver mines, which are at slightly higher elevations, a few workings above the 100-foot level were accessible.

The country rock of the Tuscarora mines is rhyolite and andesite porphyry, which at many places are covered by a thin layer of Quaternary gravel. Most of the deposits are in the porphyry, which in the vicinity of the mines is highly altered. It is the propylite of the Fortieth Parallel Survey. High on the southeastern slope of Mount Blitzen relatively fresh andesite outcrops at several places. The freshest andesite is composed of a dense greenish groundmass containing phenocrysts of andesine, orthoclase, hornblende, and biotite. Toward the mineralized area the andesite is greatly altered. At some distance from the veins chlorite is formed in great abundance and the rock is dark green, but in the highly mineralized area and within a few yards of the veins sericite and iron pyrite have been extensively deposited by replacement. On oxidation this rock alters to a brown iron-stained porphyry, which constitutes a large part of the various mine dumps. Some specimens of what seemed to be the least-altered phases of the porphyry in the mineralized area proved, on examination, to be rich in quartz and orthoclase. It will probably be found that the porphyritic rock commonly regarded as andesite



Topography based on map of Elko County by E.C. McClellan

TOPOGRAPHIC MAP OF NORTHERN QUARTER OF AREA SHOWN IN FIGURE 2



consists of several related kinds of rock, the separation of which will require great patience even under favorable conditions.

The rhyolite is when fresh a white or greenish dense or almost glassy rock; at many places it is a flow breccia. In the vicinity of the ore bodies it is extensively altered, and even the freshest specimens show, under the hand lens, a considerable amount of secondary pyrite.

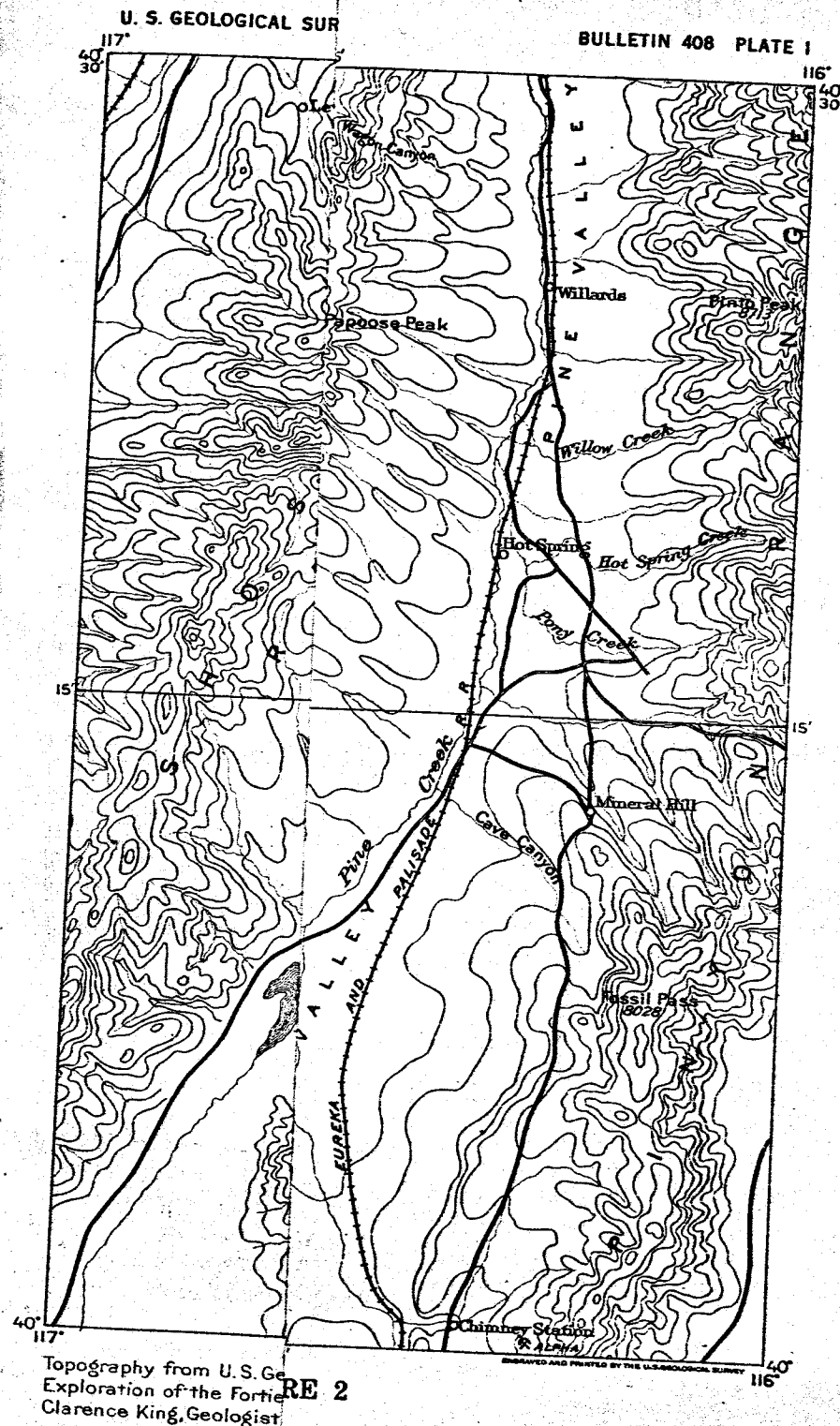
In the open cut at the Dexter mine the relations of the andesite and the rhyolite are distinctly crosscutting, one rock intruding the other in a very irregular manner. Owing to hydrothermal action and subsequent oxidation it is not possible to ascertain which rock intrudes the other, but if the rhyolite is a flow, as is indicated by the banded shaly phases, then the andesite is the later rock and is intruded into the rhyolite.

#### ORE DEPOSITS.

The ore deposits, so far as could be ascertained from the limited observations which were possible when they were visited, are silver lodes in andesite, fractured zones or stockworks of gold ore in rhyolite, and gold placers.

**Silver lodes.**—The silver veins occur in an area of highly altered andesite, which contains small masses of rhyolite. Most of them strike a few degrees west of north and dip toward the west. The gangue is mainly quartz. The ore minerals are ruby silver, enargite, and other silver sulpharsenic and sulphantimony minerals, silver glance, galena, pyrite, and arsenopyrite. A little chalcopyrite and bornite were noted, but these are not abundant. Here and there is a little malachite, but copper is present only in small traces—as a rule, much less than 1 per cent. Shoots of gold ore are found in some of the silver lodes and most of the silver ore contains gold. Near the surface there was much horn silver and native silver. A single block of horn silver from the Commonwealth mine is said to have sold for \$30,000. The veins are fissure fillings between the walls of porphyry, and in some of them the ore surrounds numerous fragments of brecciated country rock. Locally the wall rock is replaced by workable ore, and at many places in the vicinity of the veins the country rock is said to carry low values in silver and gold.

The Navajo lode, which is about one-fourth mile west of Tuscarora, was the most productive system of veins. It strikes about N. 80° W. in the Navajo ground and it has been followed northwestward for about a mile. The deposits of the Navajo, Belle Isle, North Belle Isle, Nevada Queen, Commonwealth, and North Commonwealth mines are on this lode. At the North Commonwealth it bends and strikes about N. 60° W. The total production of these mines is said to have been about \$15,000,000. East of this lode, and situated in the main on lodes which are approximately parallel to it, are the



deposits of the Independence, P. & P., Eira, Silver Prize, Buckeye, De Frieze, Grand Prize, and other mines. According to report, most of the larger ore shoots were at the junction of fissures and pitched toward the northwest.

In the North Belle Isle, on the 70-foot level, several narrow fissure veins strike north and dip from  $35^{\circ}$  to  $80^{\circ}$  W. These carry values in silver and gold up to several hundred dollars a ton, and where they join, about 20 feet below the 70-foot level, they make a shoot of ore several feet wide from which \$1,000,000 is said to have been taken.

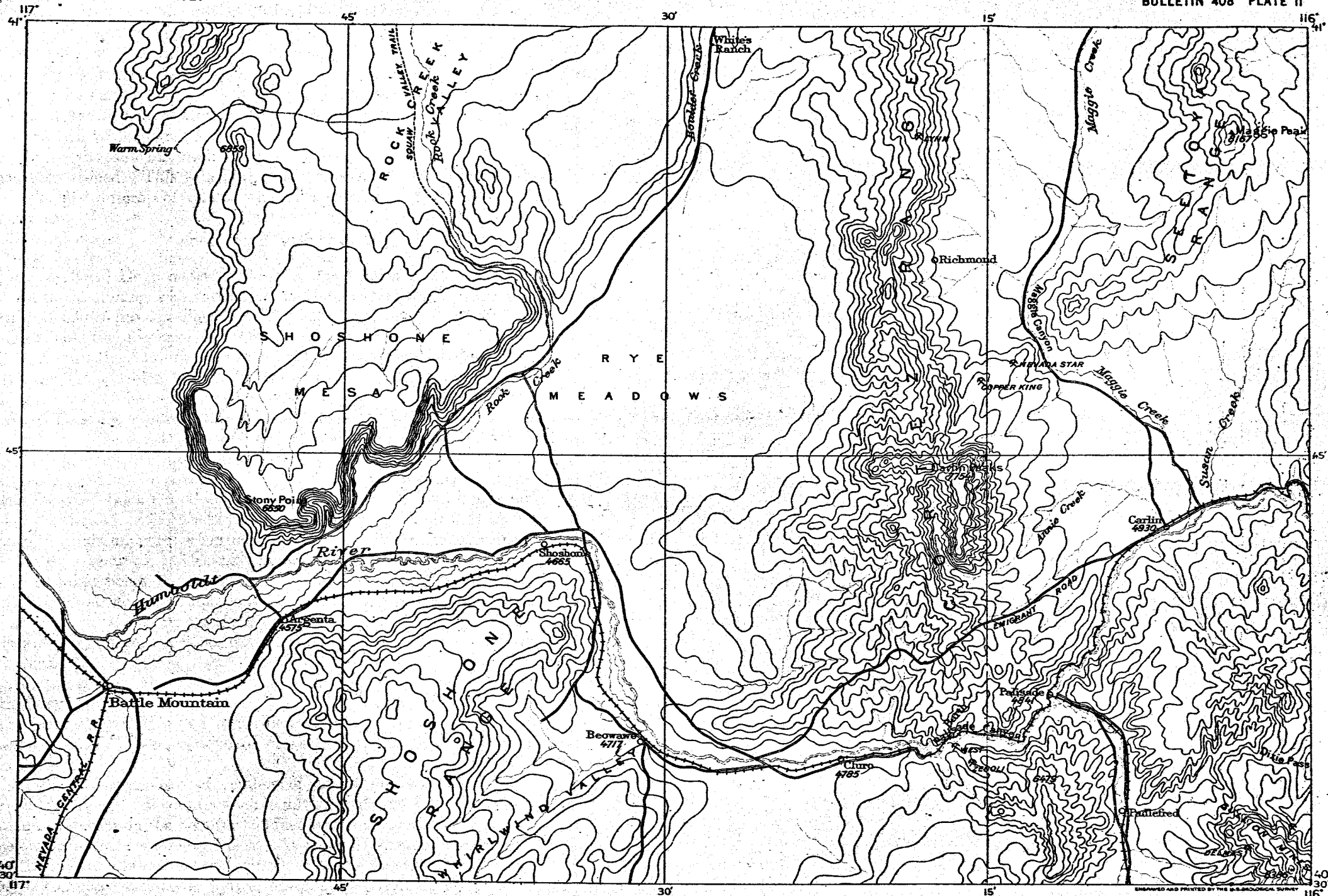
*Gold deposits.*—The most important gold deposit at Tuscarora is that of the Dexter mine. This is situated near the contact of rhyolite and andesite and dips northward at a low angle. A zone, mainly in the rhyolite, is strongly fractured for a distance of 1,400 feet east and west and about 200 feet north and south. Pockets of rich ore occur here and there in this zone, and it is said that the whole mass of this rock could be worked profitably by cyaniding on a large scale. The deposit is crossed by numerous closely spaced veinlets of quartz, which strike in all directions. In many of them the fissures are not completely filled, and the centers of the veinlets contain long, narrow druses lined on both sides with well-formed crystals of quartz half an inch long. Locally there is considerable adularia in crystals up to one-fourth inch long, deposited in drusy veinlets with quartz. These veinlets are said to carry high values in gold. The rhyolite of the fissured zone is strongly impregnated with pyrite, even the freshest specimens showing much pyrite under the hand lens. The gold seems to have been deposited through replacement of the rhyolite and also in numerous small open spaces. The deposit is crossed by several faults which strike northeastward and dip toward the northwest. The throw of all these faults is said to be toward the south; the hanging wall on the west side of the fault has moved downward, causing an offset of the ore zone toward the south. The faulting is therefore normal.

Some gold placers are located from 1 to 3 miles west of Tuscarora. They were extensively worked in the seventies and are said to have produced \$7,000,000, but little work has been done of late years except that carried on by a few Chinese. The deposits were worked mainly by ground sluicing. The gold occurs as dust and as nuggets of considerable size. One of these, about one-half gold and one-half quartz, weighed 9 ounces, and many nuggets have been found which weighed more than an ounce. The source of the gold is presumably some gold lodes which occur to the north and west of the diggings.

At the Rose mine, about  $1\frac{1}{2}$  miles west of Tuscarora, several low-grade quartz veins have been found, and the country rock, which is altered porphyry, is said to carry appreciable values in gold.

On Beard Hill, 2 miles southwest of Tuscarora, the Surprise group is situated just above some old placer workings. The country rock





Topography from U.S. Geological  
Exploration of the Fortieth Parallel  
Clarence King, Geologist in charge

# TOPOGRAPHIC MAP OF SOUTH-CENTRAL QUARTER OF AREA SHOWN IN FIGURE 2

10 5 0 10 Miles

is-shattered rhyolite, which is cut by many veinlets of iron-stained quartz that pans gold freely. Some of the placers were probably derived from these deposits.

A large acreage of ground west of Tuscarora has been located and sampled with drills. It is said that much of this ground will pay to work with dredges, and two companies are planning such operations. A large number of samples are reported to have given an average of about 14 cents per cubic yard.

#### FALCON MINE.

West of Tuscarora there is a great area of mountainous country, the higher peaks reaching elevations of 8,000 to 9,000 feet. The rocks are in the main Carboniferous quartzites capped by rhyolite and intruded by andesite and related rocks. A large mass of granodiorite, probably older than the rhyolite and porphyry but intrusive in the sedimentary rocks, is exposed at the headwaters of Willow Creek and Rock Creek.

The Falcon mine, at the head of a small tributary of Rock Creek, is about 12 miles by wagon road west of Tuscarora. The mine was worked from 1879 to 1881 and the ore was hauled to Tuscarora. In 1884 a four-pan silver mill was built, but this was not operated and is now in ruins. The deposit is a fissure vein from 2 to 5 feet wide and is approximately vertical. Two deep shafts are sunk on it and shallow pits are dug at several places. The country rock is andesite, which near the vein is altered to a light-gray rock composed largely of white mica, but the fresh dark andesite is exposed at several places within 300 or 400 feet of the vein. The ore is highly siliceous and contains a small proportion of finely divided pyrite and other dark sulphides, which are banded with the quartz and show comb and ribbon structure. The values are said to have been in ruby silver.

#### CORNUCOPIA.

The mines at Cornucopia, about 8 miles southwest of the stage station on Deep Creek, were operated actively in the seventies, when they produced, it is said, over a million dollars in silver. The ore was treated by pan amalgamation in a 20-stamp mill at Mill City, 2 miles below the town. The principal mines are the Leopard and the Panther, which were operated through shafts. The Leopard shaft is said to be 800 feet deep. When the camp was visited in 1908 all the deep workings were caved and only some shallow pits and surface stopes were accessible.

The country surrounding the Cornucopia district is a large area of low hills, which in the main are capped with rhyolite and obsidian. Under the microscope the denser rhyolite is seen to be composed of a glassy microlitic groundmass which contains phenocrysts of quartz,

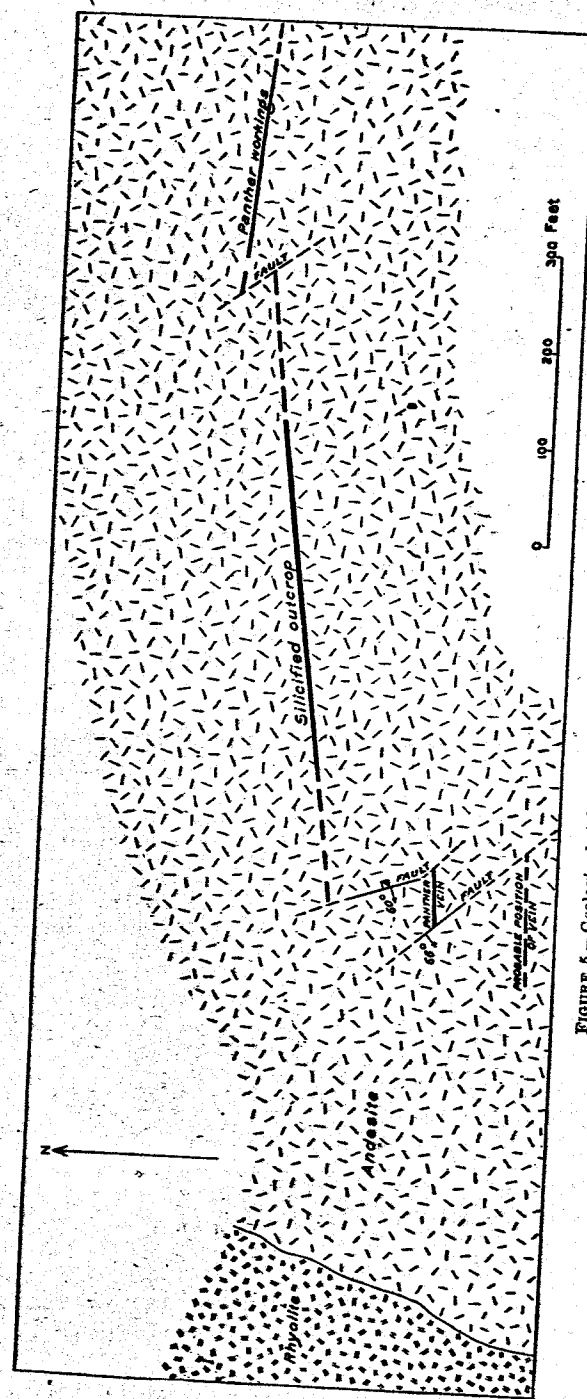
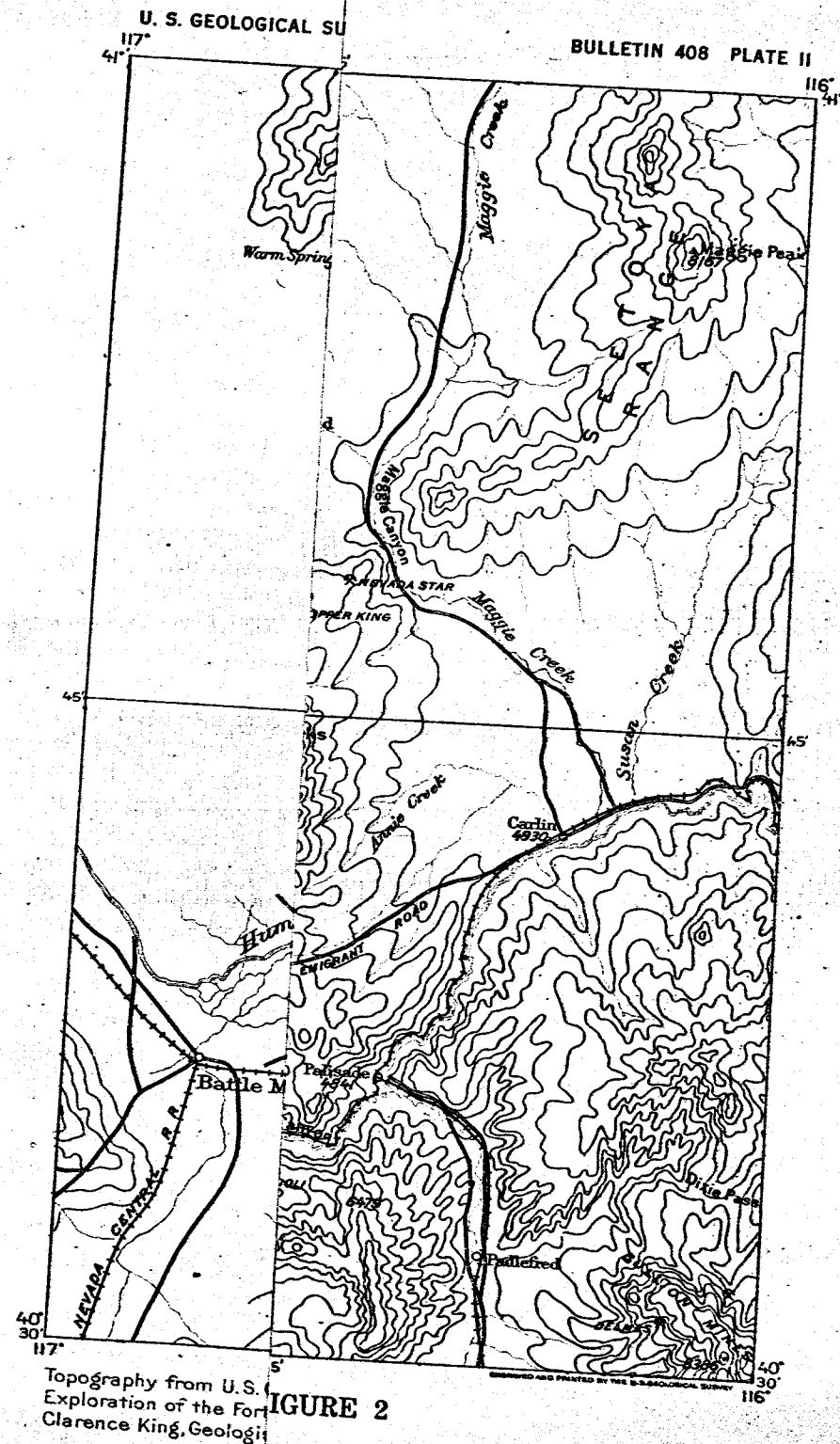


FIGURE 5.—Geologic sketch map showing Panther vein, Cornucopia district.

oligoclase, pyroxene, magnetite, and a little hornblende. It is more basic than most rhyolites of this area and approaches andesite in composition. Some phases of rhyolite are vesicular and some are pumiceous. The rhyolite is cut by intrusive andesite, to which the accessible ore deposits are restricted. An exposure of the andesite in a relatively fresh condition may be observed near the ruins of a stone house at Cornucopia. The rock is a dark porphyry, composed of a glassy groundmass which contains many phenocrysts of basic andesine and pyroxene, with large chloritic patches that seem to have resulted from the decomposition of hornblende. At the exposure named it may be noted grading into a highly decomposed sericitic phase of the andesite, which is white or stained with yellowish-brown iron oxide. Everywhere in the vicinity of the ore deposits the andesite is similarly decomposed. Masses of quartz porphyry occur in the area of the andesite and are probably intruded into it. The quartz porphyry is light colored and is composed of a groundmass, presumably microcrystalline, which contains white mica, feldspars, and small phenocrysts of resorbed quartz. The rock outcrops in the tunnel of the Leopard mine, but none of the deposits, so far as known, is inclosed in it.

The ore deposits are sheeted zones in decomposed andesite. The ore is white quartz, which carries a very small proportion of dark sulphides, forming narrow ribbons in the quartz. Pyrite, argentite, and gray copper are present, and ruby silver is said to have been an important ore mineral. On the surface the ore minerals are mainly horn silver and a yellow mineral which is probably pyromorphite. The proportion of the sulphides present is very small, but they must have been rich, for the ore is said to have carried 400 ounces of silver to the ton for mill runs. In some of the ore the minerals are arranged symmetrically with respect to the walls, the quartz crystals pointing to the center of a druse, showing that the ore was deposited in open spaces. The country rock along the veins is, however, silicified and otherwise altered by the vein-forming solutions, and at some places carried workable values.

The Panther vein in the principal workings southwest of the silicified outcrop shown in figure 5 strikes S. 78° W. and dips 83° N. to 90°. Here underhand stoping has been carried down for a distance of 60 feet along the strike. The country rock is altered andesite, a soft kaolinized mass cut through by veinlets of white quartz. At the west end of the stope a smooth slickensided fault strikes northwestward, cutting off the vein. The surface of the fault shows striæ inclined northwestward to a line along the direction of steepest dip and making an angle of 15° with it. The country to the north has been prospected for the vein, but it has not been discovered in that direction on the southwest side of the fault. If the fault is



normal, the vein to the west of it should be found south of the present workings, where possibly it is represented by some poorly defined masses of quartz which outcrop at that place.

A few rods northeast of the surface stope is a prominent ledge which strikes a few degrees north of east. This ledge, which is several hundred feet long, is the altered andesite somewhat silicified, fractured, and seamed with quartz veinlets. To the east of the ledge a vein in altered andesite has been developed for a few feet and some ore has been stoped. This vein is probably the faulted continuation of the silicified outcrop of quartz which lies between the two groups of workings.

#### GOOD HOPE DISTRICT.

In the Good Hope district, which is about 12 miles southwest of Cornucopia, mining was carried on in the early eighties, when the camp is said to have produced over \$100,000 in silver. The principal mines are the Buckeye and Ohio, the Snyder, and the Page & Kelley. All these mines were inaccessible in 1908 except the Buckeye and Ohio, which was under water above the adit level. The deposits are in the main sheeted zones in rhyolite flow breccia, but altered andesite is exposed at several places and it is probably the country rock for some of the ore deposits. The leaching of the country rock is extensive near some of the deposits, but is not so general as at Cornucopia. Pyritization is, however, more pronounced in the wall rock and the ore at Good Hope contains a much greater amount of the sulphides. The Buckeye and Ohio mine is on Fourmile Creek near its junction with Atlantic Cable Gulch. The mine was operated from 1882 to 1884, and the ore was run through a 5-stamp mill  $1\frac{1}{2}$  miles below the mine. This mill was equipped with roaster, pans, and settlers and employed the Reese River process. A small concentrator was built in 1903, but the treatment employed was presumably unsuccessful, as only a small amount of ore was put through it.

On the surface above the adit level obsidian and other varieties of glassy lavas outcrop at several places. In the mine the rhyolite is a light-colored flow breccia, which is locally altered to a white claylike mass. Along a zone of movement it has been converted to gouge.

The lode is composed of veinlets of quartz and sulphides, which include masses of the country rock highly altered and partly silicified. A tunnel driven on the vein for 300 feet southwestward gives a depth below the surface of about 65 feet. At some places stopes are carried to the grass roots and several winzes are sunk upon the vein. The ore is composed of quartz, pyrite, arsenopyrite, freibergite, stibnite, and dark ruby silver.



The vein, as shown in figure 6, is followed by the adit for a distance of 300 feet. At the breast, where it dips steeply westward, it is cut

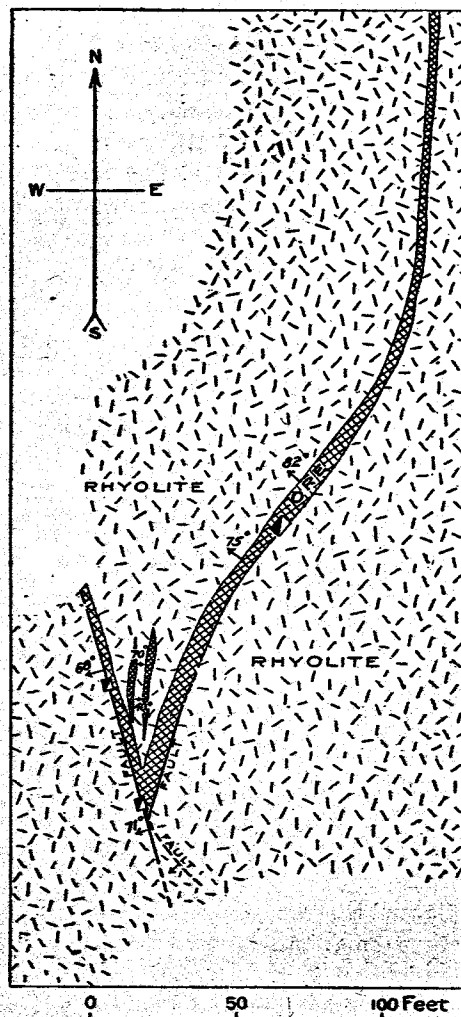


FIGURE 6.—Plan of adit level of Buckeye and Ohio mine, Good Hope district.

off by a fault which strikes  $37^{\circ}$  E. This fault follows a vein also and carries much crushed ore and some banded ribbons of unbroken ore. A stope from this vein is carried to the surface. Near the junction of the two veins a second fault, which deviates from the principal fault about  $5^{\circ}$ , cuts off the west vein. The ore therefore forms a letter V, which points to the south. If the faults are normal the continuation of the principal vein will be found south of the present workings, on the west side of the fault.

Near the head of Atlantic Cable Gulch, about 1 mile above the Buckeye and Ohio mine, several prospects show brecciated rhyolite silicified and cemented by quartz and dark sulphides. One of the lodes outcropping boldly on either side of the gulch strikes  $N. 10^{\circ} E.$  and dips  $35^{\circ} W.$ , and its outcrop forms a V pointing up the gulch. In places it carries a considerable quantity of dark pyritic ore which has been crushed and recemented by white and

barren-looking quartz. At one place an abandoned incline is driven on the lode to a depth of about 30 feet, exposing a considerable mass of quartz and sulphides.

#### BURNER HILLS.

##### GENERAL FEATURES.

The Burner Hills, which are some 10 miles west of Good Hope, rise about 800 feet above the broad undulating plain of the Owyhee Desert, which lies to the east and north. From Good Hope to the

Burner Hills this plain is covered by beds of rhyolite and rhyolite pumice. Nearly everywhere these beds are flat or dip at low angles in various directions, but as they approach the hills the marginal fringe of rhyolitic pumice becomes steeply upturned and dips away on the east side at angles up to  $35^{\circ}$ . Still higher on the hills siliceous shales with beds of intercalated limestone outcrop at many places. These beds are highly tilted and show a considerable variety of attitudes, but the prevailing dip appears to be away from the central axis of the hills, the summit of which is a fresh andesite showing massive and probably rhyolites also, although the contact at this place was not seen. A number of claims are located on these hills, but the Mint mine is the only one on which any considerable amount of work has been done. This mine was operated in the early eighties and shipped about \$30,000 worth of lead-silver ore to smelters. Active operations were suspended in 1893, and since that time but little work has been done.

#### MINT MINE.

At the Mint mine a tunnel is driven southwestward for 175 feet to the lode, which it follows for 300 feet. The lode strikes  $S. 25^{\circ} W.$  and is approximately vertical. Here and there stopes have been carried upward and a winze is driven on the lode below the adit level. The ore consists of galena, sphalerite, pyrite, arsenopyrite, and chalcoppyrite, in a gangue of quartz and calcite. Near the surface lead carbonate and iron oxide are present. The sulphides and quartz occur as ribbons parallel to the walls or as masses impregnating the andesite, which is somewhat altered by the vein-forming solutions. The high-grade ore is said to be irregular and buncy in the vein, but a zone up to 4 feet wide is regarded by the owners as available for concentrating, as a considerable proportion of the silver values is in galena.

South of the Mint mine are several small veins of iron-stained siliceous silver ore. Some of these cut across the sedimentary rocks; others occur as stringers parallel to the bedding.

#### CENTENNIAL RANGE.

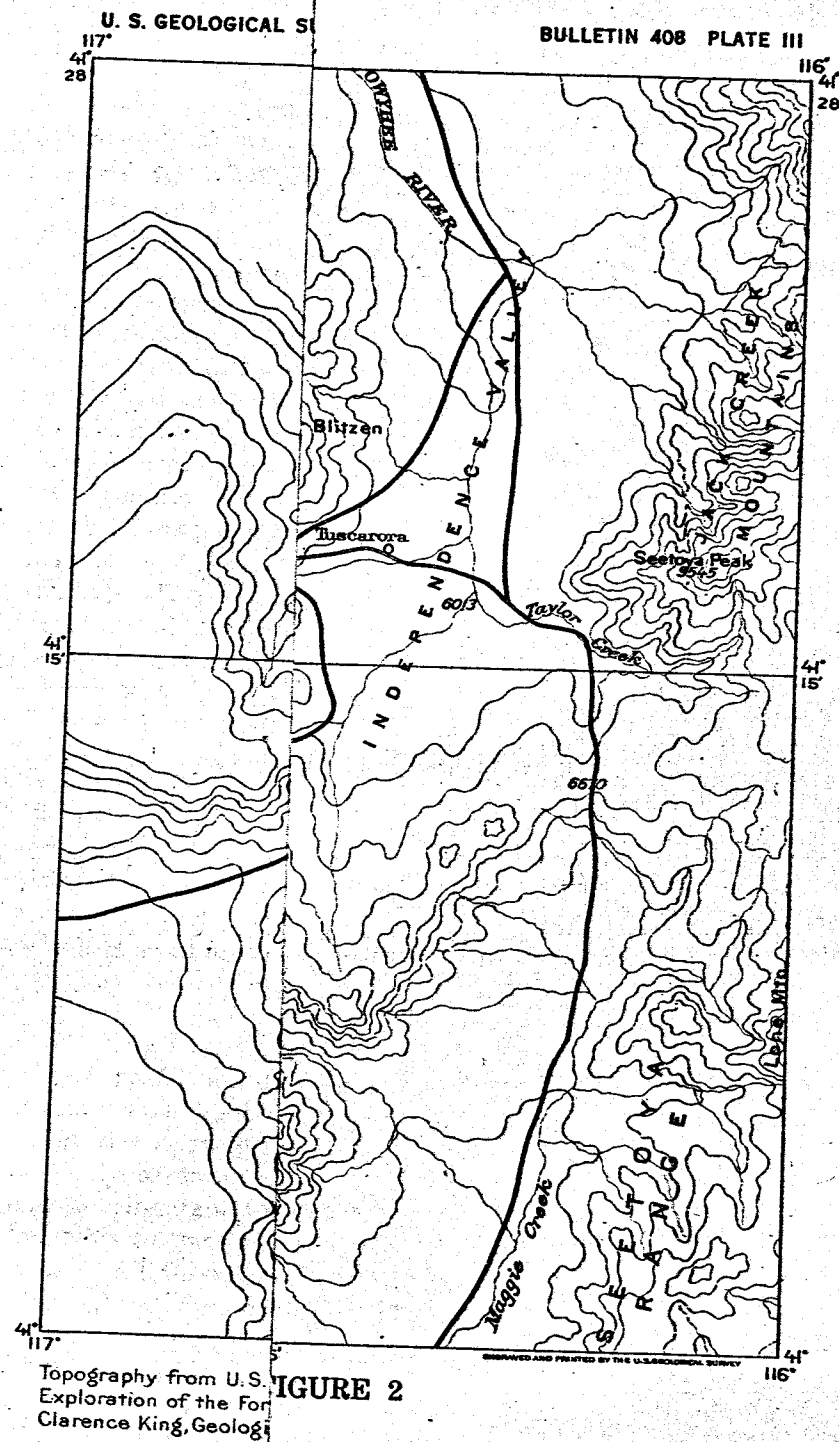
##### GENERAL FEATURES.

The Centennial Range, which lies between Deep Creek on the south and East Fork of the Owyhee on the northeast, is about 20 miles long and from 5 to 10 miles wide, its principal axis trending northeastward from Lime Mountain to Montana City. The higher summits rise from 3,000 to 4,000 feet above the Chellis Valley, which topographically is a part of the Owyhee Desert, a great rolling plain of sagebrush that extends northwestward far into southern Idaho.

The range is separated from the Jack Creek Mountains, to the south-east, by Bull Run Basin, which is drained by Bull Run Creek. This stream flows westward through a deep V-shaped canyon that separates the central mountain mass of the Centennial Range from a narrow, lofty ridge which extends southward toward Deep Creek. The highest part of the range is a compact group of mountains that lie between Bull Run Creek and Blue Jacket Canyon and cluster about Porter Peak, the loftiest summit. North of Blue Jacket Canyon the hilly country extends to Mountain City and beyond that northward into Idaho. The topographic expression of the range is due to faulting modified by erosion and to a trivial extent by glaciation.

The rocks are mainly Paleozoic quartzites, limestone, and shales. On the slopes of Porter Peak the prevailing dip is northward, almost at right angles to the principal axis of the mountains. The great faults on which the chief structural features depend have so broken the geologic column that in the absence of fossils it was not possible to determine the age of the rocks satisfactorily in the limited time devoted to the work, but from the lithologic descriptions published by the King Survey for the country to the south it seems highly probable that the Carboniferous formations have the widest distribution. The great quartzite beds which form the southern portion of Porter Peak and which include the ore deposits at Edgemont and at Bull Run are regarded as Carboniferous. This is a medium-grained quartzite, which through great thicknesses shows comparatively slight variations. At the Bull Run mine there are some thin-bedded siliceous, shaly layers, and on the north slope of the hill south of Edgemont some fine conglomerates were noted, but the great mass of the formation is a dull gray or pink quartzite, massive, thick bedded, and strongly jointed, at many places showing too little evidence of stratification to define its attitude. On the ridge north of the stream which flows westward from Porter Peak through Edgemont the quartzite is overlain by a great series of limestones. This series is several thousand feet thick and on the north slope of Porter Peak grades into black shales which still farther north are overlain by a thick series of limestones and shales. The great expanse of hilly country between White Rock and Mountain City was not traversed in this reconnaissance, but at a distance it appears to be composed in the main of sedimentary rocks capped with rhyolite.

At a number of places, including Blue Jacket Canyon on the south-east side of the range and the ridge south of White Rock Canyon on the northwest side, the limestones are intruded by medium-grained granitic rocks. None of the outcrops of these intrusive masses are very extensive, but at the north end of the range they are numerous, and possibly they are connected in depth. A characteristic specimen from one of the larger masses on the ridge south

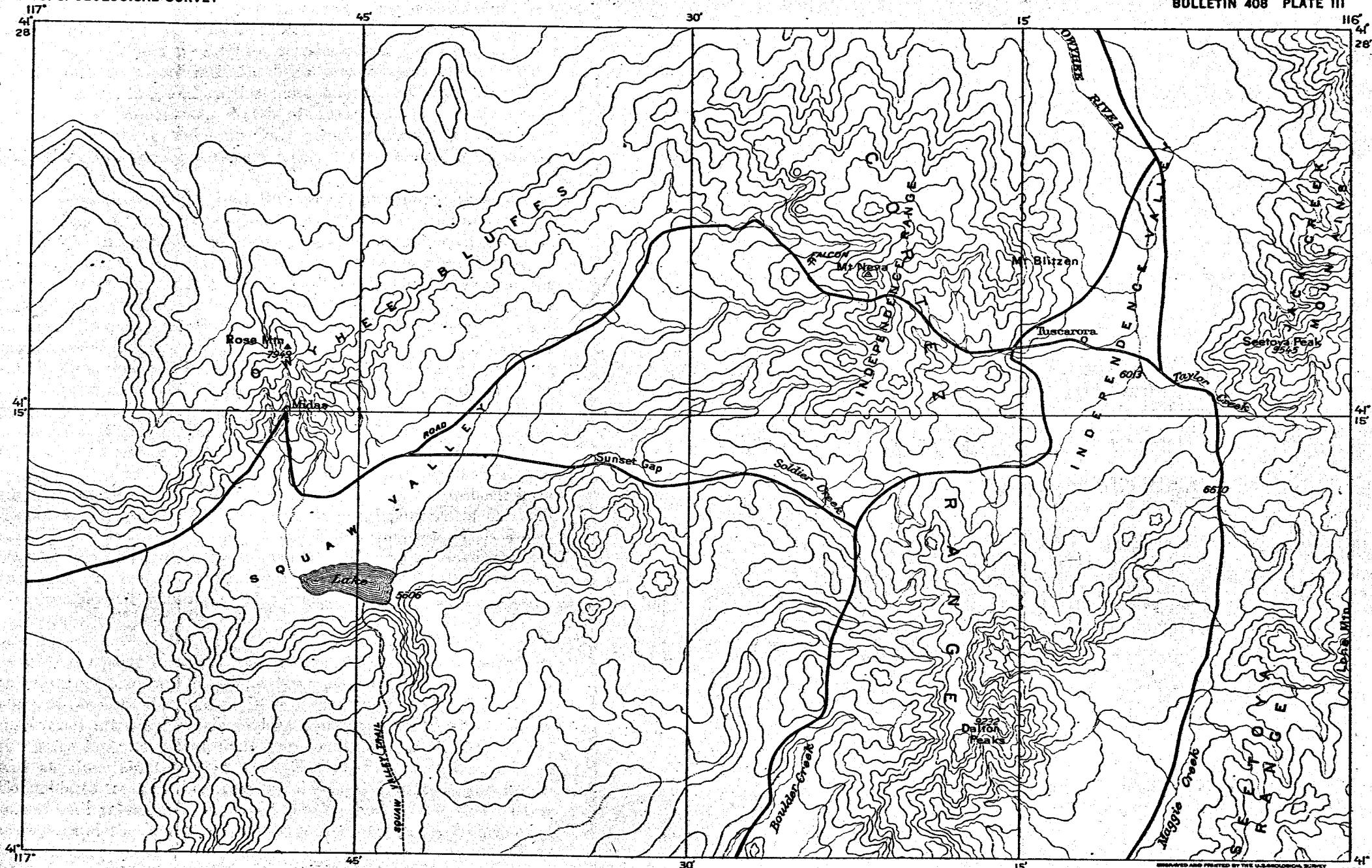


of White Rock Canyon is a granodiorite composed of oligoclase, quartz, orthoclase, biotite, and hornblende. No garnetization of limestone was noted near these intrusions. At Mountain City the sedimentary rocks are intruded by a granodiorite, which is more coarsely crystalline and carries more quartz and orthoclase than the average granodiorite. North of Aura and also on California Hill, 2 miles above Mountain City, garnet, epidote, tremolite, and actinolite have formed extensively near the contact of granodiorite with limestone.

Here and there in the Bull Run Basin, protruding through the cover of granite, are outcrops of rhyolite and basalt, and in the country to the east, extending to a great but unknown distance, are thick beds of rhyolite with a subordinate amount of rhyolite flow breccia. Very extensive beds of rhyolite occur also in the lower country to the west and south of the Centennial Range. This rhyolite is much younger than the sedimentary rocks composing the main mass of the Centennial Range, and if it were in its original position it would now be above the sedimentary rocks instead of forming the floors of the lowest depressions, such as Bull Run Basin. The present structure was brought about by faulting and tilting. North of Bull Run Creek, on the south slope of the high mountains which form the central portion of the range and near the trail from Aura to the Bull Run mine, there are bluffs of volcanic agglomerates and tuffs composed of rhyolite fragments with a large proportion of diorite porphyry. At the base of the exposed portions of the beds there are some layers of shaly coal. The agglomerate beds are of Tertiary age, and as they dip toward the Paleozoic rocks which form the central and most elevated portion of the range, there must be a fault of several thousand feet between the two systems of rocks.

#### ORE DEPOSITS.

In 1869 a party composed of Cope, Dixon, and others, going from Silver City, Idaho, to White Pine, Nev., made discoveries and located claims near Columbia and in Blue Jacket Canyon near by. These discoveries attracted considerable attention to the district, and in the early seventies silver mills were built in Blue Jacket Canyon and at Mountain City. In 1875 Edward Stokes built a mill at Columbia to treat the ore from the Revenue, California, and Infidel mines. All these mills employed the Washoe or the Reese River process, and the conditions for operation were most trying, as it was necessary to haul the bulky supplies required for silver milling 75 miles or more by wagon road. Although a considerable tonnage of chloride ore, taken from the upper parts of the deposits, was put through these mills, it is a question whether much profit was made from the operations. Owing to the insuperable difficulties in



Topography from U.S. Geological  
Exploration of the Fortieth Parallel  
Clarence King, Geologist in charge

TOPOGRAPHIC MAP OF NORTH-CENTRAL QUARTER OF AREA SHOWN IN FIGURE 2

10 5 0 10 Miles

1909

DRAWN AND PRINTED BY THE U.S. GEOLOGICAL SURVEY



the way of getting cheap transportation, together with the faulted condition of the lodes, the operators lost heart and turned their attention to other fields. In the nineties the mining industry was revived by the discoveries of gold ores at Edgemont, and in 1906 the country again felt the stimulus of enthusiasm for prospecting which swept over Nevada from the southwest. In that year several gold veins were discovered near Aura and elaborate preparations were made to reopen some of the silver mines at Mountain City, but these operations were stopped in 1907 when it became difficult to obtain money for prospecting or development work.

The ore bodies are fissure veins which cut across the bedding of sedimentary rocks, bedding-plane deposits which follow the stratification, and fissure veins in granite. The sulphide ores fall into two general classes—(a) gold deposits of highly siliceous ore carrying a small percentage of pyrite and galena and (b) silver deposits carrying these minerals in greater abundance, together with a small proportion of arsenic and antimony minerals. At Edgemont and Aura the deposits are in the sedimentary rocks, but at Mountain City they are mainly in the granodiorite. They were formed before the faulting took place. In every mine where any considerable amount of development work has been done faults have been encountered. These are nearly everywhere of the normal type, which implies a downward movement of the hanging wall.

The rhyolites that flank the mountains are probably younger than the deposits which have been developed in the Centennial Range. At Gold Circle, Lynn, and elsewhere this rhyolite carries gold deposits that are of a different type from those of this range, and there is no reason why it should be avoided by the prospector, especially where it is intruded by dark rocks (andesite) and in areas where it is leached white by hot waters.

#### LIME MOUNTAIN.

Lime Mountain forms the southern extremity of an elevated ridge about 6 miles long, which lies between Bull Run Basin and Chellis Valley. This ridge, which may be regarded as a southward extension of the Centennial Range, is separated from it by the very steep canyon occupied by Bull Run Creek. The rocks at Lime Mountain are in the main dark-gray limestones, which at the summit of the mountain dip from 20° to 40° W. The limestone is cut by dikes and other intrusions of igneous rocks, which include quartz porphyry, andesite, and diabase. Locally the limestone is metamorphosed to a coarse-grained marble, but the metamorphic action is not intense and very little garnet or hornblende has been developed. The principal workings are at the Eldorado mine, where a 200-foot tunnel driven westward into the mountain is connected with a shaft 115

feet deep. At their intersection and upward to the surface much of the workings is in ore that is said to average several per cent of copper, with values in gold and silver. The ore consists of pyrite, chalcopyrite, and bornite, which are intergrown with white and black mica, calcite, and quartz. The deposit, which is probably of contact metamorphic origin, has been fissured since deposition, and there has been some secondary chalcocite enrichment of the copper-iron sulphides. The rock that caused the metamorphism could not be determined. About 1,000 feet northwest of the mine is a considerable area of quartz porphyry, and a diabase dike, outcropping on the crest of the hill, 500 feet above the mine, strikes toward it. On the crest of the ridge, at places which are much nearer to those rocks than the Eldorado, the limestone is not greatly metamorphosed, except in some localities where it is a very coarse marble.

#### COLUMBIA AND AURA.

##### GENERAL STATEMENT.

Columbia, which is situated at the north end of Bull Run Basin, was in the seventies the headquarters for prospecting and mining in the central part of the Centennial Mountains. In the boom times of 1906 Aura was founded a mile or two below Columbia, and it is now the post-office and supply point for the east side of the range.

Several mines are located near Columbia, but all of them except the Big Four have long been idle. This mine, which was discovered in recent years, made several shipments of ore in 1908 and is commonly regarded as a property of some promise. The silver mines which were abandoned years ago were relocated recently, but little work has been done except enough to hold the ground.

In the canyon of Blue Jacket Creek, which joins Columbia Creek in the north end of Bull Run Basin, there are several mines and prospects, but none of them have been extensively exploited except the Blue Jacket, which was worked in the seventies. Two 5-stamp amalgamation mills were built in Blue Jacket Canyon to work the gold ores, utilizing the water power of Blue Jacket Creek. Both were idle when the camp was visited in 1908. Some years ago a company was formed to mine the gravels of Bull Run Basin, which are said to carry gold, and considerable money was spent in ditches, flumes, and pipe. The effort was presumably not successful, and the project was abandoned after a few hundred yards of material had been put through the sluice boxes.

##### MINE DESCRIPTIONS.

*Infidel mine.*—The Infidel mine, which is located on the hill above Columbia, was worked from three tunnels driven northward into the hill. The mine has been idle for many years and the middle tunnel

only was accessible in August, 1908. The rocks near by are mainly limestones and shales, but between the Infidel and Big Four mines is a body of granodiorite of considerable size. The lode strikes  $30^{\circ}$  W. and lies approximately parallel to the bedding of the country rock, a dark shaly limestone. It is a sheeted zone composed of three or four veinlets of white quartz closely spaced and nearly parallel. The ore is white quartz, containing a very small proportion of galena, pyrite, and other dark sulphides, said to carry high values in silver.

**Big Four mine.**—The Big Four mine is on the east bank of Columbia Creek, about one-fourth of a mile above Columbia. The deposit is a flat vein which follows the bedding of a shaly limestone dipping from  $10^{\circ}$  to  $15^{\circ}$  S. Three tunnels, each about 100 feet long, are driven on the vein, exposing an ore body that has a maximum width of about 5 feet. The lode is a sheeted zone in the shaly limestone, and the ore is composed of quartz, calcite, pyrite, galena, zinc blende, and chalcopryite, with iron oxide and some green copper carbonate. It is said to carry high values in both silver and gold, the cobbled ore

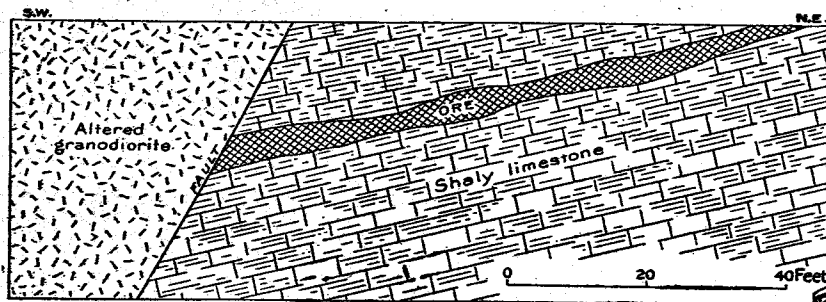
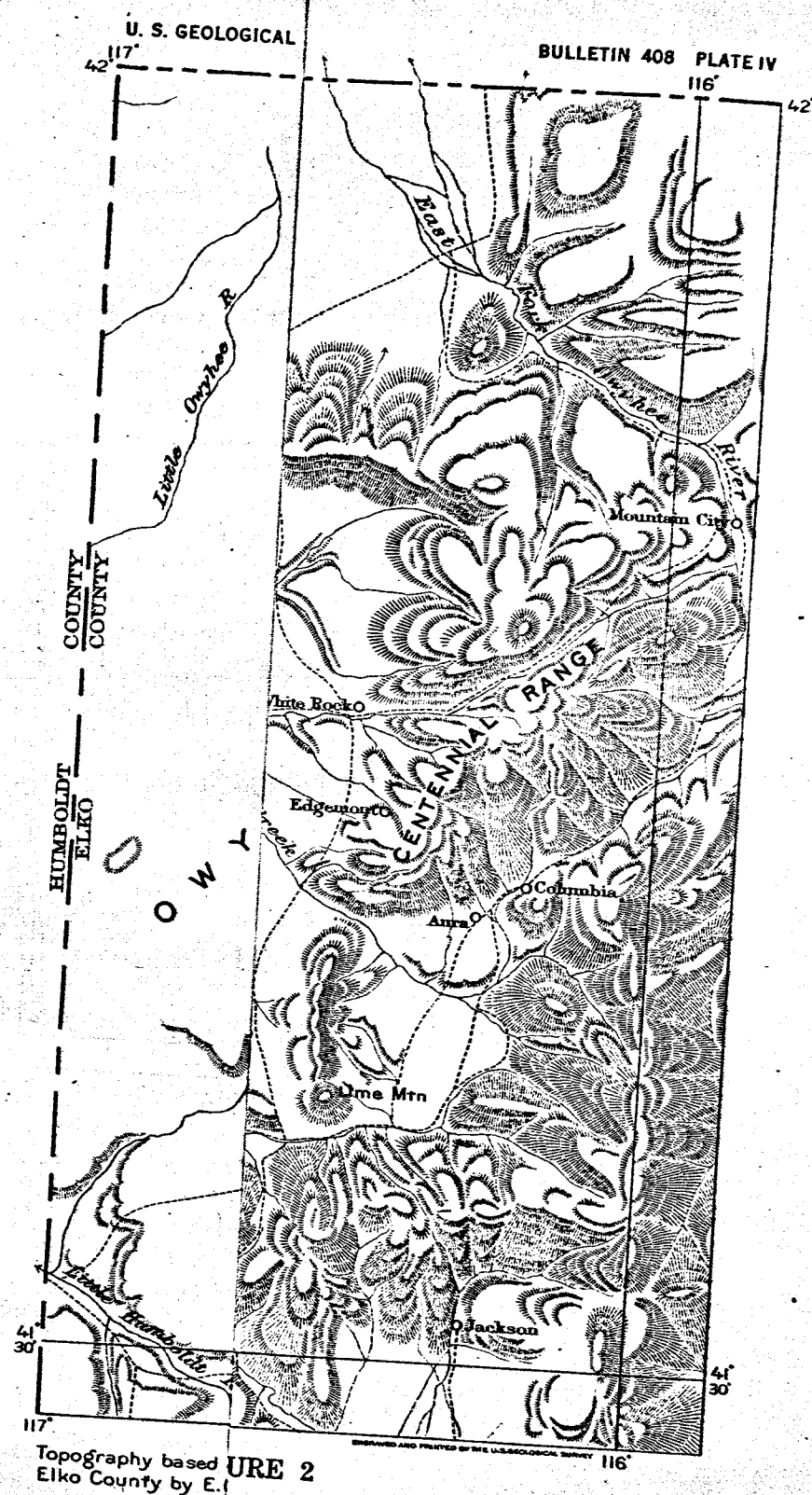


FIGURE 7.—Cross section of Big Four lode, Columbia.

being rich enough to pay for shipment. Near the lower tunnel the vein and the inclosing limestone are in faulted contact with granodiorite, as shown by figure 7.

**Columbia Queen mine.**—The Columbia Queen mine, formerly the Bonanza, is on the west side of Columbia Creek, about 300 yards west of the Big Four mine. Like the Infidel and Revenue, it was the property of the Stokes Company, which operated it in 1875. The deposit, which resembles that of the Infidel, is a sheeted zone in limestone. The lode is 3 feet wide and carries galena, zinc blende, pyrite, and gray copper, with high values in silver and some gold. As shown by figure 8, the deposit dips toward the south and is displaced by three northward-striking faults, each of which offsets the lode toward the north.

**Blue Jacket mine.**—The Blue Jacket mine is located at the head of Blue Jacket Creek near the divide between this stream and Silver Creek. The deposit was worked through two tunnels and a deep shaft, all of which were inaccessible when the mine was visited. The



country rock is limestone and, to judge from the dump, the ore is similar to other silver deposits near by. It is composed of white quartz carrying a small percentage of galena, pyrite, and zinc blende, with copper carbonate, iron oxide, and other minerals. The ore was carried over a wire tramway to a 20-stamp pan-amalgamation mill, the ruins of which may be seen below the mine at a bend of Blue Jacket Canyon.

*Jack Pot mine.*—The Jack Pot mine is on the south side of Blue Jacket Canyon, about 300 yards below the lower tunnel of the Blue Jacket mine. It was discovered in 1906 by Blewett Brothers, who have done about 800 feet of development work. The country rock is

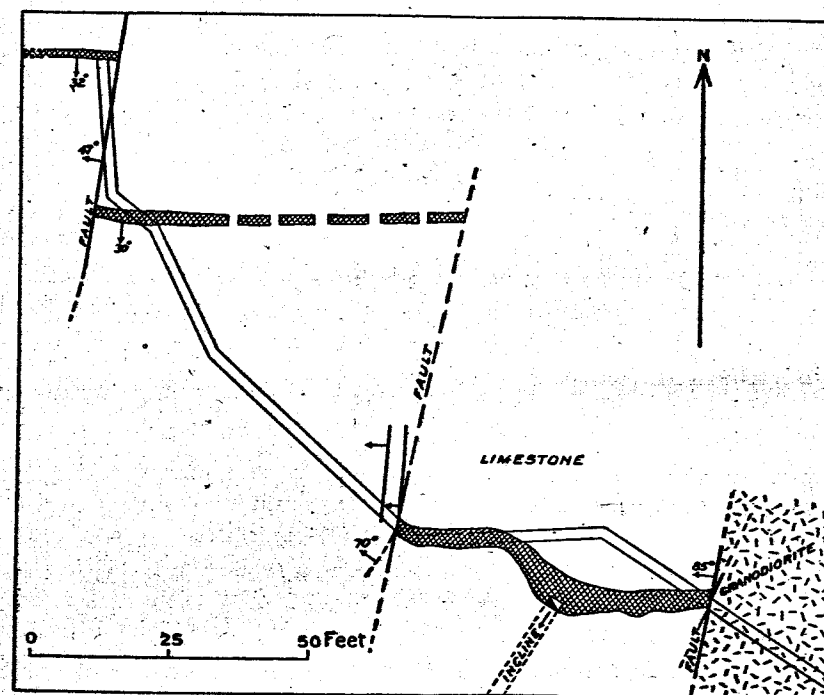


FIGURE 8.—Plan of tunnel level, Columbia Queen mine, Columbia.

limestone, which, some 200 yards south of the mine, is intruded by a broad dike of granodiorite. The lode, which is developed by four tunnels driven one above another, strikes northwestward and dips  $35^{\circ}$  SW. and carries shoots of ore which have a maximum width of about 5 feet. The ore is in the main decomposed, silicified limestone, stained with iron oxide. Galena, pyrite, chalcopyrite, and zinc blende are found in the lower workings. About 60 tons of the ore has been put through the Walker mill, but the saving by amalgamation was not satisfactory. A considerable tonnage on the dump and in the mine is said to be rich enough in gold to yield a profit on cyaniding.

*California mine.*—The California mine is located on the east slope of Porter Peak, near the head of a small tributary to Blue Jacket Creek. The lode is a siliceous replacement vein, which cuts across the bedding planes of limestone and dips southwestward at a high angle. The ore consists of white quartz, galena, and iron oxides, with some green copper carbonate. Where exposed in the principal working pit the lode is 4 or 5 feet wide.

*Tiger lode.*—The Tiger lode is on the north slope of Porter Peak, at the head of Silver Gulch, which drains westward from the central axis of the range. The lode dips 60° W. and is opened along the surface by five short tunnels driven one above another. Some ore from this mine is said to have been packed by mules to Mountain City in the seventies. The lode is a 3-foot vein of ore, very high in silica, and contains galena, pyrite, and a small amount of zinc blende. The surface ore carries copper carbonate, pyromorphite, and iron oxides and is said to be rich in silver. North of the Tiger lode, at the head of Silver Creek, there are a number of abandoned shafts that were driven on lodes of siliceous ores in limestone. Northwest of these shafts, on the ridge between White Rock and Silver Creek, dark limestones dip from 45° N. to 90°. Three or four silver veins striking northeastward cut across the limestone, and on the crest of the ridge these veins outcrop boldly at several places. With better transportation facilities these deposits should be regarded as worthy of more careful prospecting.

*Humboldt mine.*—The Humboldt mine is at the head of Polaris Gulch, about half a mile southeast of the Blue Jacket mine. The country rock is contorted shaly limestone, and the vein, which is 1½ to 3 feet wide, is composed of white quartz, galena, pyrite, chalcopryite, and gray copper. An incline is driven southeastward at a low dip, but when the mine was visited most of it was under water. About 100 yards east of the Humboldt shaft a surface pit in granodiorite shows a strongly sheeted and leached zone, which is said to carry up to \$3 a ton in gold.

*Polaris mine.*—The Polaris mine is in Polaris Gulch, about one-fourth mile southeast of the Humboldt. An incline is sunk about 200 feet deep and from it two levels are turned. A fissure dipping 32° SE. cuts across the bedding of the limestone. Here and there along the fissure are masses of quartz and silver-bearing sulphides. This mine supplied some ore to the Columbia mill in the seventies.

*Aura King mine.*—The Aura King mine is in Blue Jacket Gulch, between the Walker and the Aura King mills. The vein, which is in limestone, dips 30° SW. and has been followed on the strike for 200 feet. It is from 3 inches to 1 foot wide and is said to carry high values in gold.

## EDGEMONT.

*Lucky Girl group.*—Edgemont is an active little mining camp located on a branch of White Rock Creek, on the west slope of the Centennial Range. It is supported in the main by the mining and milling operations of the Montana Gold Mining Company, owning the Lucky Girl group of claims, which includes all of the deposits which have been extensively developed on the west side of the range. These claims were purchased in 1898 by Alex. Burrell, and a 20-stamp mill was built in 1902 and has been in continuous successful operation ever since, treating about 60 tons of ore a day. Electric power is transmitted from a plant installed on a tributary of White Rock Creek, 4 miles north of Edgemont. The mines of this company comprise about 5 miles of underground workings and extensive ore bodies have been developed. The deposits include the Lucky Boy, Lucky Girl, and Big Bob veins. The Lucky Boy vein is the most extensively developed and has supplied most of the ore to the mill. This group of mines and the Bull Run mine on the south slope of the mountain have yielded since they were opened about \$1,000,000, chiefly gold.

As now arranged, the ore is dropped to the fifth-level adit and is drawn by mules to the portal, where it is fed automatically to a bucket tramway, 3,600 feet long, which carries it to the mill 800 feet below. At the mill the ore falls on grizzlies and the large rock goes to a 9 by 11 Gates crusher. There are four batteries of five stamps each. The fine rock goes to the outside stamps, which weigh 750 pounds, and the coarse rock to the inside stamps, which weigh 1,000 pounds. The stamps drop 8 inches eighty-five times a minute. About 50 per cent of the values are caught on amalgamation plates, from which the pulp passes to three Wilfley tables and one Pinder concentrator, where the galena and pyrite are removed. To utilize a water supply from a gulch north of the mill, the tailings are passed through a flume to a dam about 2,000 feet below. Here the slimes are drained from the sands and the sands are loaded into nine 50-ton cyanide tanks. The slimes are collected at a second dam below and are loaded dry into a mixer, where they are broken and mixed with water to the desired consistency. From this they pass to the agitators and thence to decantation tanks. The total extraction is from 90 to 95 per cent, the ore carrying from \$5 to \$10 in gold and 1 ounce of silver to the ton. The ore yields about 0.6 per cent in concentrates that carry about \$115 in gold, silver, and lead.

The deposits are fissure veins in siliceous sedimentary rocks which are steeply tilted, folded, and faulted. The country rock is a brown or gray quartzite of rather uniform grain, with here and there thin beds of siliceous shale, which at some places is dark gray or nearly



black. Near the veins a little sericite or white mica has been developed in the quartzite, together with a small amount of pyrite, but, compared with deposits in the porphyries, the wall rock is but slightly changed in composition. Between the shaft of the Lucky Girl and the portal of the low-level tunnel, conglomerate beds are interstratified with the quartzite. These beds are only a few feet thick and consist in the main of well-rounded pebbles of uniform size, about one-half inch in diameter. Most of them are white quartz, with here and there a pebble of red jasper. In the Lucky Boy mine small folds may be observed at several places on the surface and underground, and the difficulties of interpreting the structure are increased also by pronounced sheeting across the bedding in the same general direction as the lodes and by jointing in other directions. The prevailing dip of the sedimentary rock is  $30^\circ$  or more northwestward, but at some places the dip is about  $40^\circ$  NE. Some of the quartz was deposited before the deformation of the rocks was completed, as is shown by the

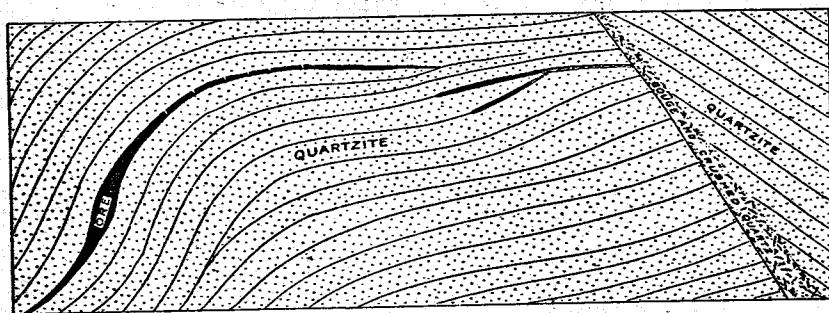


FIGURE 9.—Sketch of wall on level 8, 1,200 feet from portal, Lucky Boy mine, Edgemont.

fractured ribbons of quartz indicated in figure 9. The principal deposits, however, are little affected by folding and their deposition must have followed the greater deforming movements.

The veins, which at most places cut across the bedding of the quartzite, outcrop plainly on the surface, where they are composed of white quartz slightly stained with iron oxide. The three lodes that are most developed strike northeastward and dip from  $15^\circ$  to  $45^\circ$  SE. The ore is highly siliceous and carries more than 90 per cent of quartz. The sulphides are pyrite, galena, and arsenopyrite. The gold is associated mainly with the sulphides or with their oxidation products. The oxidized and sulphide ores carry approximately the same values, from \$5 to \$10 a ton, and there is no evidence of secondary enrichment other than that due to the removal of soluble constituents; this, owing to the comparatively firm condition of the ore, is small. Copper carbonates are rare or altogether lacking, and no zinc minerals were noted. Considerable fissuring with slickensiding must have taken place before deposition, as is indicated by the section shown in figure 10, where

slickensided fissures stop at the vein, which they do not disturb or cross. Movement subsequent to deposition has produced much gouge along the walls, but this is barren except where it contains crushed quartz. The sharp contact of country rock and vein quartz

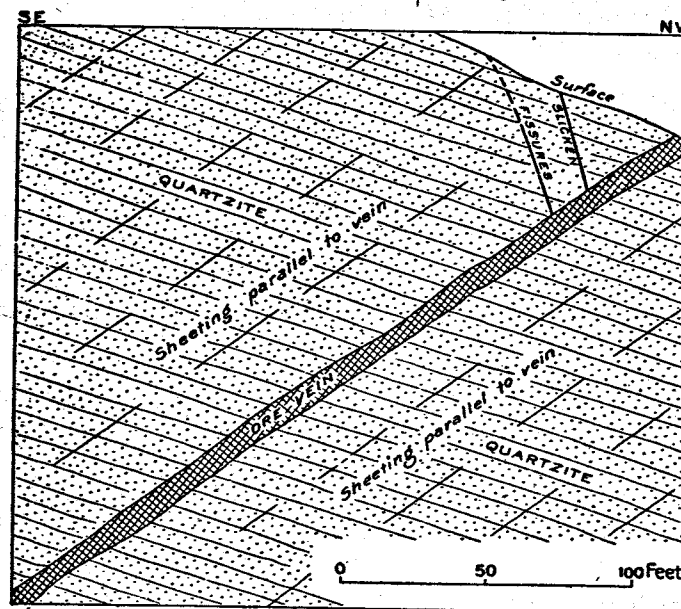


FIGURE 10.—Section S.  $40^\circ$  E. through Lucky Girl vein, Edgemont.

and the dependence of vein fillings on previous openings are illustrated by figure 11.

The Lucky Boy vein has been developed along the strike for a distance of about 3,200 feet and through a vertical depth of 400 feet. On the fifth level a fault which strikes approximately with the vein

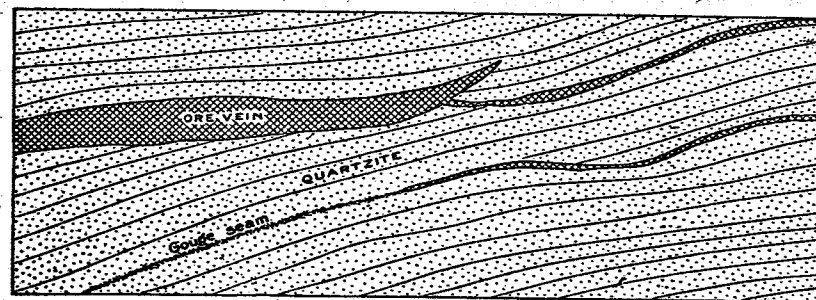


FIGURE 11.—Sketch of the northwest wall on level 8, Lucky Boy mine, Edgemont.

and dips in the opposite direction, from  $40^\circ$  to  $80^\circ$  NW., may be located for a distance of 2,000 feet, being exposed at five places in various drifts and raises. The throw of the fault is about 30 feet, measured vertically, as shown in the section given in figure 12. It

results in a duplication of the vein on level 5. At some places the wide zone of faulting carries much gouge, and it is difficult to locate the main fault plane precisely or to determine the direction of dip, but in the main the slicken planes dip to the depressed side, indicating that the fault is normal. In a block of ground about 1,000 feet northeast of the portal of level 5 and extending for 500 feet toward the breast the vein has not been discovered, and on levels 6 and 8 in this block of ground its position is unknown. Presumably it has been shifted by faults which cross the great strike fault above mentioned and which may displace it also. To the northeast of this block of ground the vein continues with its usual dip and strike for 1,500 feet.

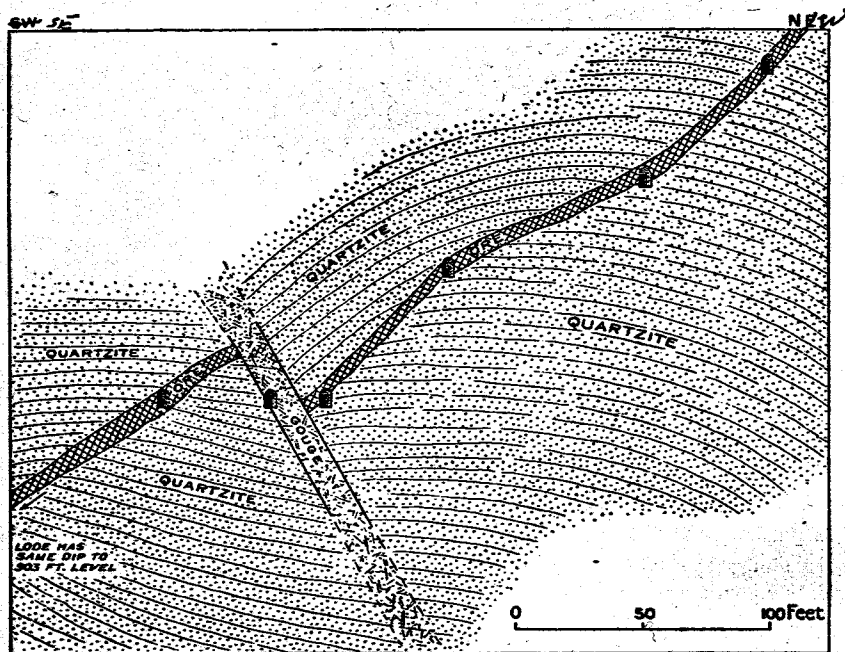


FIGURE 12.—Cross section of Lucky Boy vein, Edgemont, looking southwest, 775 feet southwest of intersection of vein with Gossip adit. Line of section trends N. 35° W.

The Lucky Girl vein, which lies several hundred feet northwest of the Lucky Boy, strikes N. 50° E. and dips from 35° to 45° SE. On the surface its outcrop is clearly exposed below the company bunk house. It cuts across massive quartzite which on the foot wall dips 22° NE. An incline is driven on the vein from which two levels are turned and a considerable portion of the lode above the lowest level has been removed. The vein is from 2 to 7 feet wide and resembles the oxidized portion of the Lucky Boy vein, being composed of banded, sheeted quartz, stained yellow with iron oxide and carrying several dollars to the ton in gold with about 1 ounce of silver. A section of the vein is shown in figure 10.

The Big Bob vein, which is similar to the Lucky Boy and Lucky Girl veins, outcrops a few yards above the mill, where it dips about 15° SE. It is opened on five levels, the lowest of which is driven about 130 feet vertically below the outcrop. The larger part of the workings on this vein were under water in 1908.

**Bull Run mine.**—The Bull Run mine is located high on the south slope of Bull Run Mountain, which lies just north of the great canyon through which Bull Run Creek flows to Owyhee River. In 1902 a 10-stamp amalgamating mill and cyanide plant were built near the portal of the lowest adit, but according to report the successful operation of this mill was impossible owing to the prohibitive expense of freighting fuel and supplies up the steep hill to the mine. About \$120,000 was recovered in 1902 and 1903, before the mill was shut down. The developments comprised about a mile of underground workings on the lode. The country rock is quartzite which carries thin layers of slightly micaceous shales. The quartzite, which resembles that of the Lucky Boy, is strongly sheeted and locally the

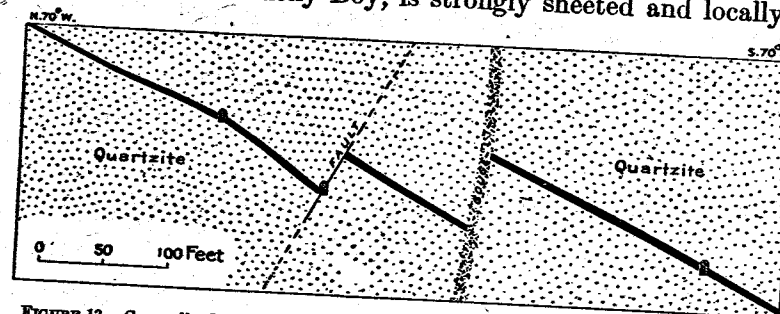


FIGURE 13.—Generalized section through Bull Run mine, S. 10° E. from tunnel 1 to tunnel 4.

shales have been contorted by compressive movements that took place before the deposition of the ore. The deposit is a well-defined fissure vein which has a maximum width of about 6 feet. It strikes northeast and dips from 22° to 38° SE.

The quartzite is sheeted parallel to the vein, and in places its apparent stratification is parallel to the vein, but on the surface, where the true dip may more easily be made out, it strikes nearly eastward. The ore is composed of white quartz, stained here and there with iron oxides. In the lower levels pyrite and galena are present in small quantities, these sulphides having been leached out in the upper workings. The ore is said to carry several dollars to the ton in gold, a large proportion of which is free. The silver present is practically negligible. The composition of the ore, the country rock, and the structural features of the vein resemble very closely those of the deposits of the Lucky Girl group at Edgemont, which is not more than 2 miles to the north. The lode outcrops plainly in the steep cliffs of the mountain and may be followed through a vertical range of about 400 feet. As shown in figure 13, the lode is displaced by

two faults, both of which cross tunnels 2 and 3. The faults strike about N. 15° E. and displace the lode from 30 to 60 feet. The first one encountered in tunnel 3 dips 60° W. and the second is a wide crushed zone which shows slickensided planes dipping toward both walls with numerous fragments of quartz and much clay gouge. In both faults the west wall has dropped.

Between the Lucky Girl group of veins and the Bull Run mine there is a steep canyon which is occupied by a small stream that flows westward to Bull Run Creek. A good deal of this country is covered and so the conditions for prospecting are not favorable, but its position in the line of strike of the Bull Run and Edgemont veins would seem to warrant a closer scrutiny than it has received.

#### MOUNTAIN CITY.

##### LOCATION AND HISTORY.

Mountain City is situated in the northeastern part of the Centennial Range on the north fork of the Owyhee, about 1½ miles east of the boundary of the Duck Valley Indian Reservation, some 40 miles by stage from Tuscarora. The first discoveries were made in 1869 by Jesse Cope and others who were on their way from Silver City, Idaho, to the White Pine district, Nevada, and from this circumstance the Mountain City region is called the Cope mining district. In the seventies there was considerable activity in mining and three silver mills were in operation. These were small amalgamation mills of the Washoe pattern, equipped with stamps, pans, and settlers. It is said that over \$1,000,000 in silver was recovered prior to 1881, mainly from surface and shallow workings. Since 1881 considerable prospecting has been done, but the production of ore has been small. In late years three gold mills have been built and are still in good condition, but they were not running in the summer of 1908, when the camp was visited.

##### GEOLOGY.

The rocks at Mountain City are limestones and shales intruded by granodiorite and overlain by rhyolite and basalt. On the summit and south slope of California Hill, 2 miles south of Mountain City, and extending northwestward from that point, is a thick bed of light-buff marbleized limestone. On the north slope of this hill, near intruding granodiorite, tremolite, actinolite, epidote, white mica, garnet, and other silicates of contact-metamorphic origin are developed in the limestone. The granodiorite is composed of plagioclase, orthoclase, quartz, mica, and hornblende. In the coarser varieties, as at the Protection mine, some of the crystals of feldspar are 1 inch long. The granodiorite is cut by aplitic dikes composed of quartz and orthoclase. Around the border of the mineralized areas there are extensive flows of rhyolite, the commonest variety of which is a purplish-pink rhyolite with phenocrysts of quartz, feldspar, and a

little black mica. Other varieties of the rhyolite are flow breccias, brown glass, and black obsidian. Vesicular basalt, rich in olivine and pyroxene, was noted on the surface east of the Resurrection claims. The granodiorite is younger than the limestone, which it intrudes, causing contact metamorphism. Where the rhyolite flows were noted above the granodiorite the contact relations could not be made out, but from consideration of areas elsewhere the rhyolite and basalt are regarded as of later origin than the granodiorite, and at Mountain City they are probably later than the deposition of the silver ores.

##### ORE DEPOSITS.

The ore deposits are fissure veins in granite and in metamorphosed limestones. They outcrop plainly at the surface, where some of them carry good values in silver. The veins do not fall into well-defined parallel systems but strike in various directions, the prevailing dip being toward the south.

Some of the veins, as shown on California Hill, are later than the aplitic phase of the granite which cuts the normal coarse-grained granite. None of the developed deposits are in rhyolite or basalt, although some gold-bearing veins in rhyolite are said to occur in the country east of Mountain City. In the Nelson mine the lodes pass from granite to limestone without much change in width or value. There is little replacement of the limestone, for the walls are clear cut and angular fragments of the country rock are included in the veins. Where the wall rock is granite the dark silicates have been leached out and sericite and pyrite have been developed in the granite by secondary processes.

The unoxidized ore is composed of quartz, pyrite, galena, zinc blende, gray copper, argentite, gold, and arsenopyrite, with a little chalcopryite. All of the ore is highly siliceous, quartz constituting as much as 90 per cent of the rock. The oxidized ore is composed of quartz, chalcedony, horn silver, pyromorphite, iron oxides, native gold and silver, lead carbonate, copper carbonate, and copper silicate. Brittle silver and dark ruby silver are said to be present also. The oxidation of the deposits is erratic, the sulphides occurring at some places within a few feet of the surface, while some of the minerals of oxidation are to be found as deep as the lodes have been explored, or about 250 feet below the surface. The greater proportion of the silver values are in decomposed chloride and lead carbonate ore. Specimens of rich ore show large flakes of greenish-yellow horn silver deposited in the cavities of dark quartz. Some of the iron-stained siliceous ore pans gold liberally.

The lodes are fractured and faulted, and locally the ore is reduced to a white sand, in which there are numerous small rounded fragments of quartz about the size of a hazel nut. The faults that cross the

lodes are mainly of the normal type, the hanging wall having dropped with respect to the foot wall.

#### MINE DESCRIPTIONS.

*Protection mine.*—The Protection mine, located three-fourths of a mile below Mountain City, was one of the early discoveries of the district and was worked in the early seventies, when considerable chloride ore is said to have been treated in a silver mill near by. In late years the mine has been reopened and considerable exploration work has been done. A 10-stamp amalgamating and concentrating mill was built near the portal of the tunnel to treat the ore. At present part of the mine is leased and is being worked in a small way, but the mill is shut down. The principal vein is a fissure filling in granodiorite and has a maximum width of about 4 feet. The sulphide ore is composed of quartz, pyrite, galena, zinc blende, gray copper, brittle silver, and ruby silver. The surface ore is stained with iron and manganese oxides and contains horn silver, a little copper carbonate, pyromorphite, and a yellowish-green mineral, said to be silver bromide. The sorted ore carries \$100 a-ton in silver and gold. At some places near the vein the granite wall rock is but little altered; at others it is a light-colored decomposed rock, the ferromagnesian minerals having been leached out and the feldspar sericitized. A shaft is sunk to a depth of 62 feet and a level turned at the bottom. This is connected with an adit driven 80 feet below the bottom of the shaft, which gives a depth of 142 feet at this place.

The Protection vein strikes a few degrees west of north and has been followed into the hill on the adit level for a distance of some 750 feet to a point where it abuts against a fault that strikes eastward and dips about 40° N. A drift has been run on this fault for 400 feet, but no vein has been encountered on the hanging-wall side at this end of the drift. On the other side of the fault a vein with the same general dip and strike as the Protection vein is 35 feet farther south and is possibly the same vein, but if so the fault is reverse—a rare type of faulting in this part of Nevada. Along this fault there are stringers of quartz in place, and in the level above both the Protection vein and the faults are mineralized on both sides of their intersection. The relations indicate that the Protection fissure was displaced by faulting before deposition of the ore and that there has been considerable movement subsequently.

*Resurrection mine.*—At the Resurrection mine, a few rods north of Mountain City, a large amount of work has been done in tunnels, pits, and shallow inclines, but most of the workings were inaccessible when the mine was visited in 1908. The country rock is granodiorite, to the east of which are flows of rhyolite and basalt. The granodiorite, which is highly altered, is sheeted by closely spaced fissures that strike northeastward. Several narrow quartz veins cut the granodiorite

parallel to the sheeting. The surface ore is composed of quartz, horn silver, lead carbonates, and iron oxide; the sulphides are galena, gray copper, a little pyrite, and chalcopryrite. In the seventies considerable rich chloride ore was taken from the surface pits and worked in silver mills near by.

*Nelson mine.*—The Nelson mine is on a branch of the north fork of the Owyhee, about 1½ miles above Mountain City. Some 4,000 feet of workings have been run, mainly on two adit levels driven at a difference in elevation of about 100 feet. When the mine was visited in 1908 only the lower adit was accessible. A mill recently built at the portal of the lower adit is equipped with Blake crusher, nine stamps, amalgamation plates, and three Wilfley tables, and has treated a small amount of ore. The country rock of the mine consists of granodiorite, limestone, and aplite. The granodiorite intrudes the limestone and causes contact metamorphism with the development of epidote, actinolite, garnet, and mica in the limestone. In places this rock is so rich in actinolite that it has the appearance of a basic igneous rock and has been mistaken for diabase. The granodiorite is cut by aplite, which occurs as dikes and irregular intrusive masses. The ore deposits are fissure fillings from 1 to 3 feet wide and occur in granodiorite, limestone, and aplite. Several veins outcrop boldly on the hill above the mine, cutting across beds of metamorphosed limestone. The veins cross the contact of igneous and sedimentary rocks unbroken, but have been developed mainly in the granodiorite. The sulphide minerals present are quartz, pyrite, galena, zinc blende, gray copper, chalcopryrite, and arsenopryrite, with here and there a small amount of ruby silver and argentite. Native silver and horn silver are present near the surface, where the ore is stained with copper carbonates, iron oxides, and manganese oxides. Free gold, some of it with the crystal form, is associated with quartz and brown iron oxide. The sorted ore carries good values in both silver and gold, some specimens containing a high percentage of horn silver.

The Standard vein, which is developed in the lower tunnel, strikes southeastward and has been followed for about 1,000 feet, with overhead stoping here and there. This vein is faulted at three places by faults that strike eastward and dip northward at various angles. One of the faults shows a horizontal displacement of about 150 feet, the other two of less than 15 feet. All are of normal type, the hanging wall having dropped with respect to the foot wall.

*Mountain City mine.*—The Mountain City mine is located about 1 mile southwest of Mountain City, at the top of a low, flat ridge that rises some 200 feet above Owyhee River. The country rock is a metamorphosed black, shaly limestone which strikes eastward and dips 50° N. The lode is a fissure vein which cuts across the limestone, striking N. 50° W. The ore is highly siliceous and is a simple fissure



filling, cementing angular fragments of the altered limestone. It carries silver chloridé and native silver, and in the seventies; according to report, several hundred thousand dollars' worth of silver ore was taken from the deposit through a shaft now inaccessible. About 500 feet S. 75° E. of the principal workings of the old Mountain City vein and lower on the hill are a number of open pits, some of which have been sunk on a vein which strikes N. 32° W. Possibly it is the faulted continuation of the Mountain City vein, but this has not yet been determined. This ground has recently been acquired by J. Hall and others, of Mountain City, and is called the New Yorkeys claim. The country rock of the lower deposit is a dark-gray metamorphosed limestone flaked with tremolite crystals. A tunnel is driven 95 feet N. 70° W. to the vein, which it follows for 90 feet, and a winze is sunk on the ore body 60 feet below the adit level. The deposit is a fissure vein and at some places a sheeted zone composed of several narrow veins with slabs of limestone between. Much movement has occurred since deposition, for at places the quartz is brecciated almost to powder. The ore is composed of quartz, iron oxide, copper carbonates, and silicates, and a little pyrite is present at the bottom of the winze. The vein strikes N. 32° W. and dips from 56° to 85° S. It has a maximum width of 5 feet, and is said to carry good milling values.

#### VAN DUZER CREEK PLACERS.

Van Duzer Creek is a small stream which flows eastward, joining the north fork of the Owyhee some 6 miles south of Mountain City. About 2 miles above the point where the stage road crosses the stream and extending westward up the main fork for about a mile portions of the channel have been washed for placer gold. Two strips of the channel, from 20 to 60 feet wide, have been worked out, one of these for a distance of 1,200 feet and the other for about 1,000 feet. Two hydraulic plants with 10-inch pipe and monitors are installed along the stream about three-fourths of a mile apart. The depth of work is nearly everywhere less than 15 feet. The ground is mainly fine gravel with few small boulders, and the bed rock is presumably limestone. The gold is said to vary from fine dust to nuggets of 5 or 6 ounces and sells for \$17 an ounce. The mines, which were discovered by R. M. Woodward in 1893, have been worked in some seasons for about fifteen years, but in 1908 were idle. The source of the gold is presumably some undeveloped veins at the head of the stream.

#### LONE MOUNTAIN.

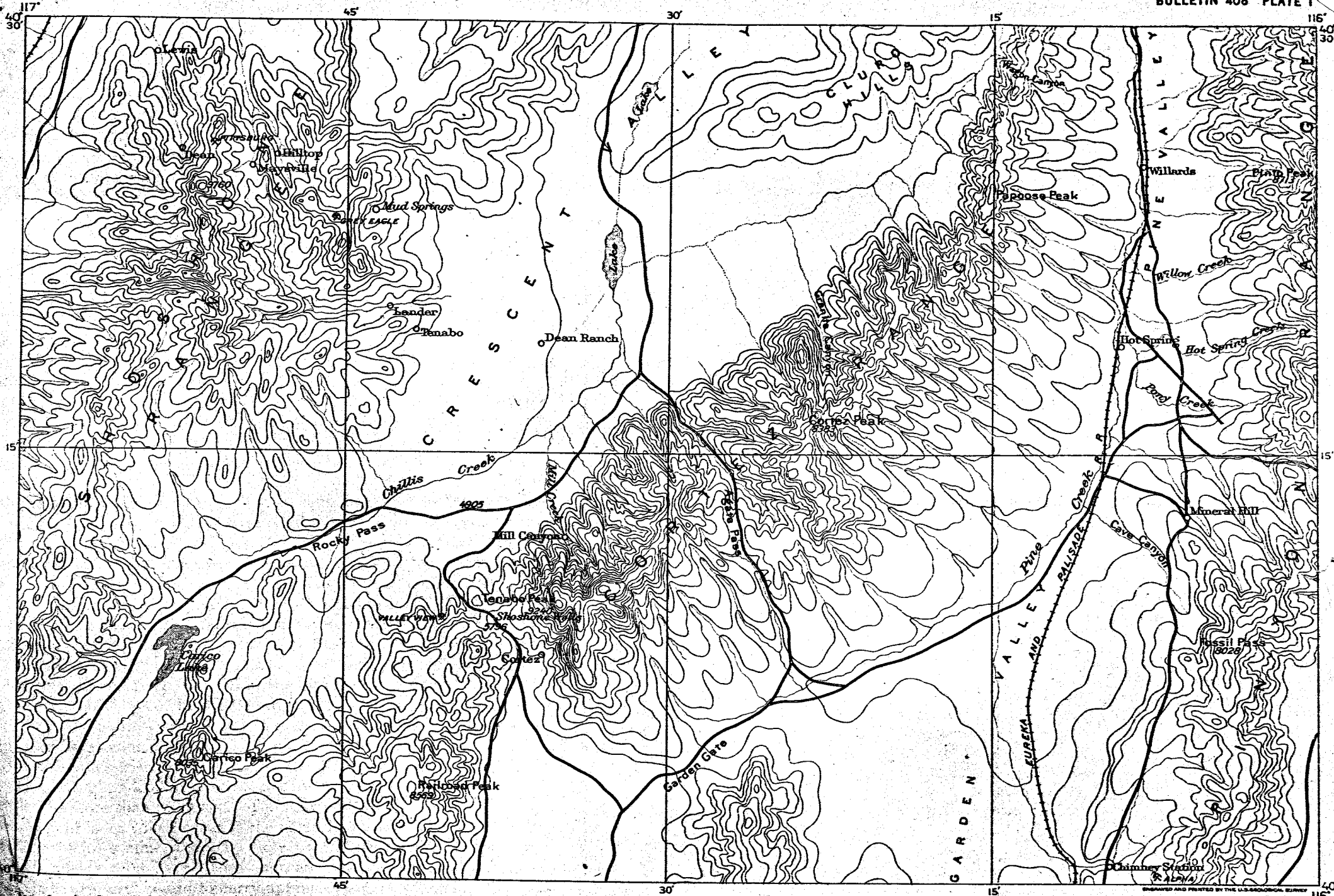
Lone Mountain, which is called Nannies Peak in the reports of the King Survey, is a striking topographic feature rising conspicuously above the main axis of the Seetoya Range to an elevation of 9,046

feet. The mountain mass is composed in the main of Carboniferous limestone—dark-blue or gray massive beds locally metamorphosed by intruding igneous rock. The prevailing dip of the limestone is from 30° to 80° W. The crest of the mountain is composed of quartz monzonite and quartz monzonite porphyry, which cut through the limestone and inclose small blocks of it. On the west slope of the mountain, from 200 to 700 feet below the summit, is a long, narrow intrusive mass of felsitic quartz porphyry which trends nearly due north. Certain phases of the porphyry are almost as dense as rhyolite; others resemble the common types of quartz porphyry. The quartz monzonite and the porphyry locally grade one into the other and are probably phases of the same intrusion. The quartz monzonite, which is of medium grain, is composed of feldspar, quartz, hornblende, and biotite. An analysis of this rock is given on page 26, where the granitic rocks are described. The porphyry has a finely crystalline groundmass composed of quartz and orthoclase, in which are embedded phenocrysts of acidic plagioclase and resorbed quartz, biotite, and hornblende.

Both the quartz monzonite and the quartz monzonite porphyry have caused contact metamorphism of the limestone. At some places the limestone is changed to a garnet-calcite rock, at others to a green actinolite rock, at others to a hard cherty hornstone, and at still others to a coarse-grained marble.

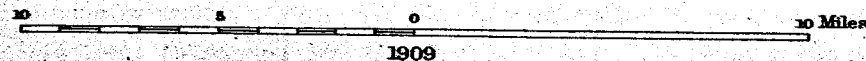
The Merrimac district is situated on Lone Mountain about 28 miles by wagon road northwest of Elko. More or less prospecting has been done in this district since 1879, and from various claims about 1,000 tons of ore has been shipped, with a total value of over \$30,000.

The ore bodies, so far as observed, are deposits of lead and copper ore in marbleized limestone and contact-metamorphic deposits of copper ore in garnetized limestone. When the camp was visited by the writer nearly all the workings were inaccessible. The lead and copper ores in marbleized limestone are near the intruding igneous rocks and are usually highly shattered and oxidized. Some of them are at the contact of quartz monzonite or porphyry with limestone, and some of them are several hundred feet from it. The common minerals are galena, pyrite, chalcopyrite, and their oxidation products. Most of the ore consists of iron-stained limestone and quartz containing lead carbonate and green and blue copper carbonates, with copper oxides and yellow pyromorphite. Such ore is exposed at several places at the south end of the mountain on the Baltimore group of claims, and also on the Floradora and Ajax claims, a mile or more northeast of the summit. This ore is said to carry high values in silver, with \$1 to \$2 in gold to the ton. A number of shafts have been sunk and short tunnels have been driven on the deposits, but the present accessible workings do not show



Topography from U.S. Geological  
 Exploration of the Fortieth Parallel  
 Clarence King, Geologist in charge

TOPOGRAPHIC MAP OF SOUTHERN QUARTER OF AREA SHOWN IN FIGURE 2



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