lava flows of this end of the range. The highest point in this part of the range is Buckskin Peak, which has an elevation of 8,800 feet. At the Oregon State line the range is only 6 miles wide and soon sinks to the lava plateau.

The range is drained on its west side to Quinn River, which flows in a sagebrush-covered valley 6 to 10 miles wide. Here gently sloping débris fans lead down from the foothills. There is flowing water in Quinn River, derived mainly from tributaries that come from the Santa Rosa Range, and it serves for some irrigation, but it sinks ultimately into the sand of the basins north of Winnemucca and Pyramid Lakes. Opposite National the river flows at an elevation of only 4,200 feet.

The eastern base of the Santa Rosa Range lies 600 to 1,600 feet higher than its western base. It is drained by Little Humboldt River and, toward the northeast, by the headwaters of the Little Owyhee, which empties into Snake River near the boundary of Idaho and Oregon. The map forming figure 2 shows well how at its northern end the range changes to a plateau having an elevation of 6,000 feet, heavily scored by erosion from the west side.

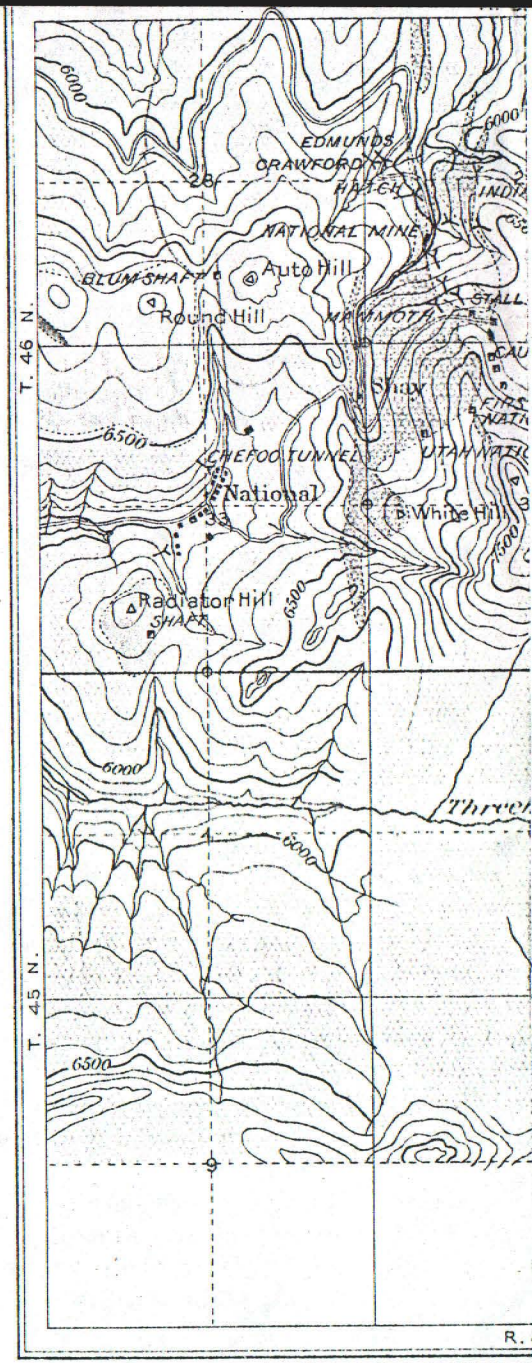
CLIMATE AND VEGETATION.

The climate at Winnemucca is that characteristic of the lower parts of the Great Basin, the summers being hot and dry and the winters cold but pleasant, with little precipitation. Toward the north end of the range the climate is much colder, and at an elevation of 6,000 feet, as at the National camp, the winters are long and the snow is deep. In the beginning of June, 1911, heavy snowdrifts were lying on the higher ridges about National, and the big cirques of Spring Peak were filled with snow.

To the casual observer this range appears absolutely devoid of arboreal vegetation, but this impression is not quite correct. A few willows along the streams and creeks contrast pleasingly with the dull brown of the rock, and in the gulches and cirques of the higher range as many as 50 trees may be counted to a square mile. There is a heavy growth of sagebrush in the valley and on the smoother foothills. The streams on the west side of the range and also the one that flows southward from Spring Peak serve to irrigate small ranches at the foot of the range, and these green alfalfa fields delight the eye of the tired desert traveler.

GEOLOGY.

Geologically the Santa Rosa Range is really a "terra incognita." The maps of the Fortieth Parallel Survey extended only as far north as Winnemucca, at latitude 41°. The outcrops on the north side of the



SKETCH MAP OF NATIONAL MINING D

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on mainly by tunnels, which reached depths of 600 to 700 feet below the outcrops. The proportion of gold to silver is said to have been greater at depth than near the surface.

Not having examined these deposits, I do not feel entirely certain that they were formed during the older period of mineralization.

On the west side of the range prospecting has been carried on at Rebel,[1] Willow, and Canyon creeks, the last only a few miles south of National. All these deposits are of the older series and are generally in slates.

Some prospecting was done on Rebel Creek in 1911. The Ohio claim is one of the earliest locations on the creek. This prospect was worked in 1884, according to the reports of the Director of the Mint. The veins of Canyon Creek lie in slate and are about parallel to the schistosity. They contain milky quartz, some siderite, and a little pyrite. The developments are insignificant.

On Pole Creek, about a mile south of the upper part of Canyon Creek, much gold quartz float was found in the early days and a 5-stamp mill was erected to treat it. The production was $30,000, it is said. No vein was found.

Placer deposits that probably derived their gold from these pre-Tertiary veins were formerly worked on a small scale at the foot of the range on Willow Creek, about due east of Spring Peak.

TERTIARY MINERAL DEPOSITS.

During the early prospecting the deposits in the Tertiary lavas of the north end of the range appear to have been overlooked, though it is said that the veins on Buckskin Peak were known many years before the deposits of the National district were discovered. These deposits, found in 1907, will be described in detail in the following pages and are therefore only briefly referred to here. They are fissure veins, most of them narrow and of low grade, carrying a little gold and a few ounces of silver. They contain, in a drusy, fine-grained quartz gangue, small amounts of pyrite, zinc blende, and other minerals, but all carry stibnite in larger or smaller amounts, and at least one deposit carries cinnabar. In one of these veins was found the remarkable shoot of pale gold (electrum) which within four years yielded nearly $4,000,000. The veins northward have a steep westerly dip and occur in rhyolite, basalt, and latite. There are no placers.

The lavas in which the veins occur are probably of Miocene age and the veins were doubtless formed by the action of ephemeral hot springs after the extrusion of a large sheet of rhyolite late in the period of volcanic activity.

[1] Burchard, H. C., Rept. Director of the Mint on production of precious metals in 1884, p. 357, 1885.

On the western slope of Winnemucca Mountain, at an elevation of 6,000 feet, a remarkable deposit, which deserves special mention, was worked by W. G. Adamson in 1911. The rocks exposed on the western slope are dark, smooth, fissile slates, slightly altered by contact metamorphism, but they include also some calcareous slates. The general strike is northward, but the dip is very irregular. A mass of intrusive diorite is exposed on the east side of Winnemucca Mountain, its contact with the slates being near the top of the ridge on that side. The slates are cut by a few dikes of porphyry, which is probably related to the diorite.

There are several prospects in this vicinity, and some of them, about 150 feet higher up than Adamson's camp, contain calcite veins cementing irregular brecciated zones. These remind one strongly of hot-spring deposits formed near the surface. The veinlets are banded and drusy, the slates between them soft and yellowish.

At Adamson's camp a well-defined vein outcrops, striking northeast and dipping steeply northwest. It is traceable for a few hundred feet. The vein filling, which is several feet wide, consists of granular calcite distinctly banded and stained yellow by limonite. At the outcrop back of the mine office it contains rather plentiful specks of cinnabar. In composition, appearance, and structure the vein recalls strongly a hot-spring deposit. An assay by Prof. E. E. Bugbee gave a trace of gold and one-third of an ounce of silver to the ton.

The northeastern part of the vein beyond the mine office appears to be faulted to the southeast with an offset of about 200 feet. The discovery in this part is an outcrop consisting mainly of brecciated slate filled with drusy quartz. This quartz vein is probably the continuation of the calcite vein. A tunnel 30 feet below the top of the outcrop disclosed a well-defined vein 10 feet wide, striking northeast and dipping 60° NW. A narrow and persistent streak along the footwall contains barite with quartz. Rich ore with pale native gold was struck in the tunnel near the floor and is contained in a narrow streak which, with clay and limonite, also lies along the footwall. The rich ore did not extend to the roof of the tunnel, but within a short space coarse gold was extracted to a value of $8,000. This was in 1911. The developments since then have been continued and a small mill has been erected. The statements in the reports on the metal production of Nevada in the Survey's "Mineral Resources of the United States" do not indicate that any large ore shoot has yet been encountered.

The high-grade ore continued below the tunnel level and was taken out by underhand stoping. In some places the gold formed an almost continuous sheet along the footwall. At other places the pay shoot widened and contained ore of milling grade. A small pan mill was

installed in 1911, the same pan in which the first high-grade ore from the National mine was milled.

The rich ore, when examined closely, is seen to consist of fine-grained drusy quartz in which the gold is contained in closely massed rodlike or clublike forms, with a tendency to dendritic development, not greatly different from the mode of occurrence at the National mine.

A tunnel 50 feet below the upper tunnel did not cut the vein, but ran into what seems to be an east-west cross fracture faulting the vein. This vein also contained some quartz and a little gold. Very likely, however, this cross fracture antedates the mineralization. There is a marked difference between the calcite-cinnabar filling in the southwestern part of the vein and the quartz-barite-gold filling in the northeastern part, so that these different parts may have been filled during successive stages of the mineralization. That the whole mineralization at this place is due to the action of hot springs at points very close to the surface can scarcely be doubted.

There are no volcanic rocks in the immediate vicinity, but there are several basalt flows near Winnemucca, and hot springs break out along Little Humboldt River, above that town.

METAL PRODUCTION OF SANTA ROSA RANGE.

Accurate statistics are unfortunately not obtainable regarding the production of the mining districts of the Santa Rosa Range. The production of Humboldt County given in the later reports of the United States Mint and the United States Geological Survey conveys little information, because the usually heavy output of the districts of the Humboldt Range forms part of it. The production falls in three well-defined periods, corresponding to the development of three districts.

The earliest period, from 1868 to 1880, corresponds with the working of the Pride of the Mountain mine, in the Winnemucca district. This mine may have yielded $1,000,000, but this figure is based upon no accurate data.

The next period, from 1880 to 1891, corresponds to the working of the rich veins of the Paradise district, and this production is said by local authorities to have amounted to several million dollars. No accurate data of total production are available. According to the report of the Director of the Mint for 1883, the Bullion mine produced in that year about $400,000 in silver and gold. From January, 1879, to December, 1883, the Paradise Valley Mining Co. produced $366,735. From August to December, 1883, the production of this company was $72,733 in silver and $9,260 in gold. In 1884, according to the same authority, the production of the Paradise Valley Mining Co. was $215,259. In 1887 the same production was $126,000; in 1888, $16,963; in 1889, $40,054; in 1890, $9,264. If these scattered figures give any indication of the real production, the total output has probably not exceeded $3,000,000. Operations ceased in 1891. Since 1911 the reports of the United States Geological Survey indicate an awakening from the dormant stage. A production of $2,313 was recorded in 1912. The production from the Rebel Creek and Willow Creek districts is not known; the former has yielded a little gold and silver ore, and placers were worked in the latter.

The last period of metal yield in the Santa Rosa Range began in 1909 with the discovery of the National bonanza in the hitherto unproductive northern part of the range. Unfortunately, though the production of Humboldt County is known, no figures showing the output of this mine separately could be given in the statistics collected by the United States Geological Survey because of the rule against disclosing individual production. From the data given in the Survey's "Mineral resources of the United States" from 1910 to 1913 and from some hints vouchsafed in the text it may be inferred that the production of the National vein was at least $80,000 in 1909, $1,000,000 in 1910, $500,000 in 1911, and $600,000 in 1912. This would amount to $2,180,000, but there are reasons for believing that this is fully $500,000 short of the actual production. On the other hand, it has been stated that the production to November, 1910, was $1,700,000, and the current reports in the district assign a production of about $3,000,000 or $4,000,000 to the mine up to the end of 1912. Certain it is that during the whole period of working more or less ore stealing went on, and it is stated that the value of the ore stolen before the present company took hold of the property amounted to many hundred thousand dollars.

The total production of the mining districts in the Santa Rosa Range since 1869 is thus probably not less than $7,000,000.

LITERATURE OF SANTA ROSA RANGE.

The literature on the Santa Rosa Range and the National mining district is scant. The following list is probably complete:

1870. Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains [for 1869], p. 193.
Describes Pride of the Mountain vein, on Winnemucca Mountain.

1877. Hague, Arnold, West Humboldt region: U. S. Geol. Expl. 40th Par., vol. 2, pp. 737–738, 1877.
Describes limestone, slate, and sandstone of Winnemucca Mountain; also diorite and syenite.

1883. Burchard, H. C., Report of the Director of the Mint on the production of gold and silver in 1883, pp. 525–529, Washington, 1884.
Contains brief descriptions of several mines in the Santa Rosa Range.

MINERAL DEPOSITS.

GENERAL CHARACTER.

The mineral deposits at National (see Pl. IV) are narrow fissure veins with a northerly trend and steep east or west dip.

The strike and dip of some of the veins at National are shown below:

Location.	Strike.	Dip.
Chefoo	N. 14° E.	80° W.
Radiator Hill	N. 10° W.	Vertical.
Do.	N. 17° E.	Steep east.
Indian Valley	N. 8° E.	80° W.
National gold vein	N. 5° W.	60° W.
National gold vein, south end	N. 25° W.	55° WSW.
National antimony vein (cut in tunnel No. 5)	N. 15° E.	56° W.

The veins intersect latite, rhyolite, basalt, basalt tuff, and trachyte. They are therefore distinctly later than any rock in the district.

Except the National vein (see Pl. V) none of the deposits has been extensively developed.

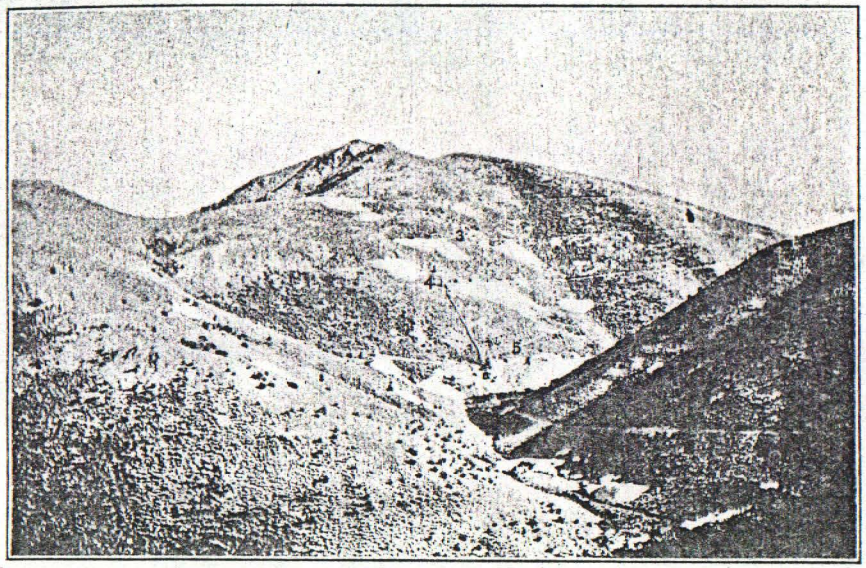
The country rock near the veins is altered by the development of pyrite, calcite, and a little sericite and adularia, but this alteration does not extend over wide areas.

The veins consist of sheared rock a few feet wide and have a well-marked footwall. Seams of quartz lie along foot, hanging, or intermediate walls.

The quartz seams generally show symmetrical banding by deposition and are often vuggy, small quartz crystals projecting into the cavities. The massive quartz is mostly fine grained. In some veins the marginal deposits are sulphides, for instance, fibrous stibnite (Pl. VI, *B*); in others, such as the National, the first deposit on each wall is translucent quartz in radial aggregates. Calcite and other gangue minerals are rare. Granular adularia was noted in the quartz of the Neversweat shaft.

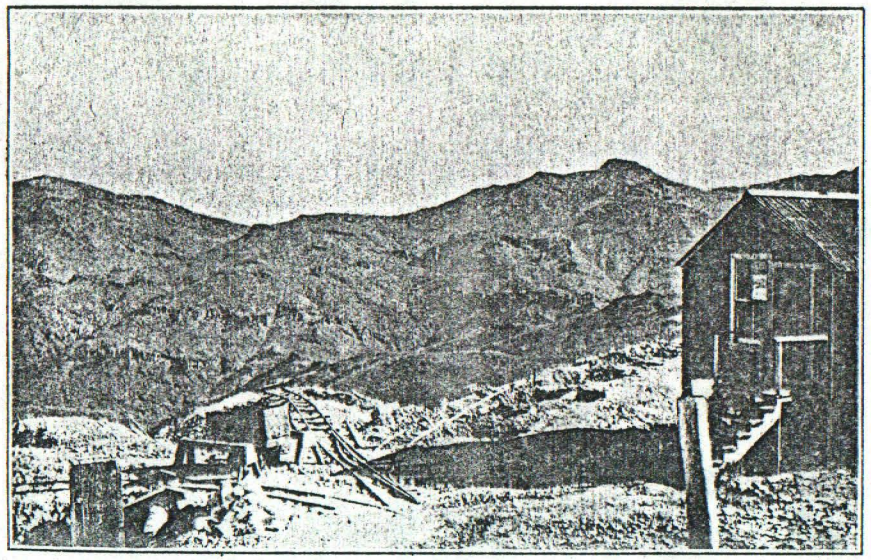
The most characteristic mineral is stibnite, for it occurs in almost every vein that has escaped oxidation. Pyrite, chalcopyrite, arsenopyrite, zinc blende, and galena occur only in small grains, which often are among the first deposits. Cinnabar was found in the vein on Auto Hill.

The veins that carry much stibnite are usually poor in gold and silver. Specimens from the vein on Radiator Hill (see Pl. VI, *B*), which shows abundant fibrous stibnite, contain only a trace of gold and 12 ounces of silver to the ton. The beautifully crystallized stibnite of the Indian Valley vein contains practically no precious metals. A specimen with much stibnite yielded on assay a trace of gold and less than an ounce of silver to the ton. A picked specimen,

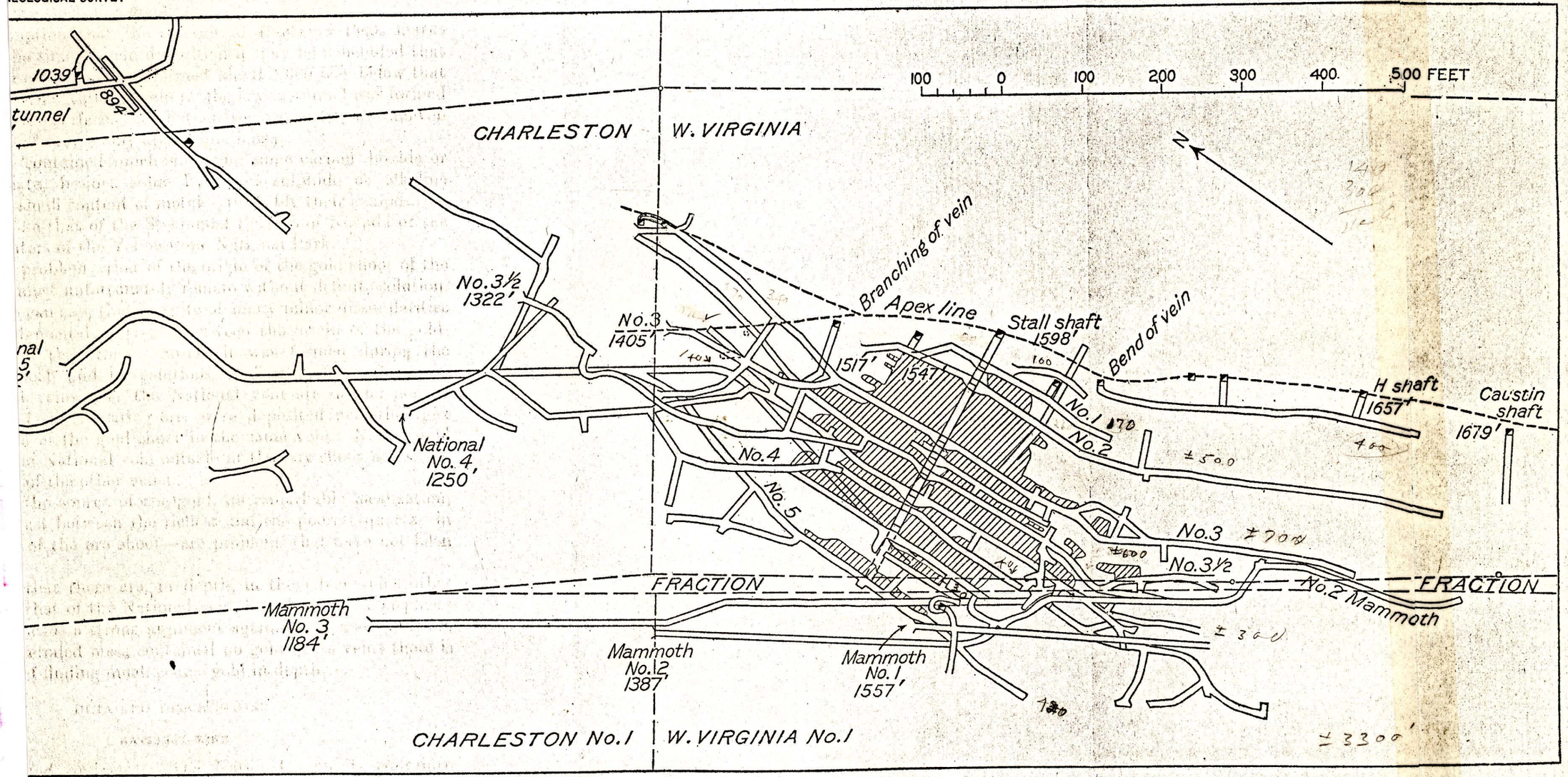


A. CHARLESTON HILL AND NATIONAL MINE, LOOKING SOUTHEAST.

1, Stall shaft; 3, tunnel No. 3; 4, tunnel No. 4; 5, mill and tunnel No. 5.



B. VIEW LOOKING NORTH FROM STALL SHAFT ACROSS EIGHTMILE CREEK.



MAP OF NATIONAL MINE.

with sulphides, from the Chefoo vein, containing but little stibnite, gave 20 cents in gold and 16 ounces of silver to the ton.

The narrow veins on Buckskin Peak are likewise silver veins, but the ore in some of them is rich. Two specimens of vein quartz from the Neversweat shaft which contained a little pyrite gave on assay, respectively, $0.40 and $1.40 in gold and 21 and 105 ounces of silver to the ton.

Native gold is found chiefly in the rich shoot of the National vein, where it occurs as electrum containing about 50 per cent of silver.

The intimate connection of many veins with rhyolite dikes soon becomes apparent to the investigator. Claims have been located along most of the narrow dikes, and in the area south of the National mine much of the rhyolite is somewhat mineralized. The narrow dikes north of the National mine and Auto Hill contain veinlets of comb quartz, and it is reliably stated that this gives assays of 50 cents to several dollars a ton in gold and silver. A sample of such material from a small prospect 600 feet northwest of Blum shaft on Auto Hill was assayed by Prof. E. E. Bugbee and found to contain in fact a trace of gold and 7 ounces of silver to the ton.

The veins of National are therefore essentially silver veins of very moderate tenor, and the gold shoot of the National vein is a unique occurrence in the camp.

The small quantity of silver ore of shipping grade that has been obtained was found near the surface and had doubtless been enriched by oxidation. Some of it was found also on Auto Hill in the mineralized rhyolite dike of that place. It contained ruby silver and silver chloride. Similar ore was discovered near the surface 30 feet south of the Stall shaft, practically at the outcrops of the National vein: It is said that it contained metal to the value of $134 per ton, chiefly silver. According to the same informant, Mr. Roy Gayer, who was one of the earliest lessees, a body of soft "talc" was struck 30 feet west of the shaft at a depth of 17 feet. This ore contained $117 per ton in silver and $0.80 in gold. Ruby silver was probably the principal ore mineral.

The underground-water level stands near the surface. At the Stall shaft, which is on top of a ridge, water was reached at a depth of 40 feet. In the Blum shaft, on Auto Hill, which is also on the summit of a ridge but at a lower elevation than the Stall shaft, the water in June, 1911, stood 160 feet below the surface.

In the National mine, the only one with extensive developments, there is good evidence of the deposition of secondary sulphides below water level. Most abundant among them is marcasite, but there are also pyrargyrite and stibnite. No secondary gangue minerals were noted. The deposition of the sulphides takes place along joints and fissures, and the crystallization of marcasite is accompanied by considerable solution of quartz and the development of irregular cavities.

GOLD SHOOT OF THE NATIONAL MINE.

The one really important development in the camp is the gold shoot of the National mine. Encountered 40 feet below the surface in the Stall shaft, it has been followed on the dip of the vein a distance of about 800 feet, the stope length reaching 250 feet. Within this distance the vein carries much coarse electrum, or silver-gold alloy, mostly in the footwall seam, and much of the ore is extremely rich, averaging $20 or $30 to the pound. This high-grade ore is so irregularly distributed that entirely barren quartz may adjoin streaks of rich quartz a foot or two in width. Small grains of the common sulphides are found at the walls of the gold-bearing footwall veinlet, which is from a few inches to a foot wide and is beautifully banded by the alternating deposition of radial and fine-grained quartz. (See fig. 6.) In places the quartz contains a little stibnite, but it is not directly associated with the gold. This gold shoot has been stoped down to the tunnel level No. 5, and it did not outcrop at the surface. The total production of this shoot is said to have been about $3,500,000. It is not probable that any other shoots with coarse gold occurred in the mass of rock removed by erosion, for no placer gold has ever been found either in Charleston Gulch or along any other creek in the district.

GENESIS OF THE VEINS.

It has been stated above (p. 21) that the volcanic flows at National are probably of Miocene age. If this statement be accepted the vein system is necessarily of Miocene or post-Miocene age.

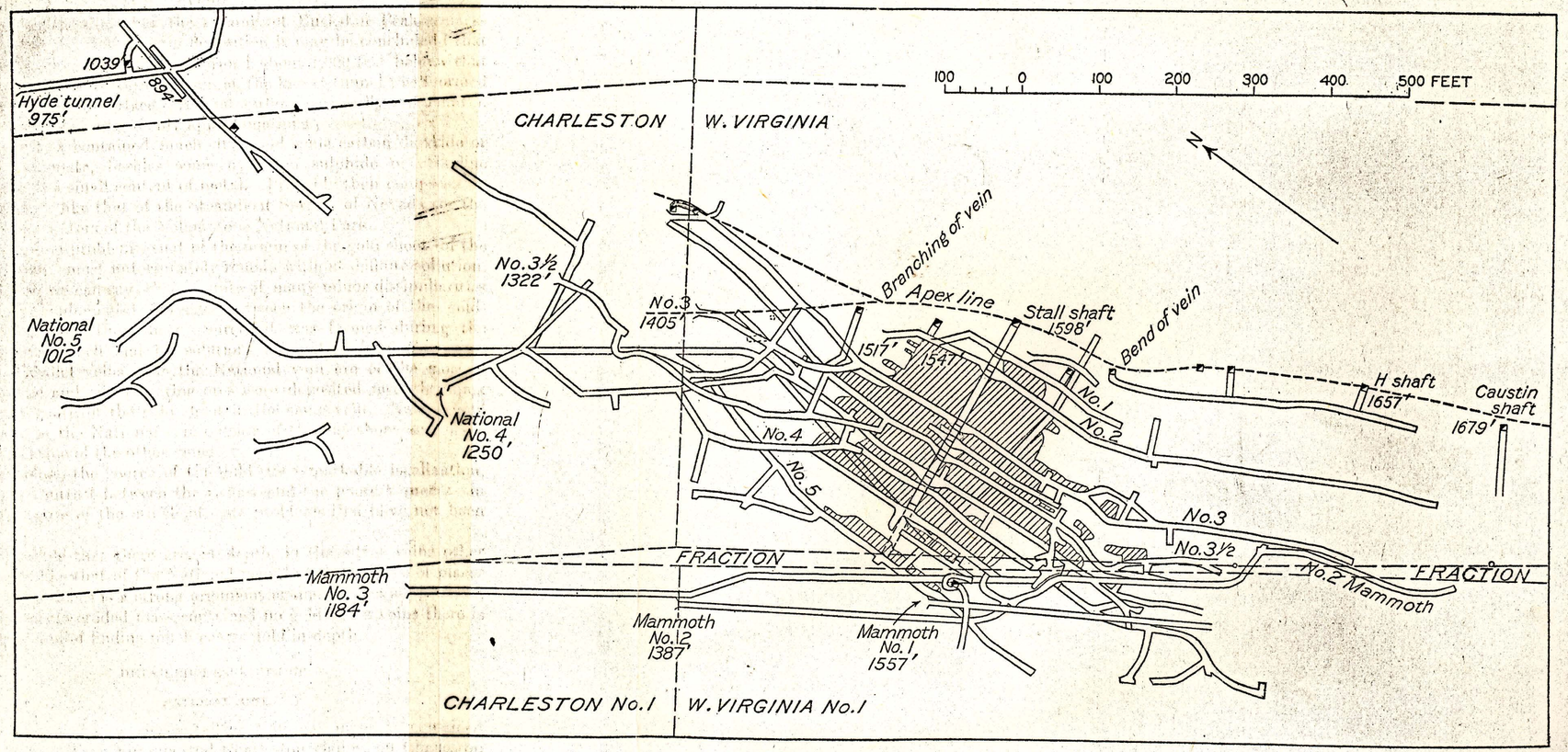
The close relations of the veins and the rhyolite, the latest rock in the district proper, is suggested by the fact that the veins follow the dikes and by the almost constant mineralization of the dikes.

Veins similar to those of National intersect the rhyolite flow of Buckskin Peak, and the summit of this mountain shows hot-spring action of the most pronounced kind, with development of chalcedony and silicified rhyolite, in which were found reddish-brown spots giving strong reaction for selenium.

There existed, then, an epoch of hot-spring action after the eruption of the thick rhyolite sheet, and it is probable that the waters ascended near the rhyolitic vents on fissures following the trend of the rhyolite dikes.

The veins have the symmetrically banded and vuggy structure which is so often seen in deposits formed near the surface by ascending hot waters, and this applies both to the gold-bearing and to the silver-bearing veins.

The composition of the veins—the fine-grained quartz, scarcity of pyrite, constant presence of stibnite, and occasional occurrences of



MAP OF NATIONAL MINE.

cinnabar—points decidedly to deposition near the surface. The alteration of the country rock is of the propylitic type.

All this evidence strongly suggests deposition by ascending hot waters during a transitory thermal epoch which followed soon after the eruption of the Buckskin rhyolite.

On the assumption that the summit of Buckskin Peak marks the surface at the time of vein deposition it may be concluded that the veins on the mountain were formed about 1,000 feet below that surface and that the National vein at the lowest tunnel was formed 2,700 feet below the surface. As that surface necessarily was uneven these figures are of course only approximations.

The solutions contained much silica and some carbon dioxide or alkaline carbonate, besides some hydrogen sulphide or alkaline sulphides and a small content of metal. Probably their composition was somewhat like that of the Steamboat Springs of Nevada or the silica-sodium waters of the Yellowstone National Park.

The principal problem—that of the origin of the gold shoot of the National vein—must unfortunately remain without definite solution.

This much we can say, that in spite of many minor dissimilarities there is no fundamental difference between the origin of the gold-bearing vein and the others. Surely it was formed during the same general epoch and by solutions originating from the same source. Parallel veins near the National vein are of the normal stibnite type and silver-bearing ores were deposited near the apex and to the south of the gold shoot in the same vein. Native gold occurs also in the National vein outside of the pay shoot and occasionally in some of the other veins.

Nevertheless, the source of the gold, its remarkable localization, the strong contrast between the richest and the poorest quartz—in short, the cause of the ore shoot—are problems that have not been solved.

It is possible that there are, in depth, in the silver veins other gold shoots like that of the National vein, but the absence of placer gold in the gulches is a strong argument against such a supposition, for if the whole eroded mass contained no gold in its veins there is little likelihood of finding much coarse gold in depth.

DETAILED DESCRIPTIONS.

NATIONAL MINE.

Development and equipment.—The National mine is contained mainly in the West Virginia and Charleston claims, on Charleston Hill. The vein was first found in the Stall shaft, on the ridge between Charleston and National gulches, and has been opened by several tunnels below that shaft, all entering on the slope toward

the National Gulch, the lowest, No. 5, being at the gulch level. The locations of these tunnels are shown on Plates I; IV, *A;* and V.

Elevations were carried forward from Winnemucca to National by means of two aneroids. The elevation of National Hotel was determined as 6,050 feet. The relative elevations of the tunnels are taken from the mine maps. The elevations of the tunnels and levels are shown below.

	Elevation.	Distance between levels.
	Feet.	*Feet.*
Stall shaft, collar	6,708	
Tunnel No. 2	6,637	71
Tunnel No. 3	6,521	116
Tunnel No. 3½	6,442	79
Tunnel No. 4	6,357	85
Tunnel No. 5	6,130	227
Level No. 6	6,003	127
Level No. 7	5,876	127

The difference in elevation between the collar of the Stall shaft and tunnel No. 5 is thus 578 feet.

Except tunnel No. 3, which is driven on the vein practically from its outcrop, each tunnel enters the hill as a crosscut and soon encounters the vein, upon which drifting had been done in 1911 each way for 200 or 300 feet. In 1911 the developments probably did not amount to much more than 1 mile of workings. Tunnel No. 5 has the longest crosscut and encounters the vein about 600 feet from the portal.

Since 1911 much new work has been done, in part in connection with the trial described on pages 52–54, and levels Nos. 6 and 7 have been driven from a new winze 380 feet north of the Stall shaft on tunnel level No. 5.

A small five-stamp mill with concentrating table is located at tunnel No. 5, but is operated only at intervals as ore accumulates. No ore of low grade—that is, below $25 a ton—was treated.

About 1912 a small mill was erected at the Stall shaft for the purpose of treating the dump, which contained about 3,000 tons of material estimated to carry about $100 per ton.

The ore is easily treated by the amalgamation process, as coarse electrum, an alloy of silver and gold, is the principal ore mineral, aside from a small quantity of ruby silver. In the early days of 1910[1] the ore, averaging $20 a pound, was crushed to pass a 60-mesh screen. The pulp was then ground with quicksilver in a 4-foot

[1] Cutler, H. C., National, Nev.; Min. and Sci. Press, vol. 101, No. 19, Nov. 5, 1910, p. 607.

amalgamating pan with mullers, 150 pounds being a charge, which was amalgamated for six hours. The tailings were shipped to the smelter. About $650,000 was turned out by this little mill in less than three months. Second-class ore was not treated at that time.

After the mill was erected the higher grade of ore, containing from $10 to $80 per pound, was shipped and the lower grade was treated in the amalgamation mill. No ore containing less than $25 a ton was treated.

During the earlier years the quartz was sorted in the mine and the high-grade ore only was taken out. Later the procedure was adopted of taking out all of the quartz in the stope and cobbing and sorting it at the surface because it often happened that small patches of high-grade ore were entirely surrounded by barren quartz and overlooked.

Geology.—All the rocks exposed are of igneous origin and are either surface flows or masses that were intruded near the surface.

Latite is the principal rock and occupies the whole slope below the Stall shaft to tunnel No. 5. The same rock lies on the dumps of all the openings. The first outcrop is seen 50 feet vertically below the Stall shaft. The latite is usually laminated and contains blebs of quartz.

Rhyolite outcrops on the slope both north and south of the narrow area of latite and is also observed on the dump of the Stall shaft. At a point 120 feet south of the shaft, on the point of the ridge, the supposed croppings of the vein (here chiefly silver bearing) are seen in pyritic rhyolite.

Basalt outcrops on the ridge above the Stall shaft and also on the crest of the lower ridge separating Charleston and National gulches.

In the workings of the mine practically all the country rock seen is latite, though the rock near the vein is often so much altered as to make its identification difficult. No rhyolite was found in the lower workings of the National Mines Co.

Basalt was encountered at one place only, 200 feet north of the Stall shaft on level No. 3½, between the main vein and a stringer.

The tunnels in the properties adjoining on the south side are mainly in rhyolite and basalt, and in these the southerly continuation of the National vein has been looked for.

Mammoth tunnel No. 1, at an elevation of 6,672 feet, starts in rhyolite, but in 58 feet encounters black basaltic rock.

Mammoth tunnel No. 2, at an elevation of 6,499 feet, enters in rhyolite, but 100 feet from the portal encounters latite. This continues to a point close to the National vein, where it enters basalt.

Mammoth tunnel No. 3, at an elevation of 6,300 feet, was 500 feet long in 1911, all in rhyolite, although the rock then visible at the breast was pyritic and looked more like mineralized latite.

Alteration of country rock.—Close to the vein the latite is somewhat bleached, greatly decomposed, and pyritic, but rarely becomes a typical sericitic rock. The alteration develops much calcite and pyrite and a little sericite, but the rock is often greenish and fairly fresh looking, even near the vein. In many places it is traversed by narrow drusy quartz veins, and in some of these adularia in its usual crystal form, ordinarily attached to the walls, was observed, but it is not abundant.

In the upper tunnels the decomposed rock is greatly softened by surface oxidation and near the vein is converted into a yellow tenacious clay.

The vein.—The National vein is best exposed in the lower levels, as the ground in the upper levels is soft and caving.

The vein is traceable on Charleston Hill for about 2,000 feet. On both sides of the Stall shaft the vein strike almost due north, but a short distance south of this shaft it bends to a strike of N. 25° W., and north of the shaft it breaks up in two branches, one trending a little to the west and the other a little to the east of north. The junction of the two branches as well as the bend is indicated on Plate V. The vein dips 50°–60° W., and has been followed along the dip for 675 feet to the lowest (No. 5) tunnel level, and in all 975 feet down to the winze level No. 7. (See figs. 7 and 8.)

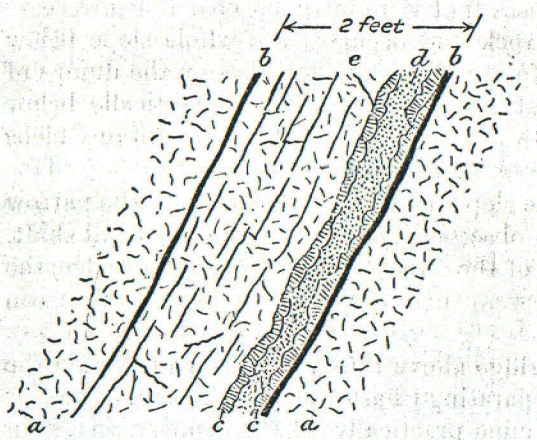


FIGURE 4.—Diagram of National vein in tunnel No. 5, near crosscut. Width of vein, 2 feet. *a*, Slightly altered latite; *b*, gouge seams on foot and hanging walls; *c*, radial translucent quartz; *d*, white, fine grained quartz; *e*, altered and pyritic latite, with slips and gouge seams.

The vein is 2 to 5 feet wide and usually has well-developed foot and hanging walls, generally with a gouge streak on the footwall. Most of the vein is soft, mineralized rock divided into several sheets by slips and false walls. (See fig. 4.) Narrow streaks of quartz, seldom more than 6 inches thick, lie on the footwall, more rarely on the hanging wall or in the middle part of the vein. At the bend of the vein, it is stated, the quartz was in places several feet thick.

It is evident that much comparatively late movement has taken place along the footwall, though within the West Virginia claim the movement has not been great enough to bring the latite in contact with rhyolite or basalt. In many places the quartz is entirely crushed, brecciated, or broken into fragments that have been more or less completely rounded. The quartz is plainly banded. Next to the footwall one finds ordinarily a layer of semitransparent, often radial quartz from 2 to 10 inches thick, with drusy surface.

Detailed notes.—No examination was made of the stopes above the third level as they were largely inaccessible and the rock extremely clayey and oxidized. There are no important crosscuts in this part of the mine.

Tunnel No. 3 intersects the vein 100 feet from the portal. The vein here strikes N. 5° W. and dips 60° W. It is only about 1 foot wide and is composed of several layers of quartz in soft rock, with intervening seams of clay. The vein here is softer and more clayey than on the lower levels and is stained yellow by antimony oxide. Two hundred feet south of the shaft on this level the vein bends sharply and strikes N. 35° W. The ore shoot lies mainly north of this bend.

A descent through the rich but narrow stopes is interesting, though the soft claylike vein filling makes observations difficult. The vein is 5 to 6 feet wide and on the whole looks like a brecciated mass of rock with streaks of black gouge and small veins of quartz. In the rich stopes between levels Nos. 3 and 4½ the vein is similar throughout, consisting of a few feet of altered rock, soft and white, with good footwall, and is traversed by several gouge walls. The vein is at many places brecciated and marcasite is abundant on secondary slips and joints. Postmineral movements have here and there broken the narrow quartz veins and rounded the fragments. Rich ore is found in many such rounded fragments. There are some seams of quartz at the hanging wall and between the walls, but most of the high-grade ore is found in the vein of white quartz, which in so many places follows the footwall slip. (See figs. 4, 5, and 6.)

The rich quartz, though it forms a distinct shoot as a whole, is in detail very irregular. For some distance the footwall seam may be entirely barren and then suddenly rich and wholly irregular streaks begin and continue for a foot or two. The yellowish-gray electrum is extremely difficult to see by candlelight. Most of the rich quartz is translucent and the gold is seen in transmitted light and is also recognized by the rough feel of the rich pieces.

On level No. 5 the rock is fresher and permits a better examination. Tunnel No. 5 at first trends N. 70° E., but soon bends sharply southward. The country rock is latite. The tunnel cuts two veins before it reaches the main vein at a point 600 feet from the portal. These two veins are well defined, with good footwalls. The first one strikes N. 15° E. and dips 56° W. It is 6 inches to 1 foot wide and consists of banded vuggy quartz and rather abundant stibnite. The second vein lies 75 feet farther east. Neither of the veins contains ore of value.

The main vein on this level strikes true north and the dip is 56° W. Its appearance is shown in figure 4. The width between good walls of soft, altered rock is 2 feet, and there are several minor slips between the foot and the hanging wall. Marcasite appears on all slips. The footwall seam of white translucent quartz, 4 to 10 inches thick, shows radial drusy structure, clearly indicating filled spaces. In the quartz itself no sulphides are now visible, but yellow stains of antimony indicate the presence of stibnite. The vein is of no great value at this place, but contains here and there a little gold and some silver. A raise was made from this level 150 feet south of the Stall shaft and some high-grade ore was found in it 120 feet above the level. (See fig. 5.)

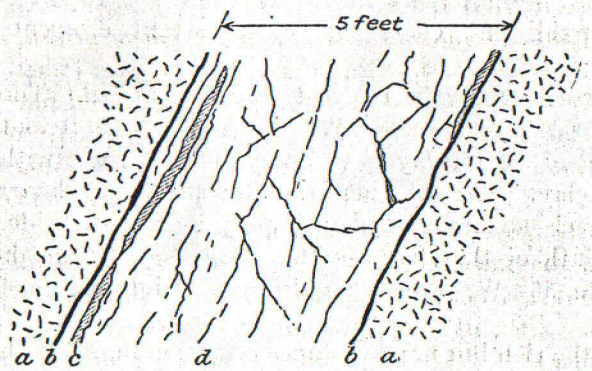


FIGURE 5.—Diagram of National vein in small stope just above tunnel No. 5. *a*, Slightly altered latite; *b*, gouge seams; *c*, quartz seams; *d*, altered, sheared, and brecciated latite, with fragments of quartz.

A 400-foot crosscut in the footwall in tunnel level No. 5 disclosed no veins to the east.

Ore shoot.—The rich ore shoot was first found 40 feet below the surface near the Stall shaft.

The Stall brothers, who discovered this wonderful bonanza in 1908, were Californians from Marysville and had not had much experience in mining. Their shaft was located on a small block of ground, leased from Workman, at a point where some good silver ore had been found at the surface. The supposed croppings 40 feet south of the shaft are said to have yielded assays of $134 to the ton, mostly in silver. About 30 feet west of the shaft, at a depth of 17 feet, a mass of kaolin was met which contained $117 in silver and less than $1 in gold to the ton. The gold ore was first found in the shaft 35 or 40 feet below the surface. It was extremely rich, especially in the footwall seam; much of the quartz was in rounded bowlders. The

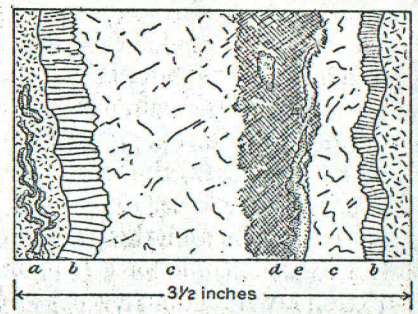


FIGURE 6.—Diagram of quartz seam in National vein in high-grade stopes between levels Nos. 4 and 4½. Width of seam, 3½ inches. *a*, Highly altered pyritic and siliceous latite with solution cavities covered with quartz crystals; *b*, translucent comb quartz; *c*, dull white, fine-grained quartz, usually carrying the gold; *d*, outline of entirely silicified rock fragment; *e*, later solution cavities coated with marcasite.

gouge carried nothing of value. The gold was pale and had a value of $11 an ounce. There was a good deal of ruby silver both in the quartz and on seams and joints.

From the point where the ore shoot was first opened it widened rapidly. At first it was mainly worked close to the south side of the shaft, but later the stopes were materially extended and are now seen on both sides of the shaft. Little or no ore was found on tunnel level No. 5, but high-grade ore was encountered in raises from this level. On the dip of the vein it is about 675 feet from tunnel No. 5 to the collar of Stall shaft, and the ore shoot as far as stoped in 1911 occupied 550 feet of this distance, with an average stope length of

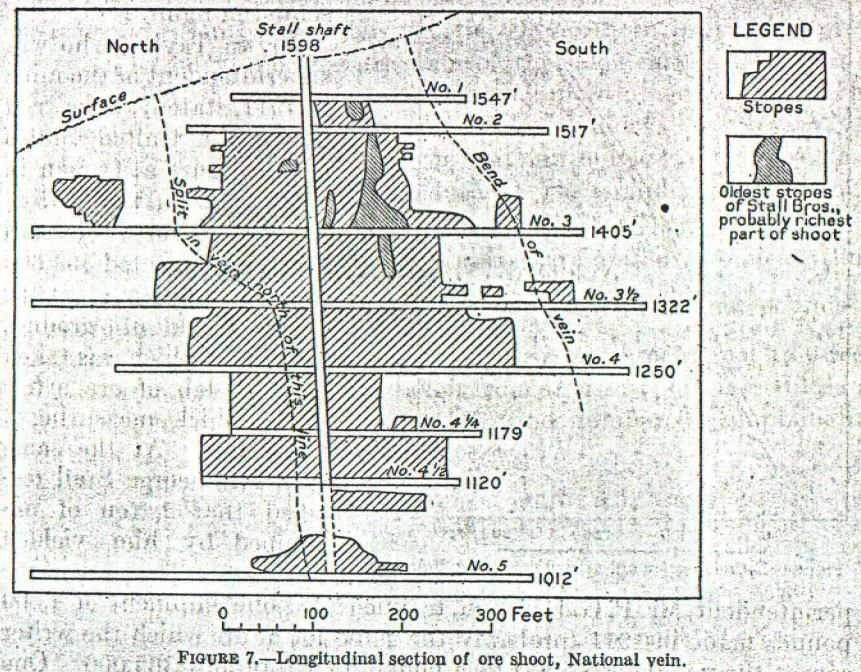


FIGURE 7.—Longitudinal section of ore shoot, National vein.

perhaps 200 feet (figs. 7 and 8). There is practically no difference in the appearance of the vein within or outside of the ore shoot. In most places the rich quartz forms the footwall seam, averaging perhaps 6 inches of pure gold-bearing quartz (fig. 6). On the assumption that this footwall seam is equally distributed and 6 inches wide the ore shoot had a content of 55,000 cubic feet, or a mass of 9,075,000 pounds, a cubic foot of quartz being taken at 165 pounds. On the further assumption that the contents in precious metals were equally distributed, the total production of the shoot being taken as $4,000,000, the ore would be worth about 44 cents per pound, or $880 per ton. It is a fact, however, that the ore averaged about $20 to

the pound and consequently this high-grade ore must have been very irregularly distributed. Only one-sixtieth part of the quartz within the shoot was rich ore. This estimate agrees with the statements of the mine officers and with the writer's observation, for much practically valueless quartz was found within the ore shoot. Within the barren quartz the high-grade ore appears suddenly in streaks that are continuous only for a foot or two.

Specimen No. 38 (fig. 6), from within the ore shoot and close to high-grade quartz, was assayed by Prof. E. E. Bugbee and found to contain a trace of gold and less than 1 ounce of silver to the ton. The sample was taken right across the specimen represented in figure 7.

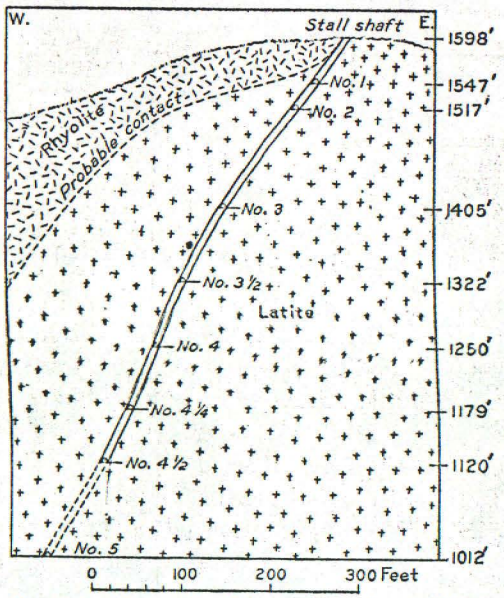


FIGURE 8.—Cross section of National vein along Stall shaft.

Mr. S. Taylor, who was superintendent of the mine in 1911, stated, at the trial before the United States Circuit Court at Carson in 1912, that on the No. 4¼ level, just north of Stall shaft, he extracted $94,600 in electrum from a very small block of ground, $70,000 of which was taken from a slab of ore a few inches thick measuring 3 by 6 feet. At the same trial Mr. George Stall testified that 1 ton of ore shipped by him yielded $135,000. The present superintendent, Mr. P. G. Harrison, testified that one shipment of 4,500 pounds made in 1911 (probably the same lot of ore which the writer saw at the mine) netted $81.20 a pound, or a total of $365,000. One of the foremen testified that he had taken out as much as 1,085 pounds of "high grade" in a shift of 8 hours.

Since the mine was visited in 1911 the stopes have been considerably extended. The stoped area now extends down to tunnel level No. 5 and some stoping has also been done between levels Nos. 5 and 6. The stope length along the drifts ranges from 200 to 450 feet and the shoot, which dips steeply to the south on the plane of the vein, has a greatest axial length of 800 feet. Much of the quartz on the outside of the shoot was stoped in order not to overlook the sparsely scattered pockets of high-grade ore. Such rich pockets might occur within blocks which developments on four sides apparently showed to be barren.

Though gold in paying amounts is confined within the shoot, specimens showing gold may occasionally be found outside of the shoot. Occurrences of this kind have been found in the Hyde tunnel and at several places in the National mine. In drift No. 2, south of the ore shoot, detailed assays of which are shown in the following paragraphs, visible gold was found at two places, although apparently no such occurrences happened to be included in the assayed material.

Secondary silver minerals are irregularly distributed through the vein, and the isolated high assays in silver found in the table given below doubtless are caused by such occurrences. The author of this bulletin was informed by the present superintendent, Mr. Harrison, and the engineer of the company, Mr. H. L. Hollis, that ore has been developed recently on a new vein in the northern part of the property, in which also occurs electrum of the same character as that in the old vein, though with a little higher percentage of gold. This ore is also said to contain primary silver sulphides.

In order to show the values in the vein outside of the ore shoot the following assay list is introduced. The samples were taken at intervals of about 5 feet in the southern end of level No. 2 over a distance of about 330 feet. The assays are stated in ounces, thus: $\frac{0.02\ (\text{oz. gold})}{1.00\ (\text{oz. silver})}$. The uniform samples, each of a few pounds of quartz, were taken across the vein over a width of 1 foot to 6 feet. This statement of assays was taken from an assay plan introduced at the trial in Carson City (pp. 52–54) and numbered Complainant's Exhibit Q.

0.08/2.92'	0.06/1.54'	0.04/0.10'	0.04/51.56'	0.04/0.12'	0.02/0.14'	0.02/0.12'	0.02/39.78'	0.06/0.94'
0.06/0.74'	0.04/2.96'	0.04/0.10'	0.04/1.16'	0.04/0.96'	0.02/3.98'	0.04/7.76'	0.02/2.38'	0.04/3.76'
0.06/1.74'	0.08/0.10'	0.02/0.20'	0.02/1.38'	[Five numbers wanting, blue print illegible.]				
0.02/1.18'	0.06/0.74'	0.02/0.38'	0.10/1.50'	0.02/1.18'	0.04/0.10'	0.02/0.58'	0.02/0.78'	0.04/0.10'
0.02/0.20'	0.04/7.56'	0.04/0.15'	0.02/0.12'	0.02/0.58'	0.02/3.58'	0.04/1.96'	0.04/2.38'	0.08/3.32'
0.04/0.06'	0.08/1.32'	0.08/6.92'	0.06/11.14'	0.06/12.24'	0.04/23.56'	0.12/14.48'	0.08/4.32'	0.10/9.70'
0.08/12.12'	0.12/3.88'	0.12/4.88'	0.12/4.48'	0.12/9.08'	0.40/7.40'	0.28/0.72'	0.28/31.12'	0.18/8.00'
0.08/6.52'	0.08/2.52'	0.14/4.92'	0.10/2.70'	0.14/42.26'	0.08/4.32'			

Average 0.71/5.93

gelatinous silica which afterward slowly crystallized to a fine-grained aggregate. (See Pls. VII, *A*; VIII, *A*.)

Plate VIII, *B*, is a photograph of a thin section of ore, kindly lent by Mr. H. L. Hollis. In this plate the dendritic development of the gold is very striking; the gold shows no tendency to follow fissure cracks in the quartz and its primary nature is beyond doubt.

The only explanation which seems to be satisfactory is that the gold and the quartz crystallized together from the same solution, and it is most likely that these solutions contained gold and silver in the form of alkaline sulphides.

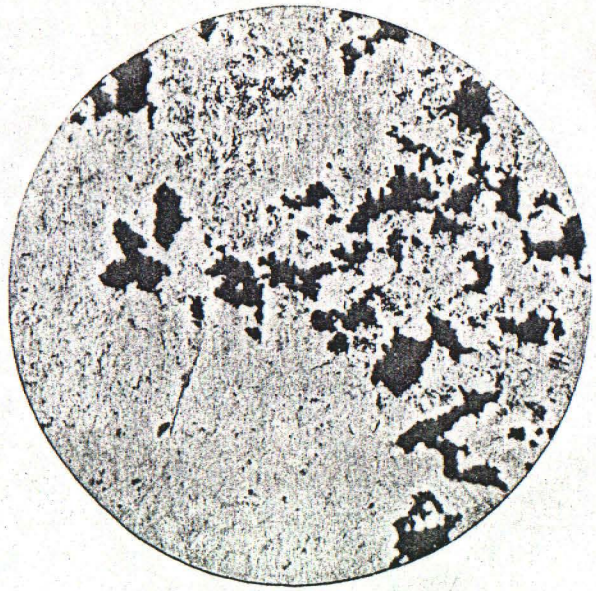
In order to ascertain the distribution of the gold a number of assays were made by Prof. E. E. Bugbee, of the Massachusetts Institute of Technology, of the footwall quartz seam in which the high-grade ore ordinarily occurs. Two assays were made of quartz found near the top of a 150-foot raise in the fifth tunnel, near high grade. The two assays gave a trace of gold and less than an ounce of silver per ton.

Another assay was made of the typical quartz seam, of which a diagram is given in figure 6. The sample was taken by the writer in very rich stopes in level No. 4½, only a foot or two from quartz containing much free gold. Chips were taken from all sides of the specimen, which formed a complete cross section of the 4-inch vein. The assay showed only a trace of gold and less than an ounce of silver to the ton.

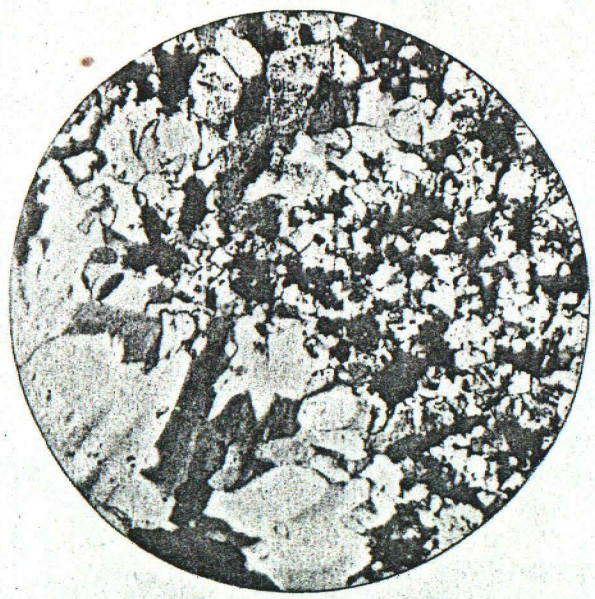
These results go far to confirm the statement of the mine officers that there was practically no second-class ore or milling ore in the rich shoot.

Oxidation.—It has already been stated that the water level at the Stall shaft stood high, only 40 feet below the surface. The outcrops of the vein are shown at only one point, near the shaft just mentioned. Some oxidized ore rich in silver was found here, and near the top of the gold shoot ore with much ruby silver was taken out. The stibnite in the vein is oxidized to yellow earthy material in the uppermost level and in places also through the lower levels. It is possible that some of this oxidation has taken place since the vein was opened and drained. It is reported by Mr. H. V. Winchell that considerable amounts of realgar and orpiment were found south of the ore shoot in a part of level No. 2, which was not opened in 1911. N. A. Winchell also states that native arsenic was found at several places. All three of these minerals have probably been formed by the oxidation of arsenopyrite.

Secondary sulphides.—As stated above, there is but little primary pyrite in the ore, and in fact primary sulphides of all kinds are scarce. Marcasite is, however, abundant and occurs throughout the vein in and out of the rich shoot, but always as coatings, crystallized or mammillary, on the joints and fissures in the quartz, or is dusted on



A. Parallel nicols; magnified 60 diameters.



B. Crossed nicols; magnified 60 diameters.

THIN SECTIONS OF GOLD QUARTZ FROM NATIONAL MINE.

the pyramids of quartz crystals in small druses. Scarcely a specimen of quartz or vein matter is without this secondary sulphide.

On the joint planes of the quartz in the rich shoot there is also more or less pyrargyrite, or antimonial ruby silver. In places there are also flat bunches of stibnite needles. In the ore of the Chefoo tunnel (p. 47) secondary stibnite was found as capillary coatings in little quartz vugs. As far as could be ascertained by the inspection of a large quantity of high-grade ore no recrystallization of the gold had taken place. In a few places, however, it was noted that the gold cut by joint planes was of a deeper yellow color than ordinarily, which would indicate that some silver had been leached from the electrum.

The secondary sulphides, then, comprise marcasite, pyrargyrite, and stibnite, and also realgar and orpiment. No gangue minerals appear to have formed simultaneously with these sulphides. It is concluded that these sulphides were deposited from cool solutions long after the vein had been formed. Whether these solutions were descending or ascending can not be positively stated, but the presence of much marcasite, taken in connection with the scarcity of primary pyrite, might indicate deposition by weak ascending solutions.

According to E. T. Allen[1] marcasite is always deposited by acid solutions. Whether the solutions that formed the marcasite in the National vein were acid or not may be left an open question; if they were acid they were descending, but they must have been weakly acidic, because the primary vein contains so little pyrite.

Observations made by the writer at the El Oro mines of Mexico seem to show that marcasite may be deposited by neutral and weak calcium carbonate solutions having a temperature of about 35° C.; and here also the deposition is distinctly a later phase than the vein formation proper.

NATIONAL MAMMOTH MINING CO.

Three tunnels have been driven by the National Mammoth Mining Co. near the property lines of the National Mines Co.

Tunnel No. 1 (elevation, 6,672 feet) enters rhyolite. About 58 feet from the portal, on the contact with basalt, lies a small vein which in 1911 had not been traced further. This is practically on the level of the collar of the Stall shaft.

Tunnel No. 2 (elevation, 6,499 feet) follows nearly the line between West Virginia claim and West Virginia claim No. 1. The portal of this tunnel is in rhyolite, and 100 feet from the portal the tunnel cuts into latite. About 600 feet from the portal a vein was cut

[1] Allen, E. T., Crenshaw, J. L., and Johnston, John, The mineral sulphides of iron: Am. Jour. Sci., 4th ser., vol. 33, pp. 169–236, March, 1912.

The rock exposed in the footwall in the south drift is a basalt but is greatly altered by the development of sericite, calcite, and pyrite. The hanging wall is still more strongly sericitized. Adjoining the unaltered footwall is a vein 3 feet wide of soft white rock containing several clay partings; next follows a seam of clay, which widens to a 4 or 5 inch vein of silicified and pyritic material, made up of fragments of country rock, and containing also small crystals of arsenopyrite, and between these fragments are crusts of fine quartz crystals resting upon narrow bands of pyrite, zinc blende, and chalcopyrite. In the vugs delicate capillary needles of stibnite rest upon the quartz crystals. This stibnite and some marcasite are the latest minerals formed. The hanging wall consists of soft white rock, which gradually gets harder with increase of distance from the vein. Assays of specimens of good-looking ore from this locality gave 20 cents in gold and 16 ounces of silver to the ton. Some ore obtained here is said to have contained tetrahedrite and is reported to have contained $40 in gold and $625 in silver to the ton. None has been shipped, and the vein is probably too narrow for exploitation.

AUTO HILL.

In the gap at the west base of the Auto Hill, about 600 feet above the hotel, are several interesting developments.

A rhyolite dike about 50 feet wide, which first appears in the upper end of the town and can be traced up to the gap just west of the Auto Hill, shows decided evidences of mineralization. It is dislocated by several small faults.

Rich oxidized ore with quartz seams was found on the ground of the Walker lease 100 feet south of the gap. Some of it is reported to have contained 2,500 ounces silver and 3 ounces of gold. The ore is said to have contained stibnite, bismuth (?), cinnabar, native silver, and ruby silver, with much yellow antimony oxide. There is also a little chalcopyrite and covellite. Some ore, probably not over 5 tons, was shipped from here. It was rich in silver but contained only $1 or $2 in gold to the ton. These workings are not accessible now and no certain conclusions as to the character of the deposit could be drawn from exposures at the surface.

BLUM SHAFT.

Deeper developments were undertaken in the Blum shaft, which is vertical and is 260 feet deep. Its collar has an elevation of 6,630 feet. This shaft is apparently sunk in the rhyolite dike. The rock is a soft earthy rhyolite with sparse crystals of pyrite. Under the microscope it shows corroded crystals of quartz and a few of sanidine in a groundmass of microgranular quartz and orthoclase. The rock contains much sericite and kaolin. The vein is narrow but well defined, strikes N. 8° E. and dips 70° W. It consists of clay gouge with several quartz

stringers 8 to 10 inches wide. Much of the soft stuff on the dump contains cinnabar, shown by panning. Cinnabar was found at a depth of 30 feet, and more abundantly in solid streaks 1 inch to 2 inches wide at a depth of 60 feet.

At the 100-foot level in the Auto shaft the vein was found in a short crosscut, run eastward, but was here pinched and oxidized.

On the second level, 160 feet below the surface, where water now stands, crustified quartz seams were observed, showing pyrite, galena, zinc blende, and slight stains of copper. On the lowest level the vein is said to have been very narrow. No ore was shipped from the shaft.

EDMUNDS TUNNEL.

The Edmunds tunnel is 100 feet below the National tunnel No. 5 on the west side of the gulch. Its course is N. 22° W. and its total length is 485 feet. At a point 320 feet from the portal a shaft was sunk to a depth of 130 feet. It was full of water at the time of visit. The country rock is basalt, but 370 feet from the portal the rhyolite dike, outcropping above, was encountered.

At the shaft a quartz seam 2 inches wide was cut, which continued down into the shaft. Operations were stopped by the sudden influx of water.

CRAWFORD TUNNEL.

The Crawford tunnel is close to the Edmunds tunnel and 40 feet above it. It extends 300 feet in a northwesterly direction. It encountered a small vein, which was followed by drift and shaft, the shaft extending 70 feet below tunnel level. Farther in the tunnel another vein was struck which, like the first, contained quartz and calcite. The two veins are 20 feet apart.

HATCH TUNNEL.

The Morning Star or Hatch tunnel, operated in 1911 by the proprietor of the National Hotel, is on the west side of National Gulch at an elevation of 5,970 feet, 130 feet vertically below the office of the National Mines Co. The tunnel was started to intercept the National vein on the supposition that the vein was faulted across the gulch. The portal of the tunnel and the first 200 feet are in rhyolite; next follows a clayey, tuffaceous rock, probably basalt tuff, which is brecciated in places and contains more or less pyrite. Some shaly and coaly material was also found. The tunnel was 900 feet long in 1911, and near the face encountered soft and whitish basaltic rock. No veins had been found, although some of the pyritic material gave assays of gold and silver amounting to $1 or $2 to the ton.

HYDE TUNNEL.

In the Hyde tunnel No. 2, about 360 feet northeast of the lowest adit of the National mine and 40 feet below it, a vein was cut 200 feet from the portal, which probably is one of the stibnite veins lying a

short distance west of the principal National vein. It was drifted on for about 300 feet, but failed to yield ore. Near the portal a shaft was sunk to a depth of 82 feet, and in this probably the same stringer was cut. The quartz sparingly present along the vuggy vein yielded some stibnite and a few flakes of visible gold. Some ruby silver was also found near the surface. The country rock is latite, considerably kaolinized, and traversed by a network of pyrite stringers.

DEVELOPMENTS SOUTH OF STALL SHAFT.

Considerable effort has been made to locate the extension of the National vein south of the Stall shaft, on that part of the ridge which slopes toward Charleston Gulch.

A few hundred feet south of the Stall shaft is the shaft sunk by Caustin and Jarvis to a depth of at least 180 feet as an incline sloping 50° W. A vein with some quartz was said to have been cut, but presumably no ore was found, for the operations were long ago suspended. (See Postscript, pp. 52–55.)

The Bankers' shaft is 225 feet farther south, and about the same distance south of this is the Diffenbach Defiance shaft. The Bankers' shaft is about 300 feet deep. A short crosscut was driven from this level and is said to have cut a vein. The shaft is an incline, dipping 60° W. The Diffenbach shaft is vertical and of about the same depth. Altered rock containing some marcasite was found at both places. The rock appears originally to have been a basalt, and a heavy body of fresher basalt lies immediately west of the three shafts.

A few hundred feet farther south a vein showing stibnite and some "silver sulphides" is said to have been opened on the property known as McDonald's lease. In the court trial referred to (see pp. 52–54) evidence was adduced that seemed to prove that the National vein passes through the Caustin shaft, the Bankers shaft, and McDonald's tunnel.

INDIAN VALLEY TUNNEL.

About 1,200 feet east of the National vein some prospecting has been undertaken on the Indian Valley claim. A tunnel has been driven 500 feet south, on a vein which contains much stibnite in spots. The vein is in places 5 feet wide and consists mainly of altered rhyolite, with some quartz stringers. The vein has a steep dip and strikes N. 8° E. A specimen of the ore shows well-crystallized stibnite, cementing the fragments of a rhyolite breccia which contains finely divided pyrite. No minerals were observed with the stibnite except a little kaolin. Picked specimens of stibnite contain only a trace of gold and less than 1 ounce of silver to the ton.

A crosscut to the east 365 feet from the portal meets basalt 90 feet from the stibnite vein and the basalt contains near the contact several seams of quartz with pyrite, stibnite, and calcite. This basalt is a part of the succession of flows which begins immediately east of the rhyolite dikes at the Indian Valley mine.

PROSPECTS ON BUCKSKIN PEAK.

Topography.—The trail to Buckskin Peak goes up Charleston Gulch to the divide and then skirts the high ridges at the head of the cirque of Threemile Creek. It is an easy trail, by which the mountain can be comfortably ascended on horseback.

The elevation at the head of Charleston Gulch is about 7,500 feet, and the top of Buckskin Peak 8,800 feet. The ridges are practically bare and are free from snow about August 1. In places in the gulches there are small groves of fir trees.

Geology.—The trail ascends the basalt flows of Charleston Gulch and at the divide passes a plug or neck of rhyolite and obsidian. For a mile the trail then continues southeastward over basalt or similar rocks. Fine views open to the west and east, and as far as can be seen the basalt flows descend down on the east side of the range; in fact, on that side nothing but basalt is in view.

About a mile southeast of the head of Charleston Gulch, at an elevation of 8,300 feet, the trail enters the rhyolite area of Buckskin Peak. The rhyolite is fine grained, felsitic, and light colored and breaks up in shordy fragments.

On the top of Buckskin Peak there are undoubted evidences of hot-spring action. The rhyolite is silicified and chalcedonic and weathers into irregular rough outcrops.

The rhyolite area of Buckskin Peak is clearly a flow which, as shown on the spur south of Threemile Creek, is underlain by basalt flows, and which, likewise, as shown on the trail to the summit, is covered by basalt. The greatest thickness of this flow is about 1,200 feet. It was probably viscous and its thickness would not be maintained for long distance from its feeders. There is no doubt that the numerous rhyolite dikes of the National district belong to the same epoch of eruption, which would fall in the later part of the period of the basaltic flows.

Veins and prospects.—The veins on Buckskin Peak are said to have been known and located long before the rich bonanza of the National district was discovered. They are near the divide, on the east slope of the main ridge just north of the peak.

The Bell & Ward prospect is situated at an elevation of 7,950 feet, the main peak bearing S. 70° W. This is the most southerly location. The developments consist of three short tunnels. The vein, which is in rhyolite, strikes north and south, and the ore consists of a

fine-grained, almost chalcedonic quartz, which probably replaces rhyolite. Bunches of stibnite needles and grains of pyrite replace this chalcedony or less silicified rhyolite. The ore is said to carry silver.

The Neversweat claim is half a mile north of Bell & Ward's, but the vein is said to lie 600 feet east of that in the latter property.

A shaft 80 feet deep has been sunk on a narrow vein striking north and dipping steeply west. Some drifting had been done. The ore is said to contain some gold, but its value lies principally in silver. Many assays of $30 to $100 are said to have been obtained.

The vein contains 5 to 10 inches of quartz filling, in places apparently pseudomorphic after calcite. Some adularia is mixed with the quartz, and pyrite was observed in the specimens. Ruby silver, cerargyrite, and native silver are said to occur in the ore, but there seems to be no stibnite. Two check assays were made of quartz from the Neversweat shaft; the first yielded 40 cents in gold and 21 ounces of silver, the second $1.40 in gold and 105 ounces of silver to the ton.

A little north of Neversweat prospect is the Martin property, but this was not visited.

In part, at least, there is some similarity between the veins of Buckskin Peak and those at National. They are mainly silver veins and at least one of them contains stibnite. The strike is north in both districts.

Summit of Buckskin Peak.—As stated above, the rhyolite summit of Buckskin Peak has been irregularly altered by hot-spring solutions. The outcrops are craggy and consist in part of silicified rhyolite of light-gray color, in part of gray chalcedony, which is pitted, irregular, and rusty.

It is stated that those hot-spring deposits contain traces of gold and silver, as well as quicksilver. No trace could be found of cinnabar in the specimens examined. They contained, however, some small reddish-brown spots, which gave distinct reaction for selenium, probably occurring native as a result of oxidation. Too little material was available to ascertain with what metal the selenium was originally combined.

There can be no doubt that the hot-spring action which produced this chalcedonic material took place at the surface shortly after the eruption of the rhyolite and in the short interval which elapsed before the rhyolite again was covered by later basalt flows.