

## CHAPTER IV.

### DETAILED DESCRIPTIONS OF MINING DISTRICTS.

#### ELKHORN AND ROCK CREEK DISTRICTS.

##### GENERAL FEATURES.

The Elkhorn mining district is situated 12 miles west-northwest of Baker City, on the eastern slope of the Elkhorn Range, at elevations of from 6,000 to 8,000 feet. This range here rises very abruptly from Powder River Valley, presenting an imposing slope which in 5 miles gains 5,000 feet in elevation. The road enters the range at the mouth of Pine Creek Canyon, which heads at the rocky, dark precipices of Deer Creek Butte and Elkhorn Peak. One mile farther up the road turns and ascends to the headwaters of Elkhorn Gulch, a tributary entering from the north side. North of this gulch is a long, high salient, prominently visible from the valley and commonly called "Old Elk Mountain." This divides the drainage of Pine Creek from that of Rock Creek, incised far back into the heart of the range. A trail leads up Elkhorn Gulch and crosses the Rock Creek divide at a gap the elevation of which is 8,250 feet.

##### GEOLOGY.

The contact between the granodiorite of the northern and the argillite of the southern part of the Elkhorn Range crosses this mining district from east to west. At the mouth of Pine Creek Canyon black massive argillite crops. Half a mile higher up the rock becomes more crystalline, indicating proximity to granitic masses. Still higher up on the Elkhorn road contorted stratification is visible in the dark-colored siliceous argillite. The actual contact is not well exposed along the road, but runs up the gulch a short distance from the Baisley mine. West of this mine it follows the gulch pretty closely and crosses the Rock Creek divide 100 feet south of the United States mineral monument. The metamorphic rocks are here imperfectly slaty, the schistosity striking east to west, parallel to the contact. For the first 50 feet the rock is a fine-grained brownish hornfels; then dark argillite appears with contorted bands of siliceous cherty rock. Dikes of fine-grained diorite occur in the sedimentary rock 400 feet from the actual contact. Loose fragments of a crystalline limestone were noted 200 feet from the same place. An ill-defined mass of contact-metamorphic

argillite was noted between the Hurdy Gurdy and the Baisley mines, contained in diorite.

The granitic rock near the contact is a diorite of medium grain, sometimes even becoming fine grained very close to the same. Northward from the contact quartz appears, the hornblende becomes less prominent, and the rock shades over into a granodiorite. Locally, as in the Baisley shaft, the diorite develops as a coarse hornblende rock.

The Pleistocene glaciation of the Elkhorn Range is well marked along Pine Creek. A broad *débris* fan extends over the valley from the mouth of Pine Creek Canyon, which is about 1,000 feet higher than Powder River. Though a few boulders are scattered over this alluvial cone, there is no good evidence that the glacier reached the valley. But immediately above the narrow entrance of the canyon morainal material is abundant. About one-half mile farther up is a well-defined terminal moraine, and all along above this point the broad bottom is well filled with glacial *débris*. A partly eroded stratum of white kaolin, an almost impalpably fine powder, covers the bottom of the canyon in places.

#### QUARTZ VEINS.

The veins of the Elkhorn district contain chiefly gold in an ore rich in sulphurets. About a quarter of the total tenor is usually amenable to amalgamation. Pyrite and zinc blende, with some chalcopyrite, are the principal minerals. The strike of the vein system is northeast to southwest, but individual veins can rarely be traced far. Most of them are contained in diorite, and the mineral belt seems to follow the contact of diorite and argillite. The total production is probably a little above \$1,000,000.

*Baisley-Elkhorn mine.*—At present this mine is the most promising producer in the district. It is located high up on Elkhorn Gulch, a tributary of Pine Creek, the elevation at the mine being 6,700 feet. Its discovery dates from about 1882. Up to 1889 the ore was worked in arrastre; in that year the present mill was erected, consisting of 2 Bryan mills with plates, 6 percussion tables, 4 vanners, and a canvas plant. In 1897, the present owners, the Eastern Oregon Gold Mining Company, bought the mine for \$60,000, since which time it has been in constant operation. Data in the Mint reports give isolated figures in regard to production: In 1889, \$3,744; in 1891, \$89,373; in 1892, \$16,500. The total yield up to 1896 is given by Mr. Whittaker, the superintendent, as \$535,000. During the last two years the production has been large, attaining from January 1 to August 1, 1900, \$94,000.

The developments consist of a 700-foot crosscut to the vein, with drifts for 700 feet south and several hundred feet north. The ore above tunnel level was stoped out before 1897. Two hundred feet south of the crosscut a shaft was sunk on the vein to a depth of 180

feet, and sinking below that level is now in progress. Drifts on two levels in the shaft aggregate over 1,500 feet, the principal developments being on the south side of the shaft.

The country rock is chiefly a normal, granular hornblende-biotite-diorite of dark color. The contact with the somewhat crystalline and contact-metamorphosed argillite is only a few hundred feet distant to the southeast, the black massive cappings of the latter being visible across the creek. On the 180-foot level, 700 feet south of the shaft, the vein, which otherwise is entirely contained in diorite, gives sign of splitting up into stringers, and a black, fine-grained hornfels appears, which is simply an argillite altered by the heat of the diorite cooling close by it. Whether this is the main mass or simply a fragment of argillite inclosed in the diorite is difficult to say. At any rate the main argillite area is not far away.

The gangue is normal vein quartz with some calcite. In general character the ore is soft and rich in sulphurets, concentrating in the proportion of 7:1. The sulphides in order of their abundance are pyrite, black zinc blende, galena, and chalcopyrite, all of which occur in irregular intergrowth with the gangue, the pyrite alone being sometimes crystallized. Ruby silver is occasionally found. The chief value of the ore is in gold, which is partly—up to 25 per cent—free amalgamating, occurring in the pyrite or intergrown with black zinc blende and calcite in form of pale-yellow wires. Some of the brown zinc blende contains 160 ounces silver per ton and no gold, while some of the mentioned black blende contains much gold and no silver. The bullion is 700 to 750 fine. The concentrates are shipped to Northport, Wash., freight and charges aggregating \$10 per ton. Their ordinary value is said to be \$50 per ton, though richer batches are often sent. They contain from 2 to 4 ounces gold and from 10 to 20 ounces silver per ton. The richest ore is hand sorted and shipped; it contains values from 4 to 6.5 ounces gold and from 14 to 21 ounces silver per ton. Along with the ore is found some diorite converted to a white mass of sericite, calcite, and with small crystals of pyrite. This metasomatic product as a rule contains no pay.

The vein, which is traceable only through two claims, Baisley and Robbins-Elkhorn, has very inconspicuous cappings. The strike is northeasterly, the dip nearly vertical. The vein matter is confined between two well-defined walls, covered with polished gouge, but within these there are often subordinate fissures. Striations dipping 20° to 40° NE. were observed on the walls. Sometimes the whole width of the vein is an altered diorite of small assay value. In the payshoot the width is from 2 to 10 feet, many gradually fading seams running out on the north side. The ore streak in this width is a soft mixture of coarse sulphides with much crushed diorite and occasional streaks of quartz which may show comb structure; in one place a 2-foot ore streak was adjoined by 10 inches of white, barren quartz.

The pay shoot is rather irregular, but on the whole confined to the southwest end of the claim.

*Other mines and prospects.*—The Robbins-Elkhorn mine is situated near the Baisley-Elkhorn and covers the southeastern extension of the latter vein. It is not worked at present, but has been a notable producer. The developments consist of a 300-foot crosscut and 1,100 feet of drift. A production of \$300,000 is reported, the ore being identical with that of the Baisley mine, and its pay shoot, in the northeast end of the claim, an extension of that of its neighbor. From all accounts it is a promising mine, but for some reason has been permitted to lie idle.

One thousand feet higher up in the gulch and northwest of the Baisley is the Hurdy Gurdy. Located in 1883, earlier than the Baisley, it was worked from 1887 to 1892, and is reported to have produced \$80,000. Three carloads were shipped, the rest of the ore being milled in a small Tremain mill. It was opened by a crosscut 378 feet long. The vein is a small one, 20 to 24 inches wide and carries oxidized free-milling ore in diorite.

The Denny group is located near the head of the gulch west of the Baisley-Elkhorn and on the trail leading over to Rock Creek. The Elkhorn Bonanza is supposed to be located on the northeasterly extension of the Baisley-Elkhorn and has been extensively prospected by 3,000 feet of workings.

*Rock Creek district.*—At the head of Rock Creek about 2 miles due west of the Baisley-Elkhorn mine is a promising district, which, however, was not visited. A trail leads west from the Elkhorn mines to a gap (elevation 8,250 feet), from which a fine view is obtained over upper Rock Creek. The contact of diorite and granite is close by this gap, and it is clearly seen to cross Rock Creek near the Chloride mine and ascend the mountains on the north side. In a general way the veins are near the contact, though they are not parallel to it, and from this prominent place there is noted a series of prospects which follow the contact to the divide between the Middle Fork of Rock Creek and Cracker Creek, a tributary to Powder River. The Maxwell mine, owned by the Pierce Mining Company, covers 11 claims, and has been worked extensively through several tunnel levels for ten or twelve years. It has 4,000 feet of development work, but owing to litigation is not producing at present. A 10-stamp mill is built at an elevation of 6,600 feet, 1,000 feet below the croppings which appear in diorite near the gap mentioned above, but which lower down seem to cut across into the argillite. The strike is northeasterly, the ore similar to that of Baisley-Elkhorn, but carries more silver.

The Chloride mine is located on Rock Creek at an elevation of 5,900 feet. A considerable amount of work has been done on this property, the ore of which contains a great deal of silver, largely in tetrahedrite.

## POCAHONTAS, AUBURN, AND MINERSVILLE DISTRICTS.

## GENERAL FEATURES.

These three districts, occupying the southern end of Elkhorn Range, are best described together. From the culminating point of Deer Creek Butte (elevation 9,100 feet) the range continues as a narrow backbone for 7 miles southeasterly, until near Auburn a sudden descent occurs. The flanks of the range are 4 to 5 miles wide and present narrow, gradually sloping ridges separated by deeply incised gulches; on the east it sinks below Powder River Valley, 3,500 feet above the sea, while its western base is covered by the gravels of Sumpter Valley at an elevation of 4,000 feet. The foot of the southern end of the range is flooded by basaltic lavas up to an elevation of 4,500 feet and Powder River surrounds it in a semicircle; its canyon, south of Auburn, has not yet cut through the lavas, so that it is evident that before the eruptions the southern slope was more prominent than at present.

Heavy timber covers the middle slopes of the range, while the upper ridges and peaks are often bare and rocky. Southeast and east of Auburn the rolling foothills covered by lava and gravel support no forests.

## GEOLOGY.

The two principal terranes which build up the southern end of the Elkhorn Range are a sedimentary series of dark-gray argillite and a dioritic rock intrusive in the former. The argillites predominate, but no detailed mapping was made of the two formations.

The age of the argillite is in doubt, as no fossils have been found, but it is believed that they are older than the Triassic series of the Eagle Creek Mountains. As, on the other hand, the strata are continuous with those of Sumpter and Bonanza in which imperfect fossils have been found, they must be post-Algonkian and are most probably of Carboniferous age. The strike and dip are often very difficult to ascertain, as most of the heavy strata consists of massive siliceous argillite without schistosity or bedding. The prevailing strike of the bedding, conforming with the structure of the whole region, is N. 70° to 80° W. and the dip 60° S.

On Marble Creek, at an elevation of 5,400 feet, is a large limestone mass embedded in the black siliceous argillite, and rising as a steep wall 300 feet above the gulch. At Pocahontas, in the foothills, the rock is very much decomposed, but on the tunnel dumps there is black fissile argillite with small lenses of limestone and sometimes sharply defined cubes of pyrite. At the mouth of Salmon Creek, one-half mile above the Nelson placers, a greenish-gray massive rock crops, showing on weathered surface outlines of fragments of probably volcanic rocks; this is evidently a tuffaceous argillite. In Washington Gulch, Griffins

Gulch, and Elk Creek, black, siliceous, sometimes cherry, argillites prevail, but contain interstratified some calcareous rocks, as well as some fissile slates.

At Auburn the series is more markedly stratified, striking N.  $70^{\circ}$  W. and dipping  $60^{\circ}$  S. A jointing, striking northeasterly and dipping  $70^{\circ}$  NW. was also noted. The rocks consist of alternating, siliceous, and fissile argillite, the former often in lenses and curved streaks. Occasionally small masses of limestone occur.

At Minersville a similar formation is shown. The rounded foothills occupied by this formation are deeply decomposed and the surface is covered with small fragments of chert or siliceous argillite.

The intrusive rock mentioned above is a light to dark greenish-gray diorite, sometimes approaching a gabbro, of medium to fine grain. Nearly always this rock is also irregularly crushed and traversed by small white seams, and is, in fact, identical with the diorite and the gabbro of the Virtue district. It is very different from the fresh and massive diorite and granodiorite of the northern part of the range and is certainly older, having participated in some of the mountain-building movements. Heavy masses of this crop on Goodrich Creek, on Marble Creek below and above the limestone, high up on Salmon Creek, and finally in the high range above Minersville. The rock is clearly intrusive in the argillite formation.

Traces of glaciers are found in most of the gulches heading close to the main range, but nowhere did they reach the valley, and none of them approached the Pine Creek glacier in size (see Elkhorn district).

The origin and structure of this range offer many as yet unsolved problems. We can not doubt that its great features were carved out long before the Miocene lavas flooded its southern foot, although many modifications in its form and structure have occurred since then. The bold front of the range facing Powder River Valley suggests an old fault line, emphasized by comparatively recent orographic movement. That such a fault plane really exists and that movements have taken place on it in Pleistocene time will be shown in the description of the Nelson placers. This direct evidence is of the highest importance, and in the light of it Powder River Valley appears as an area of recent subsidence.

#### GOLD-QUARTZ VEINS.

Though, as will be shown below, nearly every creek and gulch heading in this part of the range has carried more or less placer gold and a few have been enormously rich, there is throughout a very marked absence of important vein systems to which the origin of these placers could be attributed. In part this may be due to insufficient prospecting, but in most cases I believe that the placer gold was here rather derived from small seams and veinlets than from prominent fissure veins.

A few prospects have been discovered on Pine Creek and on Goodrich Creek. At the limestone mass on Marble Creek the black argillite contains some auriferous pyrite; but no mines of importance are found until the Pocahontas district is reached, in the foothills between Marble and Salmon creeks. Discovered in early days, it is mentioned in Raymond's report for 1872 and has been intermittently worked, in a small way, since then, the total production exceeding \$100,000.

The veins strike nearly north and south and dip  $20^{\circ}$  to  $35^{\circ}$  W. They are 1 to 3 feet wide, the vein matter consisting of clay with streaks of white quartz. The gold is very high grade, being worth \$18 to \$19 per ounce, and said to be free milling. The country rock is a very decomposed calcareous argillite. Of the different veins the Tom Paine has been the principal producer, one small chimney producing \$70,000 of coarse gold about eighteen years ago. It has been developed by several tunnels, the lowest, in Nelson Gulch, having an elevation of 4,200 feet. This tunnel is 225 feet below the croppings. A winze 60 feet deep was sunk in it. No work is done on the claim at present. The quartz is reported of sugary texture, mixed with clay. Some adjoining claims, notably the Old Soldier, were prospected in 1900. The Old Soldier is on the east side of the Tom Paine, and shows in several inclines and tunnels as a 1 to 2 foot vein of clay with streaks of quartz. Some of this ore was worked, with reported good results, in an arrastre erected in Salmon Creek.

In spite of the rich placers of Salmon Creek, no quartz veins of any importance have been located on it. In the exposed bed rock of Nelson's placers many veins are exposed which strike northeast and have a steep dip; from 1 to 2 feet wide, these veins consist of soft, crushed rock with little stringers of quartz, all of which are said to contain gold, though usually only a very small amount. Veins of this type are probably the source of the placer gold.

A few quartz prospects are located on Washington, Griffin, and Elk gulches, but have not been developed. Three miles west of Baker City, in the lowest foothills, is the Big Buffalo claim, opened by a 300-foot crosscut, and showing a mass of black argillite traversed by seams of quartz, calcite, and a little pyrite.

At Auburn several quartz claims are located north and northeast of the settlement. They have been known since early days and are mentioned in the early Raymond reports. Most of them appear to be small seams rather than well-defined veins. All of these seams, however, are said to carry gold.

At Minersville prospecting for quartz has proceeded actively during the last year. Several narrow mineralized streaks in black slate have been opened by short tunnels, and from higher up on the range a 2-foot vein of quartz with chalcopyrite is reported.

## PLACER MINES.

Nearly every gulch of the south end of Elkhorn Range has been worked on a more or less extensive scale for placer gold, though few localities have been exceedingly rich. Though the bulk of the gold was extracted shortly after the discovery, in 1862, some work is yet going on at several of the old diggings, showing that the gravels are not yet exhausted.

At the northern end of the eastern slope small placers have been worked on Marble Creek, near the limekiln. On Salmon Creek the placers are of much greater importance. This creek was worked with success for about one mile upward from the mouth of the canyon. The gravels were 4 to 10 feet deep and covered by 10 to 15 feet of an exceedingly fine, brilliantly white kaolinic material. The bottom of the canyon was originally filled with deposits to a width of one or two hundred feet. Working downstream, the placer miners at the mouth of the canyon gradually discovered a very remarkable deposit, called the Nelson placers. These have been worked successfully for thirty years by the hydraulic process, and are by no means yet exhausted. The working season extends from April to September, 1,000 miner's inches of water being used. The yearly production has generally been from \$20,000 to \$30,000. In the Mint reports for 1889 the production is given as \$77,000; in 1890, \$19,000. The total production is believed to be over \$400,000. For one period of six years the production is said to have reached \$214,000. As the available grade is small, it is proposed to use a hydraulic elevator for mining below the level of the permanent sluice.

The mouth of Salmon Creek Canyon is marked by a low spreading débris fan. The Nelson placers are working the gravels of this fan in a pit covering 40 to 50 acres and from 20 to 100 feet deep. At the top of the bank the elevation is 3,750 feet. The gravel is subangular, many fragments reaching 1 foot in diameter, and consists of argillite and diorite, very little quartz being present. There are two layers. The upper stratum has a bluish-gray color, is 10 to 20 feet thick, and contains, evenly distributed, most of the gold. The lower stratum is yellowish-brown and its rocks are more decomposed. This also contains gold, though in lesser amount, and its bottom has never been reached. Covering the top layer, near the mouth of the canyon, is the same white kaolin which covers the gravels of the creek. The gold, which is worth only \$14 to \$16 per ounce, is ordinarily fine, though nuggets up to \$10 in value occur. To the rough pieces quartz sometimes adheres.

Most interesting are the relations immediately at the mouth of the canyon, for here the hydraulic work has disclosed the presence of a continuous fault scarp 100 feet high and dipping 40° E. It is smooth



now, but when first exposed it is said to have been almost polished and in places covered with a clayey gouge. The direction is northwesterly, but with occasional bends and bulges. The exposed fault line extends completely across Salmon Creek for a distance of 1,500 feet, and the same line, less well exposed, is seen in the Baisley diggings, one-fourth of a mile northward, and in the Carpenter placers, half a mile south-easterly.

A shaft has been sunk in the bottom of the hydraulic pit near the foot of the scarp, but no bed rock was found at a depth of 90 feet. A minimum vertical throw of 200 feet is here shown, the valley side having sunk relatively to the mountains (fig. 80). The upper blue gravel probably was accumulated during the Glacial epoch, while the lower dark-brown gravel is more likely to antedate that time; whether any very recent movement has taken place could not be decided.

Small placers have been worked in Washington Gulch, and the same applies to Griffin Creek and Elk Creek. The Griffin Creek placers are the oldest in eastern Oregon, having been discovered in the fall of 1861.

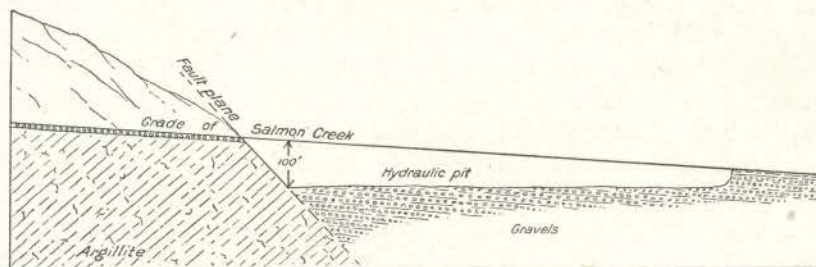


FIG. 80.—Section of Nelson placer mine, showing fault at foot of Elkhorn Range.

The workings are 6 miles southwest of Baker City and at an elevation of 4,750 feet above where the creek enters the lava hills. Some work was in progress in 1900. On the divide between Griffin and Washington creeks is a small area of high gravels which is said to contain gold in paying amount.

Most important were the placers of Auburn, in Blue Canyon, a tributary of Powder River. The diggings were discovered in 1862, and in a short time a town of several thousand inhabitants had grown up. For many years Auburn was the most prominent place in eastern Oregon; but the gold yield gradually diminished and the camp was given over to the Chinese. At the present time hydraulic mining is carried on by two or three white companies. The total production of Auburn is difficult to determine, but it did not nearly reach that of Canyon and the richest placers were soon exhausted. A small and rather steady production is maintained. The Mint reports give \$12,000 for 1889, \$2,600 for 1890, \$8,900 for 1891, \$3,000 for 1892. The important Auburn ditch was completed in 1863. It takes water

from the head of Pine Creek and other water courses and carries it down to Auburn, a distance of over 30 miles; its capacity is 1,000 miner's inches.

Auburn is located in a wide basin-like valley at an elevation of about 4,000 feet. The argillites of the mountains here dip below the lava floods of the foothills. On both sides of the town the lava reaches up to elevations of 4,500 feet. The lavas cover soft, clayey, and loamy lake beds containing some coaly layers and impressions of deciduous leaves. On top of the eroded lake beds in the wide gulch rest subangular gravels 8 to 15 feet thick; the latter have been washed both in the gulches and on the flats. Near the town the depth to bed rock is not great; but farther down the valley the thickness of the sediments increases rapidly. The gravels are thus later than the lavas and have accumulated during the erosion of the present valley.

West of Auburn, on the road to Sumpter, several gulches with old placers are passed, Poker Gulch and California Gulch being next to Blue Canyon.

The deposits next in importance are found at Minersville, situated at an elevation of 4,300 feet on one of the small tributaries of Deer Creek. This is also an old placer camp, though not as rich as Auburn. Nearly all of the creeks flowing into Deer Creek from the east have yielded more or less placer gold. Miners Creek is worked at present on a small scale at the point where the stream leaves the old rock and enters the gravel deposits of Sumpter Valley. The gravel is coarse, with many heavy bowlders, and the gold is likewise coarse. Three short gulches southeast of Minersville, heading only 600 feet higher than the town, have been worked all the way up, and the gold contained in them is evidently of very local origin. In spite of this the gulches contain but little quartz.

#### SUMPTER AND CRACKER CREEK DISTRICTS.

##### GENERAL FEATURES.

The area described under this heading practically includes the upper Powder River Valley. South of Baker City Powder River cuts through the basaltic plateau at the southern end of the Elkhorn Range in a wide semicircle, and for about 12 miles flows in a narrow canyon. Going up the river, the canyon opens, at an elevation of 4,000 feet, into the wide Sumpter Valley, an alluvial bottom flanked by broad, gently sloping, forested benches. Beyond these the snowy summits of the Elkhorn Range rise abruptly eastward, while toward the west a heavily timbered ridge, of moderate elevation, separates the valley from the Burnt River drainage basin. A little above Sumpter a canyon again begins. The river forks into Silver Creek, Cracker Creek, and McCullys Fork, all heading among the high ridges leading to Elkhorn Range or Mount Baldy.

## GEOLOGY.

The older rocks are very similar to those of the Elkhorn Range; there is no geological break between that range and the country west of it. The predominant rocks are argillites, cropping in the canyon below the Sumpter Valley, near the Burnt River summit south of McEwen's, at Minersville, all along the Elkhorn Range, and, finally, above Sumpter until the contact with the Bald Mountain area of granodiorite is reached. The argillites appear in great variety: Some of them are black and fairly fissile, forming almost normal clay slates; another and very common variety shows little stratification and is a dark-brown to black, dense, fine-grained rock, containing more silica than the ordinary clay slates. The siliceous argillite is often interbedded with the clay slate as nodules and lenses, sometimes contorted and elongated. Transitions into black or gray chert are also common. Occasionally the argillites are calcareous, but limestones are not abundant. One limestone lens crops about half a mile north of Sumpter in a low saddle, but it is not very large and is not traceable far. Interbedded fine-grained greenstones and their tuffs were noted at several places, though on the whole the series does not contain much volcanic material. Extremely altered tuffs appear on the road leading to Clifford, and also on the lower part of McCully Fork. The stratification is more clearly marked than in the Elkhorn Range. The whole series strikes east to west or a few degrees north of west. The dip is steadily southward at angles of  $45^{\circ}$  to  $80^{\circ}$ . In places a schistosity, or jointing, striking northward and dipping steeply westward, is noted. There is rarely a strong fissility developed parallel to the original dip.

The age of this argillite formation is in doubt, as no fossils of any kind have been found. Not unlikely the rocks may be of Carboniferous age; and if so, they would occupy a position very similar to that of the Calaveras formation in the gold belt of California.

Few dikes or intrusive masses are found south of the great area of granodiorite of Bald Mountain. Near Bourne small dikes of aplitic rock have been noted. Between Sumpter and Cracker Creek two dikes of very much altered igneous rock were noted crossing the road, one below and the other above Halfway House. Both were probably originally diorite-porphyrines, but they now contain so much sericite, calcite, and pyrite that their original character is obscured. One of them is accompanied by small quartz veins, and doubtless contains a little gold. Similar extremely sericitized dikes were observed in the Golconda and the Columbia mines.

The general course of the upper Powder River was evidently laid out before the Neocene outbursts of Columbia River lava began. Great basaltic eruptions flooded the valley south of Baker City to a height still clearly indicated by the flat dissected tables above the river. By

these flows the upper river was dammed to a height of 4,600 to 4,700 feet above the sea, and this barrier created Sumpter Valley. Accumulations of coarse gravels at once began and filled the valley to an elevation of 4,600 feet, and these old gravels may still be seen leaning against the older rocks—at Sumpter and Minersville, for instance. As the lava barrier was gradually cut through, lower terraces were developed. These gravel flats must be considered of late Neocene (Pliocene) age. At present the river has cut down to a depth of 700 feet below the top of the lava flows at the lower end of Sumpter Valley. The alluvial flats which follow the river should be referred to the Pleistocene period.

#### PLACER DEPOSITS.

The Sumpter placer mines were discovered in 1862, and have been worked more or less actively since that time. The first area of placers begins a short distance below Sumpter and extends up to the point where the Cracker Creek vein system cuts across the creek. Another mining district, the placers of which are mentioned under the heading "Minersville district," is situated on Deer Creek a few miles east of Sumpter. Several of the smaller creeks north of Minersville draining the western side of the Elkhorn Range and emptying into Deer Creek also contain placer gold. Placers have also been worked in several gulches above Sumpter and tributary to Powder River, such as Buck Gulch, Mammoth Gulch, and others.

The mining has been done largely by Chinese companies, and it is not believed that the diggings were very rich, compared with those of Auburn, Canyon, Mormon Basin, and similar places. It is impossible to ascertain the total output. At present the bench gravels are worked only in two places adjoining Sumpter—the Downie and Ellis mines. The annual yield of the Sumpter placers probably varies from \$10,000 to \$20,000. The present river bed, from 50 to 300 feet wide, and the low bars were worked during early days for a few miles above Sumpter, but the diggings are now abandoned. A short distance below Sumpter the gravels in the present bed contain fairly coarse gold, it is claimed, and the possibility of dredging has been suggested, though the depth is far too great to reach bed rock by such machinery. More detailed tests must decide whether this is possible.

The gravels of most importance for present operations are the bench deposits, from 30 to 100 feet above the stream channel. These deposits connect directly with the Pliocene gravels skirting the base of the hills all around Sumpter Valley. Near Sumpter the auriferous veins above have enriched them sufficiently to make them available for placer work. Between Sumpter and McEwen's many shallow gulches cut in these gravels have been profitably mined. Sumpter itself stands on these bench gravels, which have a depth of 15 feet or more. At the electric-

light plant a shaft was sunk 80 feet through sandy strata with two streaks of gravel which prospected well. Bed rock was not reached. The old channel probably underlies the bench gravels on the northeast side of the river, and from all indications it had a steeper grade than the present river. Most of the bench gravels lie on the narrow point opposite the town, between Cracker Creek and McCully Fork, on which the gravels reach a height 60 feet above the stream. The junction of two forks is here evident. The Pliocene equivalent of Cracker Creek is covered by the 200 acres of the Ellis mine, the principal workings of which are north of the Granite road where it crosses the gravel point. Several acres have here been hydraulicked, the banks being up to 80 feet high. The well-washed gravels, fairly coarse, contain the rocks which crop above. The gold occurs in medium fine particles and the yield is reported as up to 16 cents per cubic yard. The bed rock is not exposed until a few hundred yards above Sumpter, where the large gravel areas dwindle into small benches lining the banks of Cracker Creek. A considerable amount of gravel remains, though much of it is not accessible without elevators, on account of lack of grade. The water is supplied by ditches aggregating 10 miles and carrying 1,000 miner's inches. In past years these diggings have been leased to Chinese companies.

The Downie placer mines,  $1\frac{1}{2}$  miles from Sumpter, are working on gravels representing the Pliocene McCully Fork, and comprise about 140 acres. The Downie channel is higher than the one just described, and forms a distinct depression on the east side of the creek. The trough is 200 feet wide and contains well-washed gravel 50 feet deep. The bed rock is 40 feet above the present creek. Going downstream, the bed rock descends rapidly, and where the Granite road crosses the point between the forks, mentioned above, no bed rock is seen. The mines dispose of a good supply of water from 6 miles of ditches, carrying 1,000 miner's inches. Operations can be carried on until late in the fall. Two giants are usually operated by Chinese leasers, and the annual yield is reported to be about \$9,000.

Rich placers with coarse gold are located in Buck Gulch, a tributary to McCully Fork, near the Granite road and  $4\frac{1}{2}$  miles from Sumpter. Scarcity of water restricts the operations.

#### LIMESTONE AND IRON ORES.

An outcrop of crystalline limestone of good quality occurs in the argillite half a mile north of Sumpter. It could not be traced far either way in the direction of the strike of the rocks, but it may be continuous for a greater distance than is apparent, as the rocks on the hillside are not well exposed. The outcrop is 10 to 15 feet across, and a small quantity has been quarried for the smelter which was in operation for a short time during 1900.

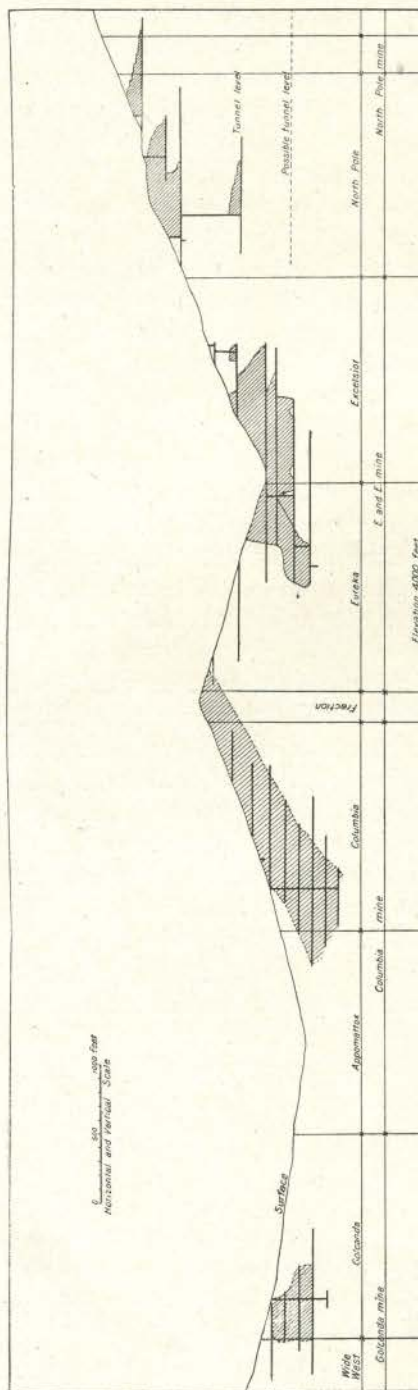


FIG. 81.—Vertical section following the vein from the North Pole mine to the Golconda mine. From data by Emil Melzer. Shaded areas indicate stoped ground. For Columbia and Golconda mines the data are only approximately correct.

A mass of hematite of no great extent has been found in the argillite on the Burnt River divide, 5 miles south of Sumpter. Three miles southwest of Sumpter a small deposit of a black earthy manganese ore occurs. It is near the Bonanza trail, also on the Burnt River divide. It was used in the smelting operations as a substitute for iron.

#### QUARTZ VEINS IN GENERAL.

Many small veins and indications of mineralization are found near Sumpter, but the big vein systems occur 7 miles above this place. There is practically one continuous vein system, beginning at the Baisley-Elkhorn mine and continuing across to Cracker Creek, with a strike varying from east-west to northwest-southeast, and some of the most important mines in eastern Oregon are comprised in it. The part of the vein system tributary to Sumpter begins at the North Pole mine and continues westward through the E. and E., Columbia, Golconda, Amazon, and Bunker Hill mines. In this distance of 5 miles the vein continues strong and unbroken, but gradually changes its strike from northeast-southwest to east-west. The country rock is, throughout, argillite, and the vein is of the composite

type; that is, it is found as a wide, shattered zone, though ordinarily with well-defined walls. The gangue is quartz throughout, containing gold and sulphurets. The width is from 5 to 100 feet. It is easily the most strongly defined and persistent vein in the Blue Mountains.

A short distance northward is the Ibex vein, which is continuous for at least 3 miles and is nearly parallel to the North Pole vein. It resembles the latter greatly, except that it is usually narrower. There are many other smaller veins and branches thrown off from the two large veins.

The veins of Sumpter were known as far back as 1870, but active exploitation was not attempted until about twenty years ago. The earliest mill was erected on the Mammoth claim about this time.

*North Pole mine.*—The most northeasterly of the important mines on the big vein comprises two full claims, the North Pole and the More-or-Less. It is located on the mountain slope northeast of Cracker Creek, and ascends to a height of 2,000 feet or more above that stream. The extent and workings will be seen from fig. 81. The elevation of the lowest tunnel is about 5,800 feet. The North Pole claim was located in 1887, croppings of rich ore being found near the surface. The following year the claim was sold to A. Baring, of London, for a reported price of \$10,000. The adjoining claim and fraction was acquired for \$14,000 in 1897. Though operated since 1887, the most active work on the property has been prosecuted since 1895. The total production is not known, but during the last four years 13,400 tons have been treated, the assay value of which approximated \$15 per ton.

The mine is equipped with a cyanide plant provided with two Bruckner roasters, which have a daily capacity of 20 tons. This plant works the zone of semioxidized ores only, and in spite of fine crushing to 1 mm. by ball mills, it is necessary to roast the ore very slowly and carefully. The cyaniding is done in 50-ton tanks, percolation lasting fifteen to twenty days. The extraction by cyanide is stated by Mr. Melzer to be 84.9 per cent of the assay value. For purposes of working the unoxidized ore a 10-stamp mill and a Huntington mill with concentrators have recently been added, making a total capacity of 80 tons per day.

The North Pole is developed by means of three main tunnels, shown on fig. 81, the upper two starting on the vein, the lower one being a crosscut for 1,000 feet. The upper tunnels are, respectively, 450 and 750 feet above the main adit, the total vertical distance on the vein opened by the workings being 850 feet.

Throughout the mine the country rock is the normal, black, hard, siliceous argillite, without clearly visible stratification. In the long crosscut a jointing shows in several directions, the most prominent

being flat or dipping gently east or west. There is no jointing or parting parallel to the vein. The strike of the vein is N. 25° E., and its dip 70° to 80° SE. The croppings are distinct and in some places carry good values. On More-or-Less claim a large mass of quartz crops along the line of the vein, measuring almost 200 feet across. Where the main crosscut meets the vein the latter is 22 feet wide; in places it bulges out to 40 feet, and again contracts to 7 feet, but never thins out entirely. The walls are fairly well-defined fault planes, especially the foot wall. The vein matter is composed of rock of all gradations between crushed argillites seamed by quartz and pure white massive vein quartz. On the whole, there is a large amount of solid vein quartz extending for several feet across the vein and for long distances parallel to it. Other parts of the vein form an intimate mixture of quartz and small leafy or irregular inclusions of argillite, sometimes indistinctly defined from the quartz and giving the impression of a mass of argillite mud partly silicified and cemented by quartz. On the whole, there are no such large and sharply defined inclusions as mark the vein in the lower tunnel of the Columbia. Comb structure is frequently seen on a small scale, though most of the quartz is massive. The argillite in and just outside of the vein is often filled with coarse cubical pyrite of low assay value. Outside the pay shoots the quartz is white and barren of sulphides. The pay quartz is characterized by arsenopyrite, and also by pyrite in minute grains and slender crystals, rarely over 1 mm. in length. In the center of the pay shoots richer lenses are occasionally found, containing up to \$150 per ton, and sometimes also a little native gold with tellurides rich in gold and silver. The ordinary ore rarely contains any sulphurets other than arsenopyrite and a little pyrite; sometimes also chalcopyrite. Native gold is seldom seen, though a little, about 6 per cent, may be caught on amalgamating plates. The chief value is in the sulphurets. The average sulphide ore contains 0.688 ounce of gold and 1.200 ounces of silver per ton, or a total average value of \$14 per ton. The white quartz outside of the pay shoots carries only small values. Very frequently a peculiar arrangement of the sulphides is noted in the pay shoots. The quartz is here full of small curved and concentric streaks of arsenopyrite, in general not parallel to the walls and frequently sharply cut off. The detailed examination shows that this irregularly concentric structure is due to crustification, but that by subsequent motions the crustified mass has been broken and recemented, in places forming a real breccia (see Pl. LXVIII, A). The quartz is free from calcite, but the latter mineral occurs on all little secondary slips and fractures which brecciated the original crust. On these secondary fractures arsenopyrite is also found.

The pay does not include the whole width of the vein, but when present occupies a space of 2 feet up to a maximum of 12 feet, appear-



ing along one wall or the other, or in the middle of the vein, adjoined by barren quartz on both sides. Usually the form is that of a number of lenses which sometimes overlap. The pay shoot, ordinarily on the foot wall, may break across in stringers and streaks and follow the hanging wall for a distance. It is stated that in general the pay has a tendency to follow the seams of gouge found in the vein. As a whole, it has a flat southwesterly dip, as in the Columbia and E. and E. mines, and may in fact be continuous with one of the E. and E. shoots. A large amount of ore is unquestionably in sight; thus, for instance, it is stated that there are 600,000 tons between the short intermediate and the uppermost tunnel level. Besides the pay shoot following the slope of the hill, there are others exposed in the lowest and middle tunnels.

A partial oxidation has taken place for a distance of 200 or 250 feet from the surface. The changes in values are, probably owing to the hardness of the quartz and the fineness of the sulphides, much less marked than is usual in gold veins. According to Mr. E. Melzer, the oxidized ore is but very little richer than the deep ore, though its physical condition has changed so that the same metallurgical processes are not applicable. Average assays of surface ore give 0.968 ounce of gold and 0.700 ounce of silver, or \$20.40 per ton, while the sulphide ore assays 0.688 ounce gold and 1.2 ounces silver, or \$14.40 per ton, the gold having thus increased slightly and the silver decreased during the process of oxidation.

*Eureka and Excelsior mine.*—The mine owned by the Eureka and Excelsior Consolidated Mining Company comprises the two claims on the North Pole vein having the above names, and is usually known as the E. and E. It was bought as a prospect in 1888, and from this time up to 1898 it has been worked. In 1900 it was idle and the underground works were not accessible. For most of the data regarding it I am indebted to Messrs. E. Melzer and J. Arthur, of Sumpter. A 20-stamp pan amalgamation mill was erected in 1889 for \$200,000, which proved utterly unsuited to the ore, and for several years the mine was worked with indifferent success. The doubtless incomplete Mint reports give the production as \$500 for 1889, nothing in 1890, \$135,000 in 1891, and nothing in 1892. In 1895 the mine was leased to Mr. J. H. Longmaid for three and one-half years. The lessee put vanners in the mill, and in three years mined and milled 75,000 tons of ore, valued at \$900,000. Since the expiration of the lease the property has been idle except for a little surface work, but it is said will soon be reopened. If worked in a rational manner the property will doubtless maintain its reputation as one of the best mines in Oregon.

The total production may be estimated as \$800,000, the mine thus possessing the record production among the new mines in the Sumpter district.

The developments consist of between 7,000 and 8,000 feet. There are two small tunnels on the hill northeast of Cracker Creek, 200 and 350 feet above its bed; two tunnels on the southwest side of the water course; a main level at creek level, at an elevation of about 6,500 feet; a shaft 200 feet deep sunk from this tunnel; and still another shaft sunk 100 feet below the 200-foot level in the first shaft (fig. 81). The mining methods employed were crude and faulty, the evident plan being to extract as much as possible without regard to even the immediate future of the mine.

The country rock is the usual black, siliceous argillite. The vein, directly continuous with that of the North Pole on the northeast and the Columbia on the southwest, strikes N. 34° E. and dips 60° to 70° SE. The croppings are well defined, and the vein seems to have paid from the grass roots down for a distance along the surface of 1,300 feet. The vein appears to be identical in character with that of the adjoining claims, being a shattered zone in argillite, in some places as much as 30 feet wide. The milling ore carries pyrite and arsenopyrite in quartz similar to that of the North Pole. It rarely contains free gold. The concentrates amount to 8 to 10 per cent and assay from \$100 to \$200 in gold, with a little silver. The 70,000 tons of ore extracted by the lessee averaged \$12 per ton by assay value. There was also a certain quantity of rich shipping ore yielding from \$80 to \$240 per ton. Some surface ore extracted in 1898 yielded \$8 per ton.

There are four pay shoots in the mine, which may be said to partly connect, forming a body dipping southwest at a gentle angle, like the shoots of the North Pole and the Columbia. In fact, the shoot of the E. and E. may be considered as the continuation of that of the North Pole. Mr. Arthur says: "A surface tunnel on the Excelsior claim disclosed a shoot 200 feet long, the ore still remaining in the face and very likely continuing to the North Pole line, 400 feet distant. This shoot is 4 feet wide and contains \$10 per ton in gold. The better-grade ore, assaying \$50, was sorted and shipped. This high-grade ore appears as a streak 2 feet wide and 75 feet long in the bottom of the drift and adjoining the milling ore. The shoot next south of this was 400 feet in length and from 1 foot to 15 feet in width, differing from the first in having a wavy character, the thickness changing suddenly and often. The shoot, with an average width of 4 feet, has been mined down to a depth of 160 feet from the surface.

The shoot south of this is on the Eureka claim and is said to be 200 feet long and 4 feet wide. From these stopes came most of the shipping ore and a higher grade of milling ore, showing some free gold, not found in the other stopes. This shoot was mined out to the 260-foot level. There is another shoot still farther south which is imperfectly known, but from surface cuts and tunnels it should be 600 feet long and one-half foot in width, averaging from \$5 up in gold."

While the deeper ore is fresh, that from the surface down to 100 feet below is more or less oxidized. Regarding the character of this oxidized ore see North Pole mine.

*Columbia mine.*—This mine is situated on Fruit Creek, at an elevation of about 5,600 feet, between the Golconda and the E. and E., and comprises two claims on the North Pole vein, called the Columbia and the Appomattox. It is owned by the Columbia Gold Mining Company, who also possess a number of other claims in the vicinity. The mine was sold to the present company in 1895 by Cable Brothers, but during the first few years there was but little gold produced. During the last three years the mine has been in active operation. The total production is not known, but is supposed to be in the vicinity of \$300,000. There is a 10-stamp mill with six concentrators on the property, capable of crushing 28 tons per day. The tailings are saved, and during 1900 a cyanide plant was built to work them. Ten additional stamps are to be erected. Besides the milling ore, smaller rich chimneys are met with. This ore is shipped to smelters, one car of 20 tons containing about \$1,000 per ton. The developments are extensive and comprise in all over 8,000 feet. There are three tunnels on the vein in the steep hill which rises 500 feet above the shaft house, the lowest being at the level of the latter. There is also a 500-foot vertical, 3-compartment shaft with five levels, from which drifts extend several hundred feet each way. Admittance below tunnel level was refused.

The country rock is the usual black argillite, rarely showing stratification or schistosity.

The surface croppings, which can be traced continuously from the E. and E., are very strong, showing a width of from 70 to 100 feet. The vein strikes nearly due northeast and has a southeasterly dip of 60°. Its general character is similar to that of the North Pole. It is a zone of fracture in the brittle siliceous argillites, with a width of about 40 feet, the walls being fairly well defined. Outside the walls there is no strong mineralization. The structure is well shown in the lower tunnel level. The zone consists of quartz, more or less completely filled with inclusions of argillite, from 3 feet in diameter down to the smallest fragment. These inclusions are cemented by normal, white vein quartz, clearly deposited in open fissures and sometimes showing drusy comb structure. The fragments are often so isolated by the quartz that though very abundant they could not have filled the space before the advent of the quartz. Still the quartz is certainly not derived from replacement, and often extends solid over spaces of several feet. This character of vein continues throughout the mine, I am informed, for a long distance, vertically and laterally, without closing down. The foot wall is smooth, hard, and extremely well defined. The hanging wall, though not so well marked, is formed of

argillite impregnated with pyrite. The argillite contains pyrite, and has in places been somewhat silicified, and is sometimes filled with metasomatic sericite. Some doubtful rocks also occur which are probably altered diorite-porphry, and now filled with pyrite, calcite, and sericite.

The ore consists of quartz carrying up to 8 per cent of sulphurets, chiefly pyrite and arsenopyrite, though the altered slate may also show fair tenor. The solid white "bull quartz" and the sugary quartz carry no values. The average value of the ore is \$10 and over per ton, chiefly in gold. About 40 per cent of the gold is caught on the plates, the bullion containing 702 parts gold and 277 parts silver. The concentrates are rich, carrying from \$100 to \$175 per ton, of which a considerable proportion is silver (Au: Ag = 1:15, by weight). Occasionally some coarse gold is seen in the ore. Smaller chimneys furnish rich ore, which is shipped, often containing 11 ounces gold and 39 ounces silver, or about \$250 per ton. This consists of fragments of sericitized argillite cemented by vein quartz and containing native gold and sulphides.

A number of interesting minerals occur on this vein. They comprise native gold, native copper (tunnel level), pyrite, arsenopyrite, zinc blende (rare), pyrargyrite, cinnabar, antimonite, chalcopyrite (sometimes several per cent in shipping ore), stibnite (tunnel level), also an unidentified telluride.

In the shipping ore there occurs also a black tetrahedrite with brown streak, which, upon examination by Dr. Hillebrand, proved to be a mercurial variety, or schwartzite, not previously known from the United States. Among gangue minerals are to be noted quartz, sericite, fuchsite or mariposite (in the rich ore), and also a little calcite. The latter mineral seems to be of very late introduction, traversing quartz and argillite in minute and irregular seams.

As will be seen from fig. 81, the pay shoot as a whole occupies the southwestern slope of the ridge between Fruit and Cracker creeks and dips about 20° SW. on the plane of the vein, similarly to the pay shoots of the North Pole and the E. and E. mines. It is believed that the shoot as a whole is continuous from the top of the ridge to the bottom of the shaft, thus extending over a vertical interval of 1,000 feet. Within this shoot are found smaller chimneys of very rich ore. The pay does not occupy the whole width of the vein, but appears in streaks from 2 to 4 feet in width, following either wall or crossing from one wall to another. On the tunnel level the principal shoot follows the footwall, but throws out three ore splits, one of which carries much free gold and cinnabar and finally crosses over to the hanging wall.

The ore worked at present from the shaft is not altered by surface influences. Above the tunnel level a partial oxidation appears and



A. GOLCONDA MINE AND MILL.



B. RED BOY MINE.

the ore is no longer suitable for concentration, being apparently similar to the North Pole surface ore, which is roasted and cyanided. Much of this oxidized ore remains as yet untouched.

*Golconda mine.*—This part of the North Pole vein was located as the Golconda claim in 1887 and sold for a reported sum of \$24,000 in 1897, there being at that time only 250 feet of development. The Golconda Mining Company at present owns, besides this claim, 8 others adjacent, which are said to cover 2 parallel veins. The Golconda and the Wide West are located on the North Pole vein. In 1898 a large bromination plant, of a capacity of 100 tons per day, was erected but soon found unsuited to the character of the ore. A 20-stamp mill and a Bryan roller mill, together with 18 concentrators, were substituted, giving a total capacity of over 100 tons per day. Crushing was begun in January, 1900, and the mine has consequently not as yet any great production to its credit. In the fall of 1899 a rich ore chimney was struck, 20 tons of which yielded \$10,000 in the mill. Still richer ore was shipped to smelting works. In September, 1900, 15 stamps were running. At present there are 2,500 feet of developments, including a 400-foot double compartment perpendicular shaft and 4 levels, the opening of the fourth having just begun; also a 650-foot tunnel running southwest on the ledge.

The country rock is the usual black siliceous argillite, sometimes showing schistosity, but oftener massive. Occasionally this contains light-gray, very much altered dikes of an igneous rock which originally may have been a diorite-porphry. The croppings of the main vein can be followed from the Columbia for at least part of the distance. A statement is made by some that there is a fault between the two mines; whether this is true is not certain; at any rate the vein holds its general direction well enough. The croppings are not very conspicuous except on the hill southwest from Golconda shaft, where they are marked by a very heavy mass of quartz similar to that above the North Pole. The outcrops carry low values throughout, rarely over \$1 per ton.

The developments in the shaft have shown the existence of a very wide mass of crushed argillite. The general trend of this is northeast; the dips in the upper levels are northwesterly at steep angles, while on the fourth level this is reversed to a southeasterly dip, similar to that of the Columbia and the North Pole. In places this crushed zone is 200 feet wide and traversed by several seams, running across the vein in a northwest-southeast direction, on some of which quartz veins carrying gold appear. The principal pay shoots are found as streaks 2 to 4 feet wide in this shattered argillite and pursue a rather irregular course. The ore carries but little quartz and is largely a replacement of argillite and some porphyry by finely divided pyrite, marcasite, and arsenopyrite and a very little chalcopyrite and zinc

blende. The average value is believed to be from \$8 to \$15 per ton. The ore is in part free milling, containing from 40 to 50 per cent of gold which can be caught on the plates. The sulphurets are stated to be of comparatively low value, the percentage contained in the ore being from 7 to 14.

On the second level the crushing and the irregularity seem to have reached a maximum. On the fourth level the lode contracts to less than 100 feet and the ultimate walls are fairly well defined. The whole mass between them consists of crushed argillite with replacing sulphides and traversed by small quartz veinlets. The pay streak is from 2 to 3 feet wide. It is to be expected that more regularity will be found in depth, and it may also be expected that there will be somewhat less free gold. The pay shoots in general follow the trend of the vein, but a very rich chimney, alluded to above, did not follow this rule. It occurred on the second level, cutting across the general direction of the vein and dipping 30° SE. The shoot was 70 feet long and 14 feet wide; it did not extend far above or below the level. Only a part of it was rich in native gold. The ore consisted of an argillite colored greenish by roscoelite and containing arsenopyrite and pyrite. The native gold, accompanied by tetrahedrite, occurred chiefly in little seams and fractures filled with normal vein quartz. The drifts and crosscuts on the four levels run very irregularly owing to the difficulty in following the pay shoot in such a wide crushed zone.

*Mountain Belle mine.*—This adjoins the Golconda property on the southwest and is located on the same vein, which here crosses Silver Creek. The Mountain Belle is as yet not a producing mine, but extensive prospecting has been done during the last two years. The vein is developed by a perpendicular shaft in the country rock 300 feet deep, with crosscuts and drifts from the levels. The shaft is located on the northeastern side of Silver Creek, 175 feet above the stream, and at an elevation of about 5,450 feet. The country rock is the usual siliceous argillite without clearly defined stratification. The vein, which shows on the surface in big outcrops of mixed quartz and argillite, strikes N. 60° E. and has, contrary to the ordinary direction for this vein, a northwesterly dip. As on the other properties on this vein, the character is that of a crushed zone between two usually clearly defined walls, the width of the zone being from 20 to 50 feet. The foot-wall half of the vein consists largely of crushed argillite cut in all directions by quartz veinlets, sometimes with comb structure. The quartz often contains minutely divided pyrite and arsenopyrite; the argillite is often filled with pyrite. The hanging-wall part is almost massive quartz, but full of little fragments of silicified and pyritic argillite. In other parts of the mine the whole vein is a quartz-seamed argillite. Again, the whole mass may consist of crumbly

quartz. The values thus far developed are said to be low and much of the quartz is entirely barren.

*Amazon, Analulu, and Bunker Hill claims.*—The North Pole vein continues clearly marked across Silver Creek and through the above-mentioned claims. The Amazon has over 1,000 feet of tunnels on a vein said to be entirely similar to the Mountain Belle. On the Analulu also a considerable amount of development work has been done. On the Bunker Hill the vein shows quartz croppings of enormous extent; the developments here also exceed 1,000 feet, and the quartz is said to assay from \$3 to \$7 and over. Three claims, the Bunker Hill, Myrtle, and Lilac, are owned by a Canadian company. The vein where struck by the 300-foot crosscut is said to be 25 feet wide.

The great fracture, now traced for almost 4 miles, has gradually swung around from north-northeast to east-northeast. Beyond the claim last mentioned its continuation is not definitely known, but it is possible that it here splits into several branches. Already, near the Golconda and Columbia, important stringers leave the main ledge and continue somewhat divergent from it. These have not yet been traced out in detail. On one of these the Free Coinage claim is located, the place of principal workings being on Silver Creek, one-third mile above the Mountain Belle. Some 500 feet of work has been done and preparations have been made to sink a shaft. The vein is inclosed in black argillite, much crushed and filled with pyrite and stringers of quartz. Satisfactory ore is reported to have been found.

*Ibex mine.*—The group of three claims, Ibex, Nachez, and Pyrites, comprising this mine is located on the high divide separating McCully Fork of Powder River from the waters running into Granite Creek and the North Fork of John Day. The elevation at the shaft is 6,270 feet. Through openings in the forest a fine view is obtained across the heavily wooded Granite Creek Basin toward the Greenhorn Mountains. A short distance northward Bald Mountain rises to 8,330 feet. The property was bought a couple of years ago for a sum reported to be \$60,000. Since then a great deal of development work has been done, consisting chiefly in a shaft 300 feet deep, with two tunnel levels, as well as a third and lowest tunnel level 800 feet long and driven 500 feet below the shaft on the Pyrites claim. Total development work, 3,000 feet. There is as yet no mill on the property.

The country rock is the usual black, hard argillite, sometimes, as at the Pyrites tunnel, showing the stratification very plainly. At this place its strike is nearly east-west and it dips steeply. A short distance northward the contact with the granodiorite of Bald Mountain begins. The vein is very strongly marked with large outcrops of mixed argillite and quartz. Its strike is E. 25° N. and its dip 60° SE. on top of the hill, increasing to 80° in the bottom of the shaft. The croppings are said to be poor, but in one spot the quartz showed free



gold and a considerable amount of pyrargyrite. The vein is from 6 to 10 feet wide and shows great similarity to the North Pole-Golconda vein. In general it consists of a zone of crushed black argillite between two usually well-defined walls. The argillite is filled with irregular quartz seams, sometimes showing plain comb structure. In other places the argillite occurs as inclusions in the quartz and is partly silicified and filled with pyrite. The pay is contained in the white quartz and is chiefly in the sulphides, which consist of pyrite and arsenopyrite. The gold, when occurring, is of rather pale color and worth only \$13 per ounce. Pyrargyrite and cinnabar have been found, the latter in several places as apparently secondary seams in the quartz.

The mine is reported to contain three shoots: The first, struck near the mouth of the second tunnel, 150 feet below the shaft, and called the Boulder shoot, carries no free gold nor sulphurets, but the ore cyanides well after roasting. This ore is said to carry 95 per cent of its value in gold. The next shoots nearer the shaft lie on the hanging wall and are from 3 to 5 feet wide. The second shoot contains 60 per cent gold and 40 per cent silver, and includes as a smaller, 8-foot long lens, the coarse gold chimney, known from the surface and the second tunnel level. Finally, the most easterly shoot is said to carry 60 per cent silver and 40 per cent gold. The pay in this vein is believed to be rather irregular and pockety, but is thought to possibly average \$10 per ton.

*Bald Mountain mine.*—This is located east of the Ibex, on the same vein. It is high up on the summit of the ridge, dividing McCully Fork of Powder River from the drainage basin of the North Fork of John Day River. The elevation at the shaft is 6,300 feet.

The mine has been developed but recently, though the vein has been known and slightly prospected for many years. The intention is announced to shortly erect a 20-stamp mill on the property.

Most of the following data regarding pay shoots and development were kindly furnished by the manager, Mr. H. S. McCallum.

The Bald Mountain Mining Company owns 38 claims, of which two, the Bald Mountain and the Midnight, are on the Ibex vein, taking in 3,000 linear feet of this. The principal vein is developed by a tunnel 500 feet long and by a perpendicular shaft at the mouth of this tunnel. Two levels are turned from this shaft, at 100 and 200 feet, and sinking is in progress below the latter level.

The country rock is a hard, black siliceous argillite, often massive, more rarely showing a stratification, the strike of which is nearly due east-west, the dip being 60° S. The vein is exceedingly strong and well defined. It is a typical fissure vein, showing a width from 1 to 30 feet and averaging several feet. Its strike is N. 60° to 65° E. and its dip averages 70° S., the vein thus cuts the stratification in strike and dip.

The gangue is throughout a white massive quartz, such as normally occurs as filling in fissure veins. The vein is sometimes filled with solid quartz, though more commonly, especially in the wider portions, much of the vein matter is a shattered argillite cemented by auriferous quartz. The vein shows in its structural feature a great resemblance to the Ibex, of which it is the extension. Besides free gold and a very small percentage of pyrite the quartz occasionally contains bunches of cinnabar.

Secondary changes apparently have had little influence except for a distance of 25 to 50 feet from the surface. Several ore shoots are known. All of them carry a certain proportion of free gold and appear to pitch steeply southwest on the vein. The first shoot near the mouth of the tunnel continues for 60 feet, carrying 50 per cent of free gold and equal quantities (by weight) of gold and silver. The vein is from 8 to 10 feet wide and the tenor of the ore is stated to be from \$8 to \$10 per ton. A second pay shoot, 75 feet long, of lower grade is met 190 feet from the mouth of the tunnel. A third shoot, 300 feet from the mouth, is 200 feet long, the width varying from 4 to 30 feet, and the value from \$6 to \$50 per ton.

On the first shaft level the first pay shoot was found a short distance from the shaft, its width of 8 feet gradually decreasing to 18 inches. Thirty per cent of the gold is here free. After cutting through this shoot the drift follows the partially pinched vein for 210 feet in quartz with low values of from \$1 to \$3 per ton. The second and third shoots have not yet been reached. To the east this level continues in ore for 14 feet.

On the second level the first shoot was met 100 feet from the short crosscut to the vein. To the east on this level there is another ore shoot 80 feet from the shaft that has been drifted on for 60 feet. It is proposed to open the vein by means of a 1,500-foot long crosscut lower down on the slope, giving backs of 900 feet, the mill to be placed at the mouth of this adit.

A short distance north of the main deposit are two strong veins, said to carry good ore, which may be offshoots of the principal fissure. They are called Fairview No. 1 and No. 2. In a small tunnel on the latter granite forms both walls, this being probably a dike or smaller intrusive mass in the prevailing argillite.

On the same strongly marked vein as the Ibex and the Bald Mountain, and half a mile eastward from the latter, is the Grand Trunk, on which the Ibex Company had a bond in 1899. Some 1,200 feet of development work was done. The vein is said to be similar in character to those of the two mines already described.

*Mammoth mine.*—The Mammoth mine is located near the head of the creek of the same name, at an elevation of about 6,300 feet. The gulch, which is a tributary to McCully Fork of Powder River, widens

near the mine. Thick timber covers the region, and down Mammoth Creek an excellent view is obtained over the southern part of the Blue Mountains. In the upper part of the gulch is evidence of extensive placers. The mine itself is one of the oldest in the district, having been worked by means of a primitive hand mortar, arrastre, and mill as early as 1881. A considerable amount of gold has been produced, stated by some to be as high as \$150,000. The mine owned by the Bald Mountain Mining Company consists of the Mammoth and the Belle of Baker claims, both on the same vein, supposed to be an extension of the Ibex vein. In 1900 this mine was reopened, with excellent results. It is at present equipped with a 5-foot Bryan mill and four concentrators. The developments consist of an inclined shaft on the Mammoth 300 feet deep and a tunnel with drifts and crosscuts on the Belle of Baker, the latter on the west side of the creek.

One-half mile from the mine toward Sumpter the main granite contact is passed, and the prevailing rock at the Mammoth is a granodiorite. It contains, however, in places masses of argillite strongly contact metamorphosed. A contact between the two may be seen in the creek just below the mine. Most of the workings are in granodiorite, though occasionally argillite appears, as in the foot wall of the vein on the second level.

The vein, which without much doubt is continuous from the Ibex, has an east-northeast direction and a steep southeast dip, similar to the other principal veins in the vicinity. In the shaft from the upper part of which the old bonanza was extracted the vein is very wide—up to 20 and 40 feet—and consists of a crushed zone of rock, traversed by several gouge seams parallel to the ultimate walls, which are fairly well defined. The ore consists of crushed country rock cemented by quartz. Some of it is a very pretty breccia of argillite, which contains a little metasomatic pyrite and arsenopyrite, and which is cemented by crusts of calcite. The calcite again contains veinlets and druses of quartz. Neither calcite nor quartz contains any sulphides. The gold is of pale color and only 500 to 600 fine, the rest being chiefly silver. On the first level in the shaft the ore was poor, but in the second a good, though spotted, free-milling pay shoot was found containing from \$6 to \$12 per ton. The third level had not yet been developed.

Late in 1900 an important and rich pay shoot was found in the Belle of Baker tunnel. This was run as a crosscut for several hundred feet. The vein, when struck, proved to be 35 feet wide and to contain a 12-foot-wide ore body of crushed rock, with cementing quartz stringers and sulphurets, but no free gold. This body seemed to cut across the vein, making for the hanging wall. From this place a gouge streak in the vein was followed for 200 feet without showing any notable values. Crosscutting toward the foot wall, however, disclosed a large body of ore with much coarse gold, containing \$25 to \$400 per ton. At the present end of the drift a crosscut showed 16 feet of ore;

70 feet from the breast it had widened to 45 feet. A crosscut 170 feet from the breast and 50 feet from the place where the vein was first struck disclosed no ore, but an 18-foot upraise caught it 5 feet wide, so that the dip of the shoot would seem to be to the southwest. The ore consists of soft, gray granodiorite containing much calcite, and traversed by irregular seams of white vein quartz inclosing pale-colored free gold, together with a little arsenopyrite and pyrite. The gold, while to some extent directly in the quartz, seems by preference accumulated in a soft greenish roscoelite which looks much like chlorite and which is contained in spots and bunches in the quartz. Numerous smooth slips with polished surfaces of gold traverse the ore. Between the tunnel and the surface there is estimated to be between \$200,000 and \$300,000 in sight. This find is of interest as illustrating the necessity of crosscutting in these wide lodes. It is similar to the case of the Bonanza mine, inasmuch as a drift was long run parallel to the ore body without suspicion of its presence.

#### CABLE COVE DISTRICT.

##### GENERAL FEATURES.

The Cable Cove district is situated 10 miles in an air line north-northwest of Sumpter, on the high backbone which separates the drainage of Powder River from that of the North Fork of John Day River. The road from Sumpter follows Silver Creek, the principal fork of Powder River. For some miles above Sumpter the canyon is narrow, but soon widens and assumes the broad U-shaped form characteristic of glaciated valleys. Near Cable Cove the road emerges from the thick timber in the bottom of the valley. The head of the creek appears as a wide amphitheater with steep slopes, sparsely timbered. Westward the ridges of Bald Mountain rise with bare, light-gray, glaciated outcrops. Eastward a number of sharp and high granite peaks meet the eye in the continuation of the Elkhorn Range (Pl. LXXII). The elevation at the California mill is 7,000 feet; the high hill back of it attains 7,900. The gaps east and west of this hill are 7,500 feet in elevation. From the summit long ridges extend northward between the heavily timbered valleys of Big Limber Creek, Bull Creek, and the North Fork of John Day. The summits of Cable Cove culminate a couple of miles southwesterly in Bald Mountain (elevation 8,330 feet), so prominently visible from Sumpter. It is a bare granitic ridge, sloping abruptly northward and here inclosing a glacial amphitheater in the center of which is a small lake.

##### GEOLOGY.

The geological features are very simple. Cable Cove is situated in a large area of granodiorite, which begins a short distance north of the Free Coinage mine, the actual contact being covered, and which con-

tinues for many miles northward. This rock, very similar to granite, is light gray, granular, and consists of quartz, andesine, orthoclase, biotite, and hornblende. For analysis and detailed description see page 587. Glaciated outcrops seem nearly white, while on the lower slopes the sandy decomposed rock appears light yellowish. Very few dikes of any kind were noted, the exceptions being small sheets of aplite. The granitic area culminates in a series of white, high, and jagged peaks situated between the headwaters of John Day and North Powder rivers.

Beginning a short distance north of the Crown Point claim and extending for several miles northwesterly on both sides of Big Limber Creek is an area of gneiss. The rock is usually sharply defined and separated from the granite and is certainly not a dynamo-metamorphic or sheared granite; neither is it a contact-metamorphic rock. It is coarse grained, very plainly schistose, sometimes contorted, consists of biotite, quartz, and a little plagioclase, and has the appearance of an Archean gneiss. At the Grizzly claims, below La Belleview mine, the strike is N. 40° E. and the dip 45° W. This occurrence is remarkable, because no rocks similar to it have been found in any other part of the area examined.

The whole summit region from Bald Mountain to the high country at the head of North Powder River bears clear evidence of having been glaciated. The higher peaks and ridges are bare, and sometimes polished surfaces are seen, though the rapid disintegration of the rock is apt to soon destroy any such marks. Silver Creek, below Cable Cove, contains morainal material as far down as the junction of the Mammoth road below the Mountain Belle mine, the elevation here being 5,400 feet. McCully Fork, joining Silver Creek near Sumpter, was also occupied by a glacier reaching down to an elevation of 4,700 feet. How far the glacier of the North Fork of John Day descended is not certain, but it pretty surely reached the mouth of the canyon at the road crossing, where the elevation is 5,200 feet.

#### GOLD-QUARTZ MINES.

*General statement.*—The mines of Cable Cove are among the earliest discoveries in the Blue Mountains, being found in 1872 by the Cable Brothers. Some rich ore was shipped in these early years, but the great expense rendered this impracticable for the ordinary run of ore. The development of the district was slow, owing to its inaccessible location. When the overland railroad was completed, about 1885, new activity followed and many claims were worked. Shipments of ore continued at intervals, and one concentrating mill was erected. During 1900 there was more activity than at any previous time. Development work was in progress upon a great number of claims and about ten carloads of ore were shipped to smelting works. Deeper exploration will soon determine the value of the district. At present



A. CABLE COVE, LOOKING EAST.



B. LOOKING SOUTHEAST FROM CABLE COVE.

ore is hauled to Sumpter, the distance being 14 miles, and sent by rail from that point.

The deposits are normal fissure veins with northeasterly strike. One strong lode, the Eagle, is traceable for at least 2 miles, and dips steeply northwest. Most of the other veins are located on the hanging side of the Eagle and generally dip southeast, following an extensive system of parallel shearing planes. One branch of the vein system (Pl. LXIV) extends across to the head of Cracker Creek. The ores consist of heavy sulphurets, chiefly pyrite, arsenopyrite, and zinc blende, with smaller quantities of galena and chalcopyrite. Their value is chiefly in gold, and very little of it is free. Two or three miles to the northwest a nearly parallel vein system appears in the gneiss, among which La Belleview vein is the most prominent. These veins carry a considerable amount of silver besides gold. Finally, in the Monumental, beyond La Belleview vein and really outside of the district, silver is the prevailing metal. The oxidized zone with free gold is only 30 to 50 feet deep, no doubt owing to the ice sheet which once covered this region and which has swept away the decomposed vein croppings. The sulphurets below the water level contain a little free gold.

*Eagle vein.*—The Eagle, which is considered as the mother lode of the district, continuing in strong development for 2 or 3 miles, is the first vein met with going up on the road from Sumpter. The developments and production of the Eagle are as yet comparatively very small, but great hopes are placed in it for the future. It is traceable with a north-northeast strike through the Homestake and Oregon Chief. The Oregon Chief has 800 feet of developments and an ore shoot claimed to be 8 feet wide and containing \$12 per ton.

The vein on the Herculean claim is well exposed by a surface cut at Silver Creek, showing a width of 15 feet between granitic walls. The vein material is an altered granodiorite, traversed by at least two streaks of arsenical pyrite half a foot wide. The vein now turns more nearly northeast, and on the adjoining claim, the Black Dwarf, preparations were made in 1900 to sink a 300-foot shaft.

On the northwest side of Silver Creek the Herculean is covered by the Eagle claim, on which a 400-foot tunnel has been driven. In a width of 15 feet of altered granite the vein here contains overlapping pay streaks from 2 to 3 feet wide, reported to average something like \$12 per ton.

*Imperial mine.*—The Eagle Consolidated Mining Company owns nine claims in the district, among them the Eagle, Imperial, and Winchester. The latter two have been actively worked during the last two or three years. In 1900 160 tons of ore, with a value of \$120 per ton, is reported to have been shipped. The developments consist of 1,500 feet of tunnels. The present working tunnel is located one-fourth mile

northeast of the old California mill, at an elevation of about 7,200 feet, 250 feet below the gap. Several hundred feet of additional backs can be obtained by a lower tunnel about 1,500 feet long.

The claims are located on veins in the hanging of the Eagle lode, which is about 800 feet distant. Northwestward from the Eagle a small vein called the Star is the first met with; then follows the Imperial, and a short distance farther the Winchester. Granodiorite is the country rock in which the inconspicuous croppings appear. The strike is N. 35° E; the dip of the Imperial 70° SE., while the Winchester is nearly vertical. The veins are from 3 to 4 feet wide, the vein matter consisting largely of granodiorite slightly crushed and darkened by the spreading of chloritic material. The pay streak is usually on the hanging wall and consists of from a few inches to a foot of nearly massive sulphurets with a small quantity of quartz and calcite gangue. Surrounding the pay streak is a belt a few inches wide of white, soft

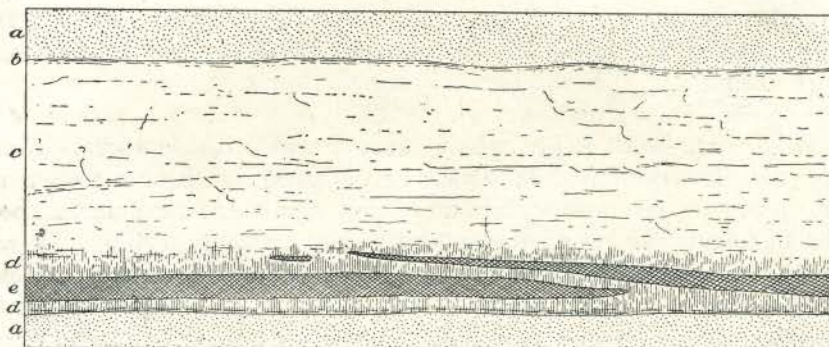


FIG. 82.—Structure of vein in Cable Cove district; width, 4 feet; horizontal projection; *a*, fresh granodiorite; *b*, hanging wall with clay gouge; *c*, crushed granodiorite; *d*, altered (sericitized) granodiorite; *e*, sulphurets with little quartz and calcite.

granodiorite, thoroughly sericitized and carbonatized. Seams striking in a northerly direction and dipping 70° W. come in on the Winchester from the hanging wall, but do not cut back into the foot wall. They carry circulating water and sometimes contain a little quartz and altered granodiorite. Both vein walls and seams show a horizontal striation.

The ore, most of which is high grade, occurs in irregular and overlapping lenses (fig. 82). The seams mentioned generally cut off the ore, the latter usually reappearing a few feet farther on. Material with over \$25 per ton is shipping ore. The 160 tons shipped in 1900 are stated by Mr. F. C. Cabell to have contained as high as 6 ounces of gold and 80 ounces of silver per ton. While the principal values are thus found in narrow streaks of rich ore, there are also in places, especially in the Imperial, smaller shoots, a few feet wide, of second-class concentrating ore. The stopes above the tunnel level are 150 feet high.



The ore minerals are galena, arsenopyrite, chalcopyrite, and pyrite, with a little zinc blende. The galena appears to be the earliest mineral and is often cemented by the others. Massive structure prevails. These sulphurets contain a little free gold, apparently chiefly connected with the galena and the zinc blende. About 10 per cent of the total gold can be recovered by amalgamation. Some nearly pure galena was assayed and contained 0.74 ounce gold and 60.86 ounces silver per ton. The arsenopyrite contained 5.82 ounces gold and 7.08 ounces silver per ton.

*California mine.*—The California claim is 1,200 feet to the northwest of the Eagle vein, and is one of the oldest mines in eastern Oregon. It was located in 1873, and in 1876 the upper tunnels were begun. At that time there were only two other quartz mines in operation, the Monumental and the Virtue. In 1878 half a ton of ore, assaying \$500 per ton, was packed on horseback to Umatilla and thence shipped to San Francisco. In 1896 a shipment of 5½ tons is reported to have yielded \$105 per ton. Further shipments were made in 1893 and 1894 of ore assaying \$60 to \$80 per ton, and in 1897 several carloads were produced.

In 1897 a 10-stamp concentrating mill was built and run with unsatisfactory results for a short time. It is claimed that the whole width of the vein was milled, thus reducing the grade of the ore too much. During 1900 five cars, or 100 tons, are reported to have been shipped. The total production is not known, but probably does not exceed \$40,000. The developments consist of 2,000 feet of drifts and crosscuts divided among six tunnels. The lowest working tunnel from which ore was extracted in 1900 is located on the steep slope 400 feet below the croppings. Its elevation is about 7,200 feet, its length 635 feet. A new crosscut, to be 900 feet long, is now in progress 400 feet lower down, 1,300 feet below the summit of California Mountain and 800 feet below the croppings.

Similar to the other veins northwest of the Eagle, the California shows inconspicuous croppings in granodiorite, strikes northeasterly, and dips steeply southeasterly. There is also on the property another parallel vein on which little work has been done. The ore is similar to that of the Imperial, consisting of heavy sulphurets in a gangue of little quartz and still less calcite. The ore seems principally of the shipping order, forming narrow streaks in a 3-foot-wide vein.

*Other claims.*—Above the mines just described California Hill is traversed by a great number of shearing planes, along nearly all of which more or less ore has accumulated. The developments are generally confined to short tunnels and small shafts. The extension of the Imperial is probably found in the Last Chance on the John Day side of the hill. From a tunnel on that claim some arsenical ore has been shipped. The probable continuation of the California is found

in the Ivy May. In the gap toward Bald Mountain is the Crown Point (elevation of croppings, 7,500 feet), which shows on the surface as a rusty belt of granitic rock traversed by seams of quartz and pyrite. An 800-foot crosscut tunnel is now being driven on this claim.

On the ridges between Bull Creek and John Day River,  $1\frac{1}{2}$  miles north of the California, is a group of veins with an east-northeast strike to which much attention has been directed lately. Among them is the Baby McKee vein, which is now being tapped by a 2,000-foot-long crosscut tunnel.

Other groups of veins extend with a northeast or east-northeast direction to a point 3 miles east-northeast of the California. Near the head of Cracker Creek,  $2\frac{1}{2}$  miles above the North Pole vein, this vein system crosses the contact of granodiorite and argillite. At least two veins enter the dark-gray, somewhat contact-metamorphic argillite. The Silver King, at an elevation of 7,000 feet, is developed by a tunnel 200 feet long and shows comb quartz with cubical pyrite; the width of the vein is 5 feet. Another vein, south of the Silver King, the Emma, is opened by a tunnel on creek level at an elevation of 6,400 feet; it strikes about east to west and dips  $60^{\circ}$  S. The width is 2 to 3 feet between walls, with a 6-inch pay streak of quartz, calcite, pyrite, and arsenopyrite. The principal value is in gold. This locality is called Quartz Basin, and some years ago a 5-stamp mill was erected here. The ore proved only partly amenable to amalgamation.

Out on the long ridges between Bull and Lake creeks are other veins which have been prospected recently. Having the same easterly to northeasterly strike, these veins are inclosed in a normal biotite-gneiss, which begins near the Rob Roy claim and continues several miles beyond La Belleview mine.

#### CAMP CARSON DISTRICT.

The mountainous and heavily timbered country north of Cable Cove does not contain extensive mineral deposits. Camp Carson, 20 miles in an air line north of Sumpter, is the principal mining district known in this region. Lying at the western foot of the high granite peaks of the Elkhorn Range near the head of the Grande Ronde River, it is accessible only by wagon road via Granite and Woodley, or by going up the Grande Ronde Valley from the town of Hilgard. This district was not visited; the following notes were obtained from Mr. Imhaus, of Baker City:

The formation is reported as granite. Near Hunters,  $3\frac{1}{2}$  miles below Camp Carson, on the Grande Ronde, are prospects on gold-quartz veins containing much sulphurets. Among them are mentioned the Royal, 6 miles south of Woodley. The vein is said to be

7 feet wide and to contain chalcopyrite and galena rich in gold. From the Pay Boy,  $1\frac{1}{2}$  miles southwest of Woodley, two carloads of ore are said to have been shipped. From the Muir zinc blende and galena, with good silver value, are reported.

Old placers have been worked in the Grande Ronde below Camp Carson, and also on Limber Jim Creek, 6 miles northward. Camp Carson itself is located at the head of Tanners Gulch, 1,200 feet above Grande Ronde River. These high placers contain a large body of well-washed, cemented, coarse gravels, presenting a bank 2,500 feet long and generally 15 to 20 feet high. This body of gravels is not exactly situated on the divide, as there are granite hills rising behind them; but it is apparent that they must have been deposited by a river system at very different level from that of to-day, and it is probable that they should be placed in the same category as those of the Griffith claims below Bald Mountain (p. 688).

While the gravels contain gold, their cemented nature interferes with the normal hydraulic process. A French company bought the deposits some years ago and installed hydraulic works, but the enterprise did not succeed well and the property was recently sold at auction.

#### GRANITE DISTRICT.

##### GENERAL FEATURES.

Under the Granite mining district will be described the headwaters of the North Fork of John Day River, Granite Creek, and its various tributaries above the town of Granite. The North Fork heads among the granite peaks of the northern Elkhorn Range, near Cable Cove, and flows in a general westerly direction for 20 miles. At this distance from its source it receives the tributary of Granite Creek, the different branches of which head in the gulches scoring the flanks of Bald Mountain and the ridge extending southeasterly from it toward Sumpter. From Bald Mountain northward the headwaters are among high and bare peaks, once glaciated, with elevations of about 8,000 to 8,500 feet. But the whole western part of the drainage area is a maze of deep gulches and moderately sharply cut canyons, separated by long timbered ridges which rarely attain elevations over 6,000 feet. The elevation at Granite is 4,680 feet. The region embraces old placer mining districts worked since 1863, and, as well, some of the most promising quartz mines developed in the last few years. The old mining town of Granite, which has recently acquired new life, is in the center of the area. A new town, called Lawton, has recently been started 2 miles below Granite. The region is splendidly watered and heavily forested, though there is but little yellow pine. The quality of the timber is not nearly so good as in Burnt River Valley and on the Middle Fork of John Day.

## GEOLOGY.

Among the older rocks the argillites of the sedimentary series are the most extensively developed formation. They form a large area extending from the granodiorite of Bald Mountain westward until, below Granite, they are covered by basaltic flows. South of the Sumpter-Granite road they are especially prominent. The dark siliceous argillites prevail, but fairly fissile, black, and normal clay slates are not absent. No limestone was noted, neither have any fossils of any kind been found, so that the age of this formation is an open question. It is, however, clearly the continuation of the series developed at Sumpter and, like those series, may provisionally be regarded as Carboniferous. The strike and dip of the strata are not always easy to determine, on account of the massive character of the siliceous argillites; on the whole the strike is a few degrees north of west and the prevailing dip is southerly at steep angles. But in the vicinity of intrusive granodiorite or diorite this strike is frequently deflected. Thus the strike follows the contact of the Bald Mountain granitic area with northwesterly direction and dips of from  $60^{\circ}$  to  $80^{\circ}$ , and again near Alamo a northwesterly direction and northeasterly dip of  $60^{\circ}$  to  $70^{\circ}$  obtain. At Red Boy mine the clay slates appear in a very exceptional flat position dipping  $15^{\circ}$  W. These deviations are doubtless explained by the presence of intrusive diorites just west of these localities. Near the Bald Mountain contact the slates are contact metamorphic and schistose, while the alteration near the diorite of Greenhorn Mountain is less conspicuous.

The intrusive rocks include granodiorite and diorite. The granodiorite area of the northern Elkhorn Range and Bald Mountain projects southward from the latter peak along the ridge separating the drainage of Powder River from that of John Day, and it extends a little south of the point where the Granite-Sumpter road crosses that ridge. The rock is here coarse grained and dark; in fact, approaches closely to a normal diorite. Diorites of more basic character and closely connected with gabbro and serpentine appear west and southwest of Red Boy mine. Again, 8 miles north of Granite, on the north side of John Day River, a medium-grained, dark diorite appears rather extensively. The canyon below Klopp's placers is cut in this diorite, which often is irregularly crushed and recemented like the rocks described from the Virtue mining district and the southern end of the Elkhorn Range.

On Onion Creek and Lake Creek, north of Bald Mountain, an area of normal gneiss appears, which has already been described under the heading "Cable Cove" (p. 672).

The Neocene volcanic rocks are represented by andesite and basalts, which, however, do not cover as large areas as farther south; but

there is reason to believe that the basalts occupy vast areas north and northwest of Granite, down the North Fork, and on the Grande Ronde. Rhyolites are apparently not represented. A gray, in part tuffaceous hornblende-andesite fills the bottom of Bull Run from 5 miles above Granite to a point on Granite Creek a short distance below the town. The thickness of the flow is from 50 to 100 feet. The same rock also appears on Granite Creek, 4 miles above the town. Post-andesitic erosion has almost cut through the flow, so that narrow bluffs remain on both sides of the creek. The rock is compact and easily dressed, and can be used with advantage as foundations for machinery and boilers. Whether the andesite is older or younger than the basalt is not definitely settled. It certainly has the appearance of being covered by basalt, and this would correspond to the sequence established in the Burnt River drainage.

Normal olivine-basalts cover small areas near the Powder River divide where crossed by the Sumpter-Granite road. A small patch was also found at the Griffith placer mine, north of that road. Again, on the road leading by the Magnolia mine to Klopp's placers, on the North Fork, basalt begins near the divide at an elevation of 5,600 feet and continues northward over Crane's flat toward Klopp's placers and eastward as far as the Grizzly mine, on Onion Creek, below La Belleview. Over this area the flow, which appears to be rather thin, is largely covered by clays and gravels.

The largest basaltic area is that which begins just below Granite and extends high up on the hills north and south of the creek. Bluffs of basalt line the creek at least down to 4 miles below Granite, and their elevation is not less than 5,000 feet, or 700 feet above the stream bed. On the south side these basalt flows connect with the large areas surrounding the headwaters of Desolation Creek and Olive Lake. The points of eruption of this basalt must have been located on the higher slopes of the Greenhorn Mountains.

It is clear that these basaltic flows dammed Granite Creek, and probably also the North Fork, to an elevation of at least 5,000 and possibly 5,500 feet, creating even more favorable conditions for the accumulation of sediments than in the upper Powder River and Burnt River valleys.

This damming explains many peculiarities in the upper drainage of Granite Creek. Soft sediments, similar to lake beds, are found in many places, and, resting on them, auriferous gravels which could not possibly have attained such positions except through a considerable elevation of the base-level (see description of Griffith's placers, below). The erosion has proved more active on this side than on the southern side of the mountains, which, indeed, was to be expected, as erosion has cut down much lower on the northern side. The barrier has been almost entirely cut through and the greater part of the sedi-

ments swept away. If we place the accumulation of the beds behind the barriers in the late Neocene (Pliocene), it is probably correct to refer the cutting of the canyon in the basalt to the early pre-Glacial part of the Pleistocene period.

The Pleistocene deposits are confined to the present river beds and the low benches, as well as to the moraines. The bottoms of Granite Creek and Bull Run as far as 4 or 5 miles above Granite are filled with gravels, forming a continuous flat up to a few hundred feet in width. For several miles below Granite the creek bottom continues several hundred feet wide and filled with tailings. Gravel benches sometimes occur along the banks from 25 to 50 feet above the creek.

Moraines are not extensive in this district. The gulches leading down from the north slopes of Bald Mountain were filled with glaciers, and it is probable that the moraine extended down to Klopp's placers (elevation, 5,200 feet).

Another center of former glaciation is in the Greenhorn Mountains. On their northern slope smaller glaciers descended as far as Olive Lake.

#### GOLD-QUARTZ VEINS.

*General statement.*—The important veins in the Granite district are chiefly contained in the argillites, and present in general a similarity to those of Sumpter and Cracker Creek districts. There are two prominent vein systems: The first extends from the Cougar mine in a northeasterly direction toward the Magnolia and Buffalo, and the veins dip southeast at steep angles. The second is developed near the Red Boy mine, the veins having a northerly strike and dipping west at angles of from  $50^{\circ}$  to  $70^{\circ}$ .

*Red Boy mine.*—This well-known property is situated on Clear Creek 15 miles in an air line west-northwest of Sumpter and 4 miles from Granite. The elevation of Clear Creek at the mill is 4,610 feet (by level), and the tunnel level is only about 60 feet higher. Heavily forested ridges surround the mine. The Red Boy for many years was worked intermittently and with indifferent results. Two mills were erected on it, each failing to achieve success. After that, Messrs. Taber and Godfrey, the present owners, built a small Crawford mill, which did excellent work for some time. Finally, in October, 1898, the present 20-stamp mill was installed, which has run uninterruptedly and successfully until the present time. As is so often the case, data regarding the total production were not obtainable, but as the mill is currently credited with turning out from \$12,000 to \$27,000 per month, it may be presumed that the total production since 1898 has not exceeded \$300,000. The property is equipped with a 20-stamp water-power mill with amalgamating plates and 8 vanners. The low-grade concentrates are treated without roasting in a small cyanide plant, the

percolation extending over thirty days. This would indicate that value is in free gold adhering to the sulphurets.

The developments on the adit level consist of a main crosscut 1,200 feet long, 470 feet below the summit of the croppings, and drifts aggregating 3,000 feet. At present sinking is in progress on a vertical shaft located on the surface a short distance above the tunnel (Pl. LXXI, *B*).

The country rock is a black argillite, not very fissile, but showing its stratification fairly plainly. The strata are here unusually flat, dipping about  $15^{\circ}$  W. The argillite, which changes in character from siliceous to calcareous, is in many places cut by light-gray, extremely altered porphyritic dikes, which have the appearance of cutting across the vein and faulting it. It is believed, however, that the veins are really later than the dikes; that the fissures in crossing them were, as often happens, split up in stringers; and that a subsequent movement has occurred along the walls of many of the dikes, so that the veins now appear dislocated by them. The dikes are so greatly altered that their original character is in doubt. Probably they were originally granite-porphyrines, but now consist chiefly of quartz, calcite, and pyrite. Several of them are seen in the crosscut to the vein, one being 60 feet wide.

There are three veins, the Blaine, Red Boy, and Monarch, all of them having an approximate northerly strike and a varying westerly dip. The Red Boy dips  $80^{\circ}$ , the Monarch  $50^{\circ}$  to  $60^{\circ}$ . The outcrops are not very prominent, and the pay shoots not conspicuous on the surface. The general structural relations are diagrammatically shown on fig. 83. The Blaine is located 300 feet west of the Red Boy, and has not yet been struck in the crosscut. It appears on the surface as a wide vein with fair values. In their general character the veins are similar to those of Cracker Creek, though they are not so wide. They consist of a crushed fault zone in argillite, from 3 to 15 feet wide, in which the broken rock is cemented by a great number of quartz seams. The two veins converge slightly and nearly meet at a main porphyry dike dipping  $60^{\circ}$  S., along which they have been sharply cut off by a smooth fault. The veins have not yet been found beyond the dike, though from surface indications it is probable that the northern block has moved, relatively, 400 feet to the east. A similar dike, 10 feet wide, faults the Monarch vein 10 feet through all levels, the throw being in the same direction as that along the big fault. Another dike cuts across the Red Boy horizontally, and still another has produced a sharp twist of the vein in the same direction.

The structure of the vein is well shown on Pl. LXV, *B*, which is drawn from a photograph of a stope on the Monarch vein a short distance above the tunnel level and near the northern end of the shoot. The foot wall of the Monarch is usually smooth and sharply defined,

while the hanging is less well marked, a definite wall being often entirely absent. The width between walls varies from 5 to 7 feet. The vein matter is a black, crushed slate, and sometimes, also, masses or bunches of soft porphyry, both containing finely divided pyrite. This vein matter is traversed by a number of small quartz seams, rarely over 4 inches wide. Most of the seams are on the foot-wall side and produce a banded appearance of the vein. The best pay is contained in the 2 feet on the foot wall, though the whole width is mined. In a few places on the Monarch vein bunches of 5 to 6 feet of solid quartz were found. The seams usually show clearly defined comb structure,

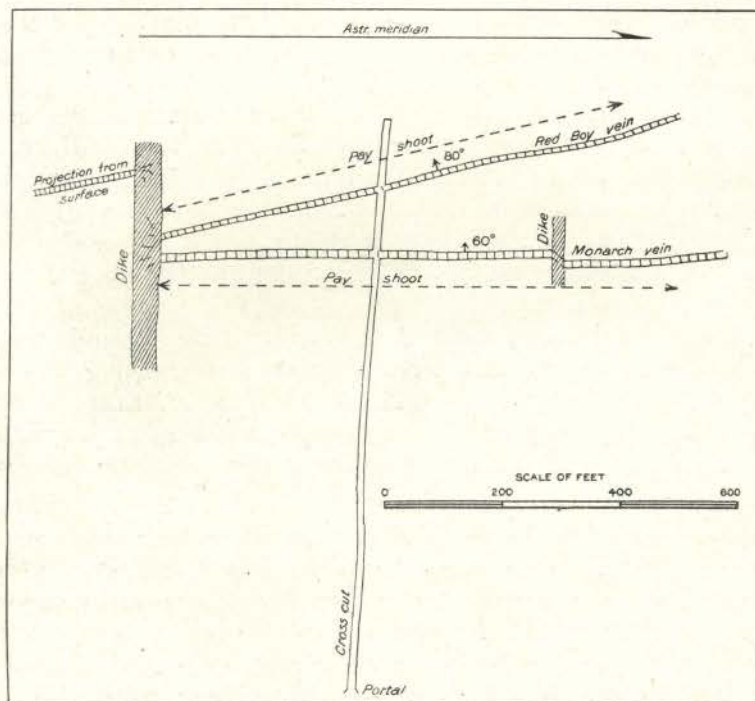


FIG. 83.—Approximate plan of Red Boy mine on tunnel level.

the crystals projecting from both sides of the seams meeting in a median line. There is no evidence of surface oxidation of the Monarch on this level.

The Red Boy vein averages from 3 to 6 feet in width and is in general structure similar to the Monarch (fig. 84), though the quartz is apt to form somewhat heavier bodies. It also contains more clay than the Monarch vein.

The value of the ore appears to be entirely contained in the quartz seams and consists chiefly in free gold alloyed with much silver, the bullion being from 515 to 525 fine. The quartz contains a small amount



of sulphides, pyrite with very little chalcopyrite, and arsenopyrite. In some parts of the mine cinnabar and native mercury have also been found. This is given on authority of Mr. J. Arthur, an assayer at Sumpter, who also states that at one time, when the Crawford mine was running, more mercury was obtained from the amalgam than had been added. Metallic silver and copper have also been found on the Monarch vein, inclosed in white massive quartz, and thus probably primary. The 5 per cent sulphurets contained in the ore are low grade, from \$5 to \$20 per ton, and probably are largely contained in the slate milled with the quartz. The average ore is reported to run about \$12 per ton.

The ore shoots on the two veins almost coincide in extent, and it is said that even the richest places in them correspond. On the surface, however, the pay shoot of the Red Boy was only 100 feet long, and that of the Monarch did not reach the surface at all. The horizontal extent on the tunnel level is 800 feet. North of this the Monarch vein consists of crushed slate with small stringers of quartz. Considerable ore bodies still remain above tunnel level.

*Claims near the Red Boy mine.*—Among the many more

or less developed claims near the Red Boy is the May Queen, which is about one-fourth of a mile distant, and, with four claims, covers the northerly extension of the Red Boy veins. The developments on the May Queen and adjacent claim consist of about 1,600 feet of tunnels and crosscuts, opening the vein to a depth of 350 feet below the croppings. In general character the ore is dissimilar to that of the Red Boy. A mill was erected during the winter of 1899-1900, but was run only a short time.

The Concord group of four claims adjoins the Red Boy on the west, and a considerable amount of prospecting work has been done here also.

*Cougar mine.*—About 4 miles north of Granite and only a short distance from the Magnolia is the Cougar vein. The elevation is 5,300 feet, and, like the Magnolia, it is not far from the main divide between Granite Creek and North Fork of John Day. Its discovery is of comparatively recent date. During 1900 it was actively worked, and a small cyanide plant had just been erected. The treatment of the ore seems to offer some difficulties, like that of the Magnolia.

The developments extend over a vertical distance of 200 feet and

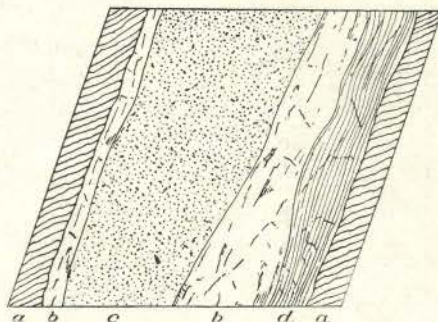


FIG. 84.—Vertical section of Red Boy vein in stope 100 feet above tunnel level; a, slate; b, quartz; c, soft altered porphyry; d, clay.

consist of several smaller tunnels and shafts. The lowest tunnel, on mill level, strikes the vein after a short crosscut and follows it for 900 feet. The country rock is a black, siliceous argillite of imperfect fissility. Its strike near the tunnel is N. 80° E., and the schistosity nearly vertical. The outcrops are not conspicuous, and show plainly only on top of the ridge. The strike is due northeasterly and the dip 60° to 70° SE. The Cougar vein forms a sheared zone in the argillite from 2 to 10 feet in width, and is marked by two not very well-defined walls and several subordinate slips. There is a little quartz with some pyrite, but this is said to generally carry low values. The ore streak is formed by the soft, whitish gouge of varying width which follows the vein. Some of this is stated to be very rich, and the whole length of the main tunnel is claimed to be in ore. The values gradually shade off toward the outside, so that it would seem that, in contrast to many other slate veins, this is a typical replacement vein. The gouge, and also to some extent the slate adjoining the vein, carries finely divided pyrite and marcasite, and probably also a very small amount of arsenopyrite. There is no free gold even in the surface ore, and the concentrates are poor, running from \$5 to \$7; consequently, considering the value of the ore, it was believed that the cyanide process might be applicable. A sample of the soft gouge said to constitute the best ore yielded 0.68 ounce gold and 23.88 ounces silver per ton. Half a mile to the southwest is the South Cougar, supposed to be located on the extension of the Cougar vein.

*Magnolia mine.*—This is located about 5 miles north-northwest from Granite. The road leads up Granite Creek for 4 miles and then up a narrow gulch for 1½ miles. The elevation at the mill is 5,300 feet. Ascending some hundred feet farther brings one to the summit of the divide between the North Fork of John Day and Granite Creek.

The Magnolia mine was bonded in 1899 by English capitalists and a 10-stamp mill erected. Work was discontinued after a short run, and in the summer of 1900, when visited, the mine was idle and a large pile of concentrates heaped up outside the mill.

The developments consist in three tunnels, the lowest, at mill level, being 760 feet long, giving a depth on the vein of 286 feet. The two upper tunnels aggregate 550 feet in length.

The country rock is black argillite or clay slate. At Granite Creek below the mine the slates are distinctly contact metamorphosed, indicating the proximity of the granite contact. The slates near the mine show distinct fissility, strike N. 35° W. and dip 60° SW.

The vein strikes northeasterly and is said to show from 3½ to 14 feet of mixed quartz and slate. In tunnel No. 1 two pay shoots are reported, 190 and 140 feet long; and in the middle tunnel is another pay shoot, 400 feet long. In all about 30,000 tons of low-grade ore are said to be in sight. The richest ore is found in the upper tunnel.

It is stated that during the short run 2,000 tons of ore, with a value of \$9 per ton, were treated. Only a small percentage of the assay value was saved. The ore contains a considerable amount of pyrite. The concentrates were found to assay 0.94 ounce in gold and 1.38 ounces in silver per ton.

*Blue Ribbon and Buffalo mines.*—These are located in slate on the main ridge a couple of miles northeast of the Magnolia, and may be considered as in the extension of the Cougar-Magnolia vein system. The claims are developed by tunnels aggregating 800 feet on each and said to show good ore bodies. The Buffalo is opened by a crosscut 300 feet below the croppings, and 300 feet of drifting along the vein has been done.

*Monumental mine.*—This is one of the oldest locations in the district, being discovered in 1874 by Mr. Burnham. Fourteen tons of ore, shipped the same year to San Francisco by pack train, netted \$500, the ore containing much silver and no gold. Some ten years later the mine was sold to an English company, who erected a silver mill to treat the ore. At present it is idle, the last work having been done in 1894. The surface vein crops in granitic rock and has a northeasterly strike. It was 18 inches wide and showed a 4-inch pay streak extremely rich in ruby silver and argentite.

The development consists chiefly in a tunnel 1,400 feet long, 600 feet below the croppings. This tunnel is said to cut 16 veins, generally small and contained in hard rock. The southeasterly vein dips very steeply northwest, the others dipping 35° against it, so that they would eventually join. Higher gold values are found in depth than on the surface.

*La Belleview mine.*—This is also one of the oldest locations, being claimed in 1877 by Mr. F. E. Cabell, to whose kindness the following notes are due. In early days considerable ore was shipped by pack train to Umatilla, and thence by water to San Francisco. A Huntington mill of a capacity of 35 tons per day with concentrators was erected in 1897 and run until 1899. The veins, on which about 7,000 feet of development work has been done, crop in a normal biotite-gneiss, and are located on a main ridge projecting from Bald Mountain toward Granite. The elevation is 6,500 feet; the summit of the ridge above the mine is 7,303 feet. There are two parallel veins with a northeast strike and with a steep northwest dip on the surface, changing to a similar southeast dip in depth. The gangue is quartz with a little calcite. The ore minerals are pyrite, chalcopyrite, galena, pyrrhotite, and strongly argentiferous zinc blende. Among rarer minerals occurring are native wire silver, argentite, tetrahedrite, stephanite and freibergite, the latter containing 1,000 ounces silver per ton.

The ores contain up to 7 per cent lead and  $\frac{1}{2}$  per cent copper; shipping ores run from \$60 to \$600 per ton, one-third of the value being

gold, lately increasing with depth to one-half. The concentrates contain \$60 per ton.

In the canyon leading down from La Belleview mine to the North Fork of John Day are several veins cropping in gneiss. One of these, the Grizzly, is located 2 miles below La Belleview mine and has a north-northeast strike. It is developed by three tunnels and shows on the surface with wide rusty croppings. The gangue is quartz accompanied by much low-grade pyrite in heavy masses.

#### PLACER MINES.

The placers of Granite have been worked since 1862, but were scarcely as rich as those of other celebrated districts. A large part of the mining has been done by Chinese. In 1870 there were 40 white men and 200 Chinese in this district (Raymond's report, 1870). The production is not mentioned. In 1882 the Granite placers produced \$20,000, in 1889 \$20,000, in 1891 \$8,500, in 1892 \$28,800 (Mint reports). The present placer production is apparently fairly steady, a number of small mines having been worked for many years with constant output. The total output does not exceed \$20,000 per annum.

The gravels in the stream beds of Granite Creek, Bull Run, and Clear Creek have been worked, chiefly by Chinese, for several miles above Granite; and below that place Granite Creek has also been worked. The gravels averaged 9 feet deep and from 50 to 300 feet across. Low gravel bars 30 feet above the river were also washed. Work on these gravels ceased about ten years ago.

The North Fork of John Day has been worked from a point 7 miles northwest of Granite, where Thornburg's placers are located, up to Klopp's placers, where the Grande Ronde road crosses the stream. But little gold was found above Klopp's. Thornburg's placers, which were not visited, have been worked steadily for many years, and with an annual output of several thousand dollars.

The Black Pine placers are situated on a small flat at an elevation of 4,800 feet, a mile below the Cougar mine. They have been worked recently on a small scale. The gravels, of coarse argillite cobbles, rest on a bed rock of volcanic breccia. Johnson placers, on Crane Flat, have been worked successfully for many years. A system of ditches and reservoirs supplies water for a long season. Two hydraulic giants are operated. The gravels are said to be unusually rich. The mines are situated a short distance north of the divide separating Granite Creek from the North Fork and at an elevation of 5,500 feet, 5 miles north of Granite. Going up the steep gulch in which the Magnolia mine is situated, one crosses a small basalt flow at the divide. From here down to the North Fork extends strongly contrasting, gently sloping ground with clayey and gravelly soil, covered with poor forest and a succession of flats and meadows. The clays are

covered by thin gravels, which are washed and which probably derive their gold from the Buffalo and Blue Ribbon veins, situated a short distance above on the main ridge.

Klopp's placers are situated on the North Fork, 2 miles north of Crane Flat, the river here having an elevation of 5,200 feet. These diggings have been worked for many years on a moderate scale and are said to have regularly produced from \$3,000 to \$6,000 per year. The deposit is certainly one of the most remarkable that has come under observation.

The clays and sands of Crane Flat continue down to the river and the workings extend in irregular pits up to 130 feet above the stream. There is, as a rule, no bed rock visible, though the sediments lean against a high western rim of diorite in which the river has eroded a narrow canyon; but in one place a projecting point of argillite laid bare by the hydraulic work appears in the diggings, and at another place a small knob of basalt occurred below the gravel. The pay dirt is a most peculiar mixture of sand, fine, well-washed gravel, and heavy, partly rounded boulders of granodiorite and diorite, and also of basalt and slate. The boulders are irregularly mixed in the clayey sand and the gravel, which rarely shows any stratification. In one place, however, strongly pronounced fluvial bedding was noted in a bank of sand underlying 12 feet of heavy boulders mixed with sand. The gold is well washed and generally fine. The gravels are not rich, but the gold seems equally distributed through the mass.

The explanation of this deposit is probably to be found in the damming of the river by Neocene basalt flows to a level of 5,500 feet, and a simultaneous accumulation of gravels in the basin thus produced. There does not seem to be any deep channel through which the North Fork could have found an outlet toward Granite Creek, but the clays and gravels probably do cover the auriferous channel of an old tributary to the North Fork coming down from the vicinity of La Belleview and Buffalo mines. To judge from the granitic boulders so abundantly scattered over this deposit it seems probable that the moraine of the glacier which once filled the upper valley of the North Fork reached down to this elevation and that the Neocene deposit has been worked over by glacial agencies.

Throughout the upper drainage basin of Bull Run above Granite many observations show that, in this watershed also, a damming by basalt flows similar to that below Granite has taken place and that the whole basin once was a lake which received fine sediments and along the margin of which, during its highest stand and during its gradual recession by canyon-cutting, the streams deposited their auriferous gravels. The best evidence of this is found at the Griffith placer mine, located 6 miles northwest of Sumpter. The road from Sumpter to Granite passes over a low gap (elevation 5,800 feet) in the ridge

separating Powder River from the Granite Creek drainage basin. Descending the slope toward Granite, one finds that the diorite of the dividing ridge soon disappears, and at an elevation of 5,300 feet the gentle slopes and small flats are covered with a clayey material with scattered, well-washed gravel. Nearly all the gulches in this vicinity have been worked with more or less success. Two miles below the summit a road leads off to the north, crosses Beagle Creek, and ascends Canal Creek some distance. The latter contains a considerable amount of auriferous gravel still available for placer work.

Griffiths Camp is situated a short distance above Canal Creek, at an elevation of 5,289 feet, or 860 feet above Sumpter. To the west rises the main dividing ridge of granodiorite, about 700 feet above the placers. About the mines there is gently sloping ground, a sort of an ill-defined bench, below which the ground falls rapidly toward Bull Run. The gravel forms a small body on the north slope above Canal Gulch and extends, apparently resting on the slope of the hill, for  $1\frac{1}{4}$  miles in a northwesterly direction. Back of it is high bed rock, but in front the downward slope of the country is unbroken. A hydraulic pit about 1 acre in extent has been made in the high gravels, and a bank 40 feet high is exposed. The gravel is fairly fine, sandy, extremely well washed, and shows fluvial stratification. On the bed rock lie coarser cobbles of slate and porphyry, also well washed. The continuation of this body in a northwesterly direction is not well exposed, but it seems to lie on a slope, and the extent and depth are difficult to estimate. Although a part of the gravel doubtless rests on diorite, the portion exposed in the pit lies on well-stratified beds of clay, with coaly layers dipping  $30^\circ$  toward the main divide. Thirty feet of these clayey beds are exposed, resting on granitic bed rock. The gold in the gravels is fairly coarse, but it is not probable that the material is very rich, though it may well pay for washing. On the slopes below the deposit and in Canal Gulch the gold has been reconcentrated, and these gravels are much richer. A small area of basalt covers a hill rising 150 feet above the gravels and seems to directly overlie the latter.

The water supply is taken from Canal and Boundary creeks, on the western slope of Bald Mountain, the ditches aggregating 9 miles in length.

#### ALAMO DISTRICT.

##### GENERAL STATEMENT.

From the Red Boy to Alamo, a distance of about 4 miles, the argillite continues, no igneous rocks being seen. Near the town of Alamo Clear Creek receives two branches, Olive and Beaver creeks. On all three creeks above Alamo good prospects occur and all of the veins crop in argillite. On Beaver Creek several promising properties are

said to be located, but this part of the district was not visited. The claims described below are situated on Clear Creek and Olive Creek. The creeks have been extensively worked for placer gold, Olive Creek and its upper tributary, Quartz Gulch, being especially rich. A belt of diorite, serpentine, and gabbro begins a short distance west of the Red Boy and continues south, crossing Clear Creek some miles above Alamo. Higher up on its tributary, Spring Creek, at the Little Giant mine, the argillite again appears. The slates near the head of Olive Creek contain strata with detritus of igneous rocks, chiefly surface lavas erupted simultaneously with the deposition. The slates are of the usual character, black clayey argillites, alternating with dark siliceous and cherty rocks. At Alamo the strike is north to northwest, the dip east at angles of  $60^{\circ}$  to  $70^{\circ}$ .

#### QUARTZ VEINS.

*Alamo claim.*—This is located on the ridge between Olive and Clear creeks, three-fourths of a mile west of Alamo, 650 feet above the latter and at an elevation of about 5,550 feet. It was located in 1899 and as yet is not greatly developed. The country rock is a soft, decomposed argillite, in part siliceous. The vein strikes N.  $25^{\circ}$  E. and dips  $60^{\circ}$  ESE. The general character is that of the usual type of composite veins. A maximum width of 20 feet is attained, the vein matter being a brown, soft, decomposed mixture of quartz and argillite. On the well-defined hanging wall is a 4-foot pay streak panning well in free gold, while the whole width prospects more or less. Certain parts of the rock outside of the hanging wall also show good values. On the foot wall lies a 5-inch streak of black decomposed sulphides. The developments consist of a 90-foot crosscut about 70 feet below the croppings, and a 70-foot winze sunk on the pay shoot below this level. The prospect seems promising, although it is probable that the ore will become more base as the present workings are deepened.

*Quebec claim.*—The ridge between Clear Creek and Olive Creek contains many strong quartz veins. About 3 miles west of Alamo is the Quebec, which is rather extensively developed and is said to be a very promising property. It has recently been sold to a company that proposes to erect a mill on the same. The Quebec is developed by three tunnels, the uppermost being 750 feet above Clear Creek, and drifted 240 feet on the vein; the second tunnel, 120 feet lower, is run on the ledge for 500 feet; while the lowest is a crosscut, just started, 400 feet below the croppings. The vein, which crops prominently and strikes northeasterly, consists of the usual brecciated argillite, cemented by quartz, which often shows pronounced comb structure. The width is 10 feet, sometimes increasing to 30 feet. In the vein matter of altered argillite occur spots and streaks of a green, earthy mineral, which is

finely divided chromium mica (fuchsite or mariposite). It is claimed that there is a pay shoot, 4 feet wide, of good milling ore, containing, in places, bunches of richer ore with visible gold; some of the latter ore is reported to have been shipped.

*Other claims.*—Near the Quebec is the mine of the Scandia Tunnel Company, which is working on a long crosscut tunnel running in under the ridge to top ledges cropping near the summit. On the north side of the creek, near the junction of Clear Creek and Lightning Creek, is the Wilson vein, its croppings showing prominently 100 feet above the creek. The croppings, which are traceable for several hundred feet, with a direction of N. 35° E., consist of the usual zone of crushed argillite cemented by quartz. Green stains of chromium mica are common in the slate inclosed in the vein. The developments consist of a tunnel giving a depth of 70 feet.

On the south side of Clear Creek, at Alamo, a 450-foot tunnel, 25 feet above the creek, has been driven by the St. Anthony Mining Company. In this distance the management claims to have crosscut four large lodes, 60, 50, 152, and 35 feet wide. It appears very clear that these "lodes" are nothing but slightly mineralized strata of the argillite cut about perpendicular to the strike. The croppings above the tunnel show nothing but heavy benches of siliceous argillite with northwesterly strike and steep southwesterly dip. The rock throughout the tunnel is soft, crushed, and decomposed—a light-gray argillite filled with light-green streaks of earthy chromium mica, and in places cut by seams of quartz, calcite, and pyrite. A great number of assays have been made, and all are said to show a minute quantity of gold. The occurrence is of interest as showing an extensive impregnation of the country rock by auriferous solutions.

Conditions similar to these appear to occur in Nevin's claim, near the town of Granite, where a 200-foot tunnel has disclosed soft slate filled with little bunches and lenticular masses of quartz and calcite and small seams of pyrite; also the same chromium-stained green spots in the slate so often noted from this region. This is probably also a case of impregnation along certain strata of argillite. Small assay values are constantly obtained.

*Strasburg claim.*—This is located 1 mile above Alamo, on the west side of Olive Creek. The developments consist of several shorter tunnels and a 500-foot crosscut from the creek level at an elevation of 4,950 feet, not yet completed. The steep slopes, adjoining a gravel flat in which Olive Creek flows, consist of very decomposed siliceous argillite without clearly defined strike, and contain dikes of a likewise soft and decomposed porphyry, probably a granite-porphry. There are two adjacent veins, one of which shows an outcrop of quartz with argillite fragments, 300 feet above the creek and 25 feet across. This is reported to average \$5 in gold, one 4-foot streak showing better



values. An intermediate tunnel exposed both veins, which are here of only moderate size; the one carrying the big outcrop is here less than 1 foot wide.

*Yellowstone and Van Anda claims.*—Across Olive Creek from the Strasburg is the Yellowstone, opened by a 600-foot crosscut. Several other lodes are found on that side of the creek, all having a north-easterly strike.

Two miles farther up Olive Creek, also on the west side, are the Van Anda claims, which are said to cover strongly pronounced croppings similar to the Strasburg and other argillite veins. The developments are not very extensive.

*Little Giant mine.*—At the foot of Greenhorn Mountain, near the head of Spring Creek, is located the Little Giant mine. The elevation is 5,911 feet. The road from Alamo, which is 6 miles distant, follows up Spring Creek through thick timber. Though placers were formerly worked in this creek, no quartz vein had been found until in 1898, when this mine was uncovered. The following year it was sold for \$30,000, according to report; developments were begun and a 20-stamp mill was ordered. On account of various financial vicissitudes, all work was suspended in the summer of 1900, though later on work in the lower tunnel has been resumed.

The developments consist of a 40-foot shaft on the croppings (elevation 6,240 feet) and an upper tunnel 80 feet lower down; this is a crosscut for 300 feet and the ledge has been drifted upon for 200 feet. The lower tunnel, 350 feet below the croppings, is at present 850 feet long, but had not, when visited, reached the vein.

Along Spring Creek, the prevailing rock is serpentine and diorite; but at the mill is a contact, and the whole east side of the gulch is composed of dark-gray, massive argillite. The vein strikes due northeast, while its dip is as yet unknown. The croppings do not show prominently, but are well exposed by means of trenches. Good pay is reported all along the surface for 600 feet northeast. Toward the southwest the serpentine contact is not far away and the vein does not seem to be traceable across it.

In the upper tunnel the usual character of veins in argillite is shown. It is a belt of crushed argillite, in places reaching 20 feet in width, filled with quartz seams and locally crushed and clayey. Much of the quartz is stained green by chromium mica, the metal probably being derived from the adjoining serpentine. No pyrite is visible in the decomposed quartz. The seams, as usual, show clearly defined comb structure, indicating deposition in open space, and the argillite is not much silicified.

The lower tunnel, as stated, has not yet cut the main vein, but has encountered two others, not known on the surface, which is covered by débris. The first of these was found 300 feet from the portal, strikes

northeast, is vertical, and consists of the usual quartz-cemented argillite, 3 feet wide. It is said to carry good value. The next, 800 feet from the entrance, strikes east-northeast and dips  $45^{\circ}$  SE. It is 1 to 2 feet wide and carries much pyrite and arsenopyrite.

#### PLACERS.

The streams above Alamo—Beaver Creek, Clear Creek, and Ruby Creek—are filled with gravel to a depth of 15 feet and a width of from 50 to several hundred feet. All of these water courses have been washed, though few placers have records of having been extraordinarily rich. Old placers on low gravel benches are also found on Spring Creek, a mile or two below the Little Giant mine. Most of this kind of placer work has been done by Chinese. Olive Creek and Quartz Gulch are the localities reported richest. For a mile or two above Alamo, Olive Creek widens considerably, but the gravels in this flat are said to have been too deep for successful work by old methods. If found rich enough they might be successfully dredged. Quartz Gulch, coming down from the vicinity of Robinsonville, is said to have been especially rich. The gold ranges in value from \$14 to \$17 per ounce, the poorest quality being found high up on the creek, where much ragged quartz gold appears. On the road from Olive Creek to Robinsonville, near the divide toward Lightning Creek, a patch of rhyolite covers the slates, and on this rhyolite, at an elevation of 5,500 feet, rests a small body of auriferous gravels, which have been worked to some extent. This is another instance of the high gravels which are found in the Granite Basin about elevations of from 5,300 to 5,500 feet, and which indicate a damming by basaltic flows to this depth.

The Olive Creek mining district was organized in 1863, and in 1870 80 white men and 50 Chinese were at work. About 1873 the yield began to decline. In 1882 15 white men and 20 Chinese were at work, and the placers are reported to have yielded \$13,000. Since then the production from this source has steadily diminished, and at present but little placer work is being done.

#### GREENHORN DISTRICT.

*General statement.*—This district, situated in the Greenhorn Mountains, embraces an approximate area of 18 square miles, extending for 6 miles east to west and 3 miles north to south. Greenhorn Ridge forms a high backbone, with bare summits, dividing the waters of the Middle Fork from those of the North Fork of the John Day River. It culminates in Greenhorn Peak, with an elevation of 8,130 feet above the sea, situated at the head of Clear Creek. The vicinity of this peak is the highest portion of the ridge; eastward, it falls off toward Robinsonville; westward, the ridge continues with an eleva-

tion of above 7,000 feet for about 10 or 12 miles, when it gradually sinks. A prominent gap, at an elevation of 7,200 feet, exists in the eastern part of the ridge at the head of Boulder and Desolation creeks. As may be expected, the climate is rough and means of communication are scant. One principal wagon road leads up Clear Creek from Alamo, climbing a long ridge which finally reaches the summits and the gap mentioned by way of the Ben Harrison and Potosi prospects. Another road leads up to the Intrinsic group from near Robinsonville. West of Boulder Creek there are no roads and few trails. Aside from a few sharp peaks the summit of the ridge is rather flat, and is sometime half a mile or a mile broad, sharp ravines being incised on both sides.

Geologically, Greenhorn Ridge is composed of an oblong area of older rocks, surrounded on the north and south at a lower level by lava flows in which the North and Middle Forks of John Day River have cut their broad canyons. The older rocks extend eastward with lower elevations, and connect with Bald Mountain and the Elkhorn Range. Westward their extent is not known, though they are ultimately submerged below basalt; but there are considerable areas of diorites and slates in the lower drainage of the Middle Fork and on Desolation Creek. The larger part of the ridge consists of diorite, gabbro, and serpentine, with minor areas of contact-metamorphic slates. The ridge north of Clear Creek consists of hard, dark-gray to light-gray diorite and quartz-diorite. A short distance above the Potosi contact-metamorphic slate with varying strike (at the road the strike is east-west, dip vertical) begins, but is not extensive. It is cut by areas of dark-green serpentine weathering brown. At Boulder Gap the rock is a light-gray granodiorite or quartz-diorite. This continues down Boulder Creek on the east side as far as the Ornament claim, and still farther down on the west side, when serpentine and slate again begin. The same rock forms the broad and high ridge east of the gap, in which but few prospects are known. Patches of basalt cover the ridges in places, especially west of the gap.

The deposits are fissure veins carrying their value chiefly in silver, thus differing from the auriferous character ordinarily found in this region. Few of these deposits can be ranked as mines, inaccessibility and expense of treatment having retarded this section very much. A few of the claims, among them the Ornament, Tempest, Ruby, Carbonate, and Potosi, were visited; regarding some of the others reliable information has been gathered.

The silver veins of the Greenhorn Mountains have been known at least twenty years, and smaller developments are noted in the Mint reports of 1890 and 1891. Lately they have been prospected more extensively.

Rich silver ores have at intervals been shipped to the smelters in

small quantities from these prospects, the Tempest being the largest producer, with 180 tons. The expenses are very high, so that ore, to be profitably shipped, must contain at least \$25 per ton. The ore must be hauled 35 miles over difficult roads to Sumpter, loaded on cars there, and reloaded on the main line at Baker City. Further, they are not very desirable smelting ores, containing no lead, but often, on the contrary, arsenic and zinc in quartzose gangue.

The ore consists of two classes: (1) Pyritic ores with pyrite, arsenopyrite, and zinc blende. These occur as seams and veinlets in large veins of altered quartz-diorite. (2) Tetrahedrite ores, consisting of irregular masses of this mineral in wider bodies of quartz. The developments are scarcely extensive enough to prove whether large masses of low-grade ore occur. If so the first class can, no doubt, be economically concentrated, but to the second this procedure is only applicable with considerable loss on account of the soft character of the tetrahedrite, which is apt to cause rich slimes.

*Description of veins.*—Near the eastern end of the high ridge are several important groups of claims.

The Intermountain group (also called the Snarr), about 3 miles due west of Robinsonville, was located in 1890 and is said to show three well-defined quartz veins in diorite and greenstone. The strike is northeast, the dip nearly vertical. The ore consists of quartz gangue with tetrahedrite, rich in silver, and the pay streak is reported 3 feet wide. Ore to the value of \$5,000 has been shipped.

The Intrinsic group, in the same vicinity, also known as the Ordway mines, is said to contain two veins converging to one at a depth of 100 feet. The developments consist of a tunnel 800 feet long. The ore is similar to that of the Intermountain, consisting of quartz gangue with irregular grains of tetrahedrite.

A few miles farther west, on the Summit plateau, is the Morris, likewise containing rich tetrahedrite and credited in the Mint report of 1891 with a production of \$15,000 in silver and \$3,400 in gold. A short distance northwest of the Morris are the Mountain Consolidated, Potosi, and Savage claims, at an elevation of 7,200 feet, all fissure veins in fine-grained diorite, and developed by short tunnels. The strike of the Potosi vein is N. 20° E., the dip 40° E. The gangue is quartz, in part with comb-structure and sometimes frozen to the walls. The width is moderate and the ores consist of pyrites, arsenopyrite and zinc blende, with a little chalcopyrite and bornite. The values are chiefly in silver, but with a little more gold than is usual in the Greenhorn veins. In 1900 about 80 tons of ore were shipped to smelter, and reported to contain \$53 per ton. One mile northeast of the group is the Ben Harrison, carrying similar ores.

At Boulder Gap (elevation 7,200 feet) is the Carbonate vein, strik-

ing northeasterly and developed by a short tunnel. The country rock is the quartz-diorite, close to the serpentine. The ore consists of fine-grained quartz, with some dolomite or magnesite, and containing arsenopyrite and pyrite, as well as stains of green chromium mica.

Going down Boulder Creek southward from the gap, the Ruby and the Chloride are passed on the right. Both are developed by a few hundred feet of tunnels, strike northeasterly, are contained in quartz-diorite, and present a general resemblance to the Tempest described below. Minor shipments of ore have lately been made from the three last-named claims. The ore consists of arsenopyrite, pyrite, zinc blende, and a little galena, all occurring in many small veinlets of comb-quartz in a diorite which is bleached by the development of sericite and calcite.

One mile down from the gap are the Tempest veins, at an elevation of 6,500 feet. The developments consist of several short tunnels. From this mine a considerable quantity of ore has been shipped, yielding a profit in spite of very adverse conditions; shipments are reported to aggregate 180 tons. There are 5 veins cropping in quartz-diorite, striking N. 35° E. and standing nearly vertical. The veins are from 2 to 4 feet wide and consist of altered sericitic country rock traversed by small stringers and streaks of comb-quartz, with arsenopyrite, pyrite, and zinc blende, the value being chiefly in silver, with very little gold.

Still half a mile farther down the gulch is the Ornament, developed by three tunnels, aggregating several hundred feet. The vein is located near the contact of slate and serpentine with quartz-diorite. The ore is similar to that of the Tempest. Small shipments were made as early as 1890.

#### ROBINSONVILLE DISTRICT.

##### GENERAL FEATURES.

A broad shoulder of Greenhorn Ridge projects eastward beyond Robinsonville, its flanks deeply scored by ravines leading down to Burnt River on the east and to the two forks of the John Day on the north and the south. The elevation at Robinsonville is 6,200 feet.

The rocks exposed are the same as in the Greenhorn Mountains; that is, they comprise large areas of serpentine, gabbro, diorite, and quartz-diorite. Included slate masses are not common. Near Robinsonville the serpentine occurs in extensive areas, and probably results from alteration of olivine-gabbro. All of the rocks mentioned are believed to form one series, and they can scarcely be separated on the map. They appear to be different facies of one intrusior and are more recent than the argillites into which they are intruded. Robinsonville is an old, celebrated placer camp, but at present consists only of a few dilapidated log cabins.

## QUARTZ VEINS.

Since early days the presence of gold-bearing veins was known, and they have been worked intermittently. On the whole the deposits seem to be pocket veins, and many rich little quartz chimneys have been found in the flat on which the town is situated. In contrast to the other veins on the Greenhorn Mountains, these are auriferous, and present such curious features as the association of native gold, galena, and dolomite.

The Spero, at Robinsonville, is in serpentine, strikes N. 30° E., is 10 to 15 feet wide, and is composed of massive white quartz.

The Virginia, one-fourth mile north of Robinsonville, in coarse, partly crushed gabbro, has a shaft 160 feet deep. Long ago a pocket of \$20,000 was found in it, but more recent prospecting has failed to produce more.

In the Morning Glory, one-third of a mile northwest of Robinsonville, the vein strikes due north and dips 80° W. The gangue is a normal comb-quartz with free gold. Some of it has been sacked for shipment. Several small pockets have been found close by.

The Junebug, one-fourth of a mile southwest of Robinsonville, in serpentine, has a northwesterly strike. The vein contains much dolomitic carbonate, and also galena, together with free gold. The developments consist of two small shafts. Fifty tons of ore, worth \$25 per ton, have been milled.

The Don Juan and Phoenix are located about 1 mile south of Robinsonville, on the headwaters of Burnt River. The ore consists of coarse, granular dolomite, with a little quartz and galena. It contains abundant high-grade gold, intergrown as small grains with the carbonate. The mine has an 80-foot shaft, 1,000 feet of development, and a 10-stamp mill. A pay shoot, 30 feet long, 4 feet wide, and containing about \$36 per ton, was found here, but did not hold out in depth.

The Banzett is located 2 miles west of Robinsonville, on the headwaters of the Middle Fork of John Day River, at an elevation of 6,350 feet. The vein is in a soft, decomposed, serpentinitoid rock, and is developed by a shaft 100 feet deep, and a tunnel 1,000 feet long 100 feet below it. The gangue is normal vein quartz, containing a little galena and chalcopyrite, and is said to run \$60 per ton in gold. Eighty-three tons of ore are said to have been shipped in 1898.

The Diadem vein is situated a short distance north of the Banzett and 100 feet higher up. The vein strikes east-west and is developed by smaller shafts and a tunnel 550 feet long. It is intended to extend the latter 200 feet, giving a vertical depth below the croppings of 425 feet. The gangue is quartz; the principal ore is mineral galena, often in considerable masses, together with a little chalcopyrite. Both are rich in free gold. The vein is claimed to be 20 feet wide, one rich

streak assaying \$200 per ton. A shipment of 16 tons in 1900 is reported by the officers of the company to have netted \$1,819.

In Quartz Gulch, leading down from near Robinsonville to Olive Creek, are several noteworthy prospects. The three Golden Gate claims are located 1 mile north of Robinsonville, and show a heavy vein of white quartz with little sulphurets, exposed by 500 feet of crosscut and 100 feet of drifts. Serpentine and gabbro form the country rock. The strike is due north, the dip 60° E. A total thickness of 47 feet of quartz is claimed to contain \$6 to \$7 per ton. A foot-wall streak 4 to 5 feet wide contains the best values. Another and parallel vein, dipping west, courses a short distance to the east, and is said to assay from \$8 to \$24 per ton.

A little lower down on Quartz Gulch are the Belcher claims, which probably do not cover the same vein as the Golden Gate. Still farther down is the Kelly group, with over 400 feet of developments. The country rock is here a tuffaceous slate cut by dikes of granite-porphry. On one of these dikes the Imperial claim is located. Quartz Gulch is known to have been very rich in gold in early days, and the locality would seem to be a good one for prospecting. Several other claims, not visited, are located about 1 mile east of Robinsonville, on the Bonanza road. Cinnabar is reported to occur in a vein or seam near Robinsonville.

About 5 miles south of Robinsonville, at an elevation of 5,100 feet, on the road to Austin, is McNamee Gulch, reported very rich in early days. A \$14,000 nugget was found here. Some prospecting for quartz has lately been done in this gulch, resulting in the location of the Pine Tree group of quartz veins. The country rock is serpentine, gabbro, and diorite.

#### PLACER MINES.

Robinsonville Gulch and several other small streams as far south as McNamee Gulch have been extensively worked for placer gold, and some work of this kind is done at the present time at the last-named locality. The gravels were shallow, resting in flat gulches, and were rich in high-grade gold.

#### UPPER BURNT RIVER VALLEY AND BONANZA DISTRICTS.

##### GENERAL FEATURES.

In many respects the upper drainage basin of Burnt River is very similar to that of Powder River. The lower Burnt River Valley extends from Bridgeport (elevation 3,400 feet) to a point 20 miles west of it (elevation 3,900 feet), and has a width of up to 1 mile of alluvial and bench lands, the former covered with meadows or alfalfa fields. The ridges rising south of this valley are smooth and bare,

patches of timber occurring only in some of the gulches. A few miles above Hereford, the principal settlement in the valley, the river enters a sharply cut canyon, continuous for 15 miles to the upper valley, the lowest elevation of which is 4,100 feet. This valley is an almost circular depression, 5 miles in diameter, its gravelly bench lands surrounded by gently sloping ridges rising to maximum elevations of 6,000 feet. This region, in the heart of the Blue Mountains, is covered with dense forest and is abundantly watered by a number of creeks, all converging toward the lower end of the valley. Much of the timber is excellent yellow pine.

#### GEOLOGY.

The older rocks are found only in the upper part of the valley, while the Neocene lavas are developed to an enormous extent in the lower drainage area. Among the older rocks argillites predominate. Such rocks make up the larger part of the long ridge separating the upper Burnt River or Clifford Valley from the Sumpter Valley. As usual, the rocks vary from fissile clay slates to dark siliceous cherts. Similar rocks are exposed on the road from McEwens to Hereford, on the north side of the ridge, below the andesite cap covering the summit. In places slightly schistose greenstones are interbedded in the sedimentary series. At the head of Gimlet and Camp creeks similar siliceous argillites form the divide. At Bonanza mine fissile black clay slates appear. At Winterville, close by the placer diggings, is found a stratum of limestone 300 feet thick, which contains unmistakable round crinoid stems. The strike of this somewhat crystalline limestone is N. 70° W. At Bonanza mine the slates strike east-west and dip 80° S. This is evidently the prevailing direction, and it is the same also in the Sumpter district. The crinoid stems of Winterville form the only cue to the age of the whole series. It may be surmised that it belongs to the Carboniferous division of the Paleozoic.

The argillites contain few intrusive bodies. In the foothills south of Sumpter Valley, near Stoddard mill, a dark granodiorite appears from the gravel flat up to an elevation of 4,900 feet. Above this follows apparently contact-metamorphosed argillite, capped by andesitic breccia. Serpentine, forming an extension of the Robinsonville areas, crops in a small area just above the town of Geiser, close to the Bonanza mine, and also a mile below it at the Winterville diggings, here associated with other, not determined, chloritic greenstones.

Neocene lavas cover an exceedingly large area south of Clifford. Rhyolites, andesites, and basalts are represented, the rhyolites being, as far as can be determined, the oldest.

Normal lithoidal rhyolite covers the whole divide between Powder and Burnt rivers from a point south of Pleasant Valley and south-



east of Baker City for 15 miles westward, to the vicinity of Hereford, where it is covered by andesitic breccia. This rhyolitic ridge attains an elevation of from 5,500 to 6,500 feet. The rock descends on the north side of the ridge to the level of the basaltic flows (elevation 4,700 feet). On the south side it reaches down to Hereford Valley and appears again in the ridges south of Burnt River. The general form of this great rhyolite mass is that of a dome sloping gradually from an elevation of 6,000 feet to 4,300 feet. From this point a sharper slope of erosion sets in to the level of the gravel benches at Hereford. Closely crowded gulches have been cut in this rhyolite dome to a depth of from 1,000 to 1,500 feet. Thinner rhyolite flows appear again in the bottom of Clifford Valley; for instance, at the junction of Pine and Camp creeks, 2 miles northwest of Clifford.

Dacite was observed closely connected with rhyolite on a small tributary of Burnt River, 4 miles north of Hereford, on the road from that place to Sumpter.

Andesite and andesitic breccia cover a very large area. Beginning on the divide north of Hereford, a thickness is exposed of 300 feet on the Powder River side and 1,000 feet on the southern slope. Near the summit, well-stratified volcanic tuffs and breccias are exposed. The latter contain angular fragments both of dark pyroxene-andesites and lighter hornblende-andesites. This area continues westward practically to the slopes of John Day Valley. The breccias appear on the floor of Clifford Valley just east of the place of that name and are here covered by bench gravels, and the same breccias extend up to the Bonanza mine. Practically the whole divide between the Middle Fork of John Day and Burnt River, forming flat-topped, forested plateaus reaching 6,000 feet in elevation, is composed of this breccia. Overflowing, the same lavas once filled the Middle Fork of John Day down to Susanville to a depth of 1,500 feet.

The breccia consist of angular fragments of normal andesites of varying appearance. Some are dark gray, others brownish or black; many fragments are vesicular. All of them are hypersthene-augite-andesites (pyroxene-andesites), and sometimes those of lighter color contain also hornblende in black needles.

Basalts are less abundant. Below Hereford, in the lower valley, normal olivine-basalts, weathering gray, cover the rhyolite. Near Austin, and above that place on the headwaters of the Middle Fork, fine-grained glassy basalts cover the andesite.

The gravel deposits found along Burnt River Valley are of several different kinds. Such deposits as may have accumulated before the volcanic period, and are, therefore, Neocene or Eocene, have mostly been eroded or covered by lavas. A few of this interesting class have been exposed by placer mining and are described under the heading "Winterville placers" (p. 703). In areal extent they are insignificant.

The damming of the lower Burnt River Valley below Bridgeport by rhyolitic flows induced the accumulation of extensive gravel deposits above. Near Hereford are two of these benches at 400 and 600 feet above the valley bottom, which is covered by alluvial deposits. They consist of coarse, well-washed gravels of rhyolite, quartz, and metamorphic rocks. The age of these bench gravels is assumed to be late Neocene (Pliocene).

Similar damming produced similar results in the upper or Clifford Valley. Wide benches are covered by coarse, well-washed gravel, resting on argillite, rhyolite, or andesite. These are excellently shown on the Sumpter road. The highest terrace slopes from an elevation of 4,550 feet down to 4,300 feet in a distance of 2 miles. A sharp escarpment separates this from a second bench 100 feet lower and 1 mile wide. Finally, a last escarpment of similar height carries one down to the alluvial flats along the river.

No indications of a former glaciation have been found in this drainage basin.

#### QUARTZ VEINS.

Though some gold-quartz veins are known from the head of Gimlet Creek and other places on the divide toward Granite Creek and Sumpter, the only place in which they appear strongly developed and in which they have been mined with success is the Bonanza district. The quartz veins of Robinsonville, which to some extent belong in this drainage area, have been described under separate heading.

*Bonanza mine.*—The Bonanza mine is situated about 10 miles west of Sumpter, on the headwaters of Burnt River, at an elevation of 5,140 feet (lowest floor of mill). The first location is said to have been made in 1877 by a pioneer prospector named Jack Haggard, who sold it in 1879 for \$350 to the Bonanza Mining Company. In 1892 the mine was bought by Geiser Brothers for a reported sum of \$3,000 and worked by them until 1898, when it was sold to the present owners, a Pittsburg, Pa., corporation, for a price believed to have been \$500,000. The production before 1892 was inconsiderable, though extending over a series of years. Geiser Brothers are supposed to have taken out several hundred thousand dollars. When sold, \$300,000 were believed to be in sight. Since 1898 at least an equal amount has been extracted, making the total production well up toward the million-dollar mark.

A 40-stamp mill and concentrator treat the ore. During the fall of 1900 only 15 or 20 of these were dropping.

The developments consist of two tunnels, the upper 1,400 feet long and 230 feet below the croppings, the lower 1,600 feet long. The latter is the main adit, 338 feet below the croppings, and a shaft is sunk in it 600 feet from the mouth to a depth of about 200 feet.

Further sinking is being carried on at the present time. In all, there are probably 10,000 feet of development work.

The country rock is a fissile black clay slate, striking nearly due east-west and dipping  $80^{\circ}$  S. A little above the town of Geiser, at the mill, this slate is cut by a considerable belt of serpentine. The same rock appears again below Bonanza, toward the diggings of Winterville. To the north and east the serpentine and clay slate are covered by andesitic lavas. The veins appear to be exclusively contained in clay slate. The Bonanza vein, cropping on a hill 500 feet above the mill and about half a mile northeast of it, strikes N.  $50^{\circ}$  W. and dips steeply southwest. It is traceable on the surface for about 2,500 feet northwest of the main tunnel, but is then covered by an extensive lava area, referred to above.

The outcrops are neither wide nor conspicuous, and have been stoped to the surface in several places. The vein appears as 1 to 3 feet of quartz between walls of decomposed slate. In depth it widens enormously in places.

Permission to visit the mine below tunnel level was refused. The following data relating to the underground works were obtained from several persons well acquainted with the mine, and are believed to be mainly correct:

The ore consists of quartz containing free gold and sulphurets and has considerable similarity to that of the Red Boy mine. The ore body as a whole forms a mass of clay slate traversed by quartz veins and seams of all sizes. The gold is low grade, being about 600 fine, or worth \$11.50 per ounce. Something like 70 per cent is free, though it is said that as the depth is increased more concentrates and less gold are obtained. The concentrates are said to vary from \$20 to \$60 per ton, chiefly in gold.<sup>1</sup> The average ore is believed to run from \$7 to \$12 per ton, but lenses of ore 8 to 16 inches wide have been mined which ran as high up as \$1,400 per ton, and several hundred tons are said to have yielded at the rate of \$100 in free gold per ton.

Though the pay streak averages only 5 to 6 feet, it is swelled in places to 40 feet by the appearance of a vast number of quartz stringers.

The upper tunnel, 1,400 feet long, is said to have encountered two pay shoots, each 200 to 300 feet long and up to 6 feet wide. Still farther in, a third pay shoot was found, which extended only 30 feet above the tunnel level. It was 40 feet long and 5 feet wide, and averaged \$15 per ton. An intermediate level, sunk 40 feet from the middle shoot, was extended for 480 feet in very poor ore.

The lower tunnel, 1,600 feet long, encountered a small shoot below the first one in the upper tunnel and was then driven for the rest of the distance on a poor streak of quartz near the hanging wall. A crosscut

<sup>1</sup>A sample gave 0.84 ounce gold and 0.76 ounce silver per ton.

in the foot, 500 feet from the portal, had failed to disclose anything of value; likewise a crosscut near the end. It seemed as if the mine was worked out when the owners were prevailed upon to crosscut at other places in this adit. These crosscuts, from 30 to 120 feet long, into the foot-wall side disclosed the presence of a magnificent lenticular mass of ore of a maximum width of 40 feet and 800 feet long.

Regarding the conditions below the tunnel level but little information is to be had. According to latest reports fine bodies of ore have been developed below the second shaft level, and the production, which had been declining before, rose to something like \$50,000 per month.

*Other mines and claims.*—Near the town of Geiser are located several mines and prospects which, though not as yet producing, deserve mention. Among these is the Richmond, a vein parallel to the Bonanza and southwest of it, which is developed by a Canadian company and on which a 10-stamp mill has just been erected. The mine is developed by a shaft 300 feet deep. The Keystone Belle covers the extension of the Bonanza and is now being prospected. The White Elephant is still farther to the southwest and is being developed by a tunnel. In character all of these are similar to the Bonanza.

#### PLACER MINES.

Many of the creeks in the Clifford Valley have been profitably worked and some have been rich. Among them are, from west to east, Bennett Creek, Camp Creek, Gimlet Creek, and Three Cent Gulch. Placer work has been done in this valley since early days and a production is still maintained.

The gravels washed range in age from Neocene or Eocene to the most recent Pleistocene. The gold is sometimes extremely coarse, as in the Winterville placers, or very fine and floury, as in the ordinary bench gravels of Camp Creek. The fineness is remarkable, some of it reaching \$19 to \$20 per ounce.

Placer mining is carried on in Three Cent Gulch by Sullivan & Co., who operate one hydraulic jet with 400 miner's inches of water. Gimlet Creek has been worked extensively at the forks above the Sumpter road, and it is said that this locality has produced \$100,000. In Camp Creek, at the junction of Pine Creek, 2 miles northeast of Clifford, are the Hindman placers. Here a low bench gravel is worked just above the creek bottom, at this point 200 feet wide. The 10-foot-high bank of well-washed gravel rests on rhyolite. About 70 feet above the creek the heavy bench gravels begin which skirt the eastern side of Clifford Valley. The gold is rather coarse, and has a fineness of 919. It is accompanied by much magnetite and ilmenite, the latter in beautiful crystals. There are also some garnets and zircons in the black sand,

as well as epidote. Mr. Hindman states that about half an ounce of platinum is obtained at each clean-up. This is the only occurrence of platinum thus far known from the Blue Mountains. The heavy bench gravels are, as a rule, too poor to pay for washing, but contain some flour gold with the fineness of 970.

The placers of Winterville and Parkerville are unusually interesting. The Winterville diggings are located on Bennett Creek, three-quarters of a mile south of the Bonanza mine and at an elevation of 4,900 feet. The placers have been worked intermittently for many years and have doubtless yielded a large sum in aggregate. According to Mint reports they produced \$25,000 in 1889, \$8,300 in 1890, \$1,900 in 1891, and \$1,400 in 1892. During 1900 they were in active operation and the production is supposed to have been over \$20,000. The water is obtained from the Mann ditch, which, with an aggregate length of 30 miles, taps the headwaters of Clear Creek and Olive Creek and is said to have a capacity of 5,000 miner's inches.

Near the Bonanza mine Bennett Creek flows on andesitic breccia, though immediately east of the creek the high slate hills of Bonanza project from below the volcanic flows. At Winterville the creek leaves the andesite and for half a mile below flows over bed rock of slate and serpentine. In this distance the gravels along the creek bed have been worked. The gravels washed at present are found about the level of the creek and on its western side. The area which thus far has been hydraulicked comprises about 3 acres, the banks being from 15 to 20 feet high. The bed rock is a serpentinitoid greenstone of uneven surface. A north-south fault in the bed rock has been exposed 100 feet long and showing a scarp 30 feet high which dips 60° E. The pay gravel, resting on the bed rock, is from 3 to 10 feet thick, not very coarse, and sometimes cemented. It contains pebbles of serpentine, quartzite, slate, and quartz. Above this rest 15 feet of clayey beds with small strata of coaly material. Above this follows 2 feet of hard, cemented gravel, covered by andesitic tuffs and breccia. The gold, found chiefly on the bed rock, is extremely coarse, the pieces ranging from 0.05 ounce up to 15 ounces in weight, but at the same time very well washed. Most of the nuggets have an oblong, flat shape. The fineness averages 900. This interesting deposit was clearly formed before the time of the Neocene andesitic eruptions and must be of Eocene or early Neocene age. The high bed-rock hills rising on the southwest side and the general configuration of the country indicate that it was a narrow gulch of an upper drainage system which had a general east-west direction across the present creek. The increasing height of the banks will soon interpose difficulties for continued hydraulic work. The bed rock seems to pitch downward at present and at its deepest point probably lies below the

level of the creek. Inclines sunk will probably develop a heavy flow of water. On the other hand, if the channel came down from the west, and there is little doubt of this, it would seem feasible to follow it up by a drift from the present bed-rock level.

Two miles west of Winterville are the Parkerville diggings, which are reported to have produced \$150,000. They are said to be similarly situated and may represent the continuation of this channel. The continuation of this channel east of Winterville has not been found and the probability is that it would be considerably below the present level of the valley.

#### CHROMITE.

Heavy float of chromite was noticed at the Winterville placers; the serpentine in this vicinity must contain a pocket of this mineral.