THE ROUND MOUNTAIN DISTRICT, NEVADA.

By Henry G. Ferguson.

FIELD WORK AND ACKNOWLEDGMENTS.

In the course of a detailed study of the ore deposits of the Manhattan district the writer made short visits to Round Mountain in 1915 and 1919. He is under obligations to Messrs. Louis D. Gordon, R. H. Ernest, and Gibson Berry for hospitality and much assistance.

SITUATION AND TOPOGRAPHY OF THE DISTRICT.

The Round Mountain district is situated on the western flank of the Toquima Range, about 45 miles north of Tonopah, the nearest available railroad point, and is reached by daily automobile stage from Tonopah by way of Manhattan. The range slopes gently toward the waste-filled Big Smoky Valley, but here and there prominent hills, of which Round Mountain is the most conspicuous, rise boldly through the valley fill near its margin. The summit of Round Mountain is about 700 feet above the level of the valley at its base, and a northern spur, known as Stebbins Hill, is about 100 feet lower. On the south side of the hill are the buildings and mill of the Round Mountain Mining Co. The town of Round Mountain occupies the flat on the northeast side of the peak. Two creeks, Jefferson and Shoshone, flow northwestward from the upper part of the Toquima Range and lose themselves in the desert a short

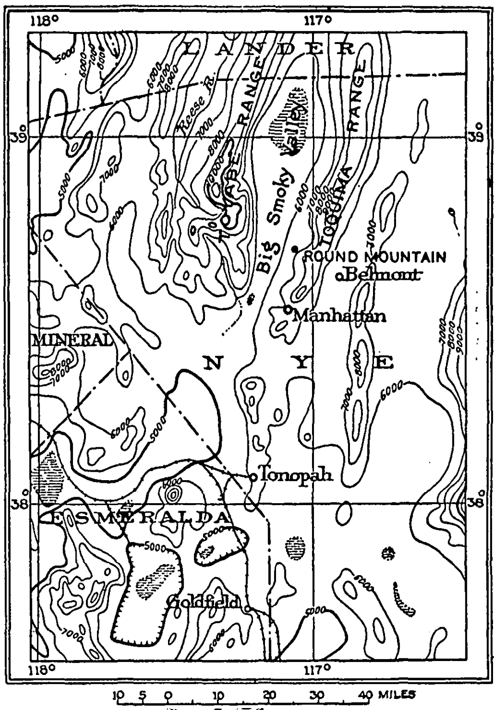

FIGURE 58.—Map of central Nevada showing location of the Round Mountain district.

distance north of the town. Round Mountain itself is nearly bare of vegetation, but the higher hills to the east are sparsely timbered; willows and cottonwoods line the lower courses of the creeks.

PREVIOUS WORK.

Very little has been published on the geology of the district. In 1899, before the discovery of the ore deposits, J. E. Spurr made a reconnaissance of central Nevada, and his report contains notes on the geology of the Toquima Range.[1] A description of the Sunnyside mine by F. L. Ransome[2] was published in 1909. At that time lode mining had reached the 500-foot level and placer mining had just begun. Two articles by George A. Packard[3] give a good description of the camp in early days. A paper by J. P. Loftus[4] gives the early production of the different gold mines. The only publication dealing with the tungsten deposits is a short note by G. Chester Brown.[5]

HISTORY AND PRODUCTION.

The ore deposits of the Round Mountain district were discovered in February, 1906. Rich ore showing free gold was found at the surface, but the lack of vein quartz seems to have caused the district to be regarded unfavorably. During 1906 two companies were at work developing lodes, but the only recorded production was obtained from dry washing the rich surface material. Lode production increased rapidly, however, and the district suffered from the usual boom and relapse, although Round Mountain was never so widely and injudiciously advertised as Manhattan. Most of the production came from the hill of Round Mountain itself and, as development work progressed, the inevitable apex litigation led to the consolidation of several companies into the Round Mountain Mining Co., which since 1913 has been the dominant producer of the district.

The placers have always contributed a large part of the output. At first the gold was obtained by dry washing; then water for hydraulicking was brought in, first from Shoshone and Jefferson creeks and finally from Jett Canyon, in the Toyabe Range.

Tungsten ore was discovered in the hills to the east in 1907 and unsuccessful attempts were made to mine the huebnerite lodes. It was not until the rise in price of the metal in the summer of 1915 that any tungsten ore was shipped. This output came from surface material worked with dry-washing machines.

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1 Spurr, J. E., Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, 1903.

2 Ransome, F. L., Round Mountain, Nev.: U. S. Geol. Survey Bull 380, pp. 44–47, 1909.

3 Packard, G. A., Round Mountain camp, Nev.: Eng. and Min. Jour., vol. 83, pp. 150–152, 1907; Round Mountain, Nev.: Min. and Sci. Press, vol. 96, pp. 807–809, 1908.

4 Loftus, J. P., Round Mountain, its mines and its history: Am. Min. Cong., 12th Ann. Sess., Rept. Proc., pp. 445–452, Denver, 1909 (also in Min. and Sci. Press, vol. 99, p. 568, 1909).

5 Brown, G. C., Round Mountain tungsten mine: Salt Lake Min. Rev., Aug. 15, 1911, p. 16.

The following table shows the gold and silver production of the camp as given in Mineral Resources of the United States. The table is incomplete because in some years it was not possible to publish details of production without disclosing individual returns.

Gold and silver produced in the Round Mountain district, Nev., 1906–1919.

[From Mineral Resources of the United States.]

Year.	Lode mines.					
	Ore (tons).	Gold.		Silver.		Total value of gold and silver.
		Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.	
1906						
1907						$122,261
1908	35,352	18,621	$384,886	13,862	$7,347	392,233
1909	41,838	23,549	486,763	14,554	7,568	494,331
1910	47,584	18,970	392,098	11,477	6,198	398,296
1911	51,904	18,402	380,385	12,242	6,488	386,873
1912	61,047	15,037	310,812	9,370	5,763	316,575
1913	55,696					
1914						
1915	50,006	12,756	263,062	6,891	3,464	266,526
1916	29,927	10,260	212,072	8,505	5,596	217,668
1917	13,584					101,565
1918	12,737					
1919	11,919	19,466	402,354	11,430	12,802	415,156

Year.	Placer mines.					Total value of gold and silver produced by lode and placer mines.
	Gold.		Silver.		Total value of gold and silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.		
1906					$39,128	
1907					49,310	$171,571
1908					55,298	447,531
1909	672	$13,885	358	$186	14,071	508,402
1910	1,743	36,026	1,026	544	36,580	434,876
1911	2,050	42,378	1,106	586	42,964	429,837
1912	1,712	35,392	969	596	36,988	353,563
1913						364,390
1914						386,067
1915	3,153	72,612	2,008	1,018	73,630	340,156
1916	5,025	103,806	3,121	2,054	105,860	323,528
1917	7,466	154,323	4,548	3,748	168,070	269,635
1918	3,566	73,710	2,137	2,137	75,847	
1919	2,225	45,981	1,276	1,429	47,410	462,566

The early production of the camp, up to the middle of 1909, is estimated by Loftus [6] as follows:

Round Mountain Mining Co.	$709,000	Various lessees	$30,000
Placers	150,000	Fairview	60,000
Sphinx	60,000		
Daisy	60,000		1,069,000

[6] Loftus, J. P., Round Mountain, its mines and its history: Am. Min. Cong., 12th Ann. Sess., Rept. Proc., pp. 445–452, Denver, 1909; Min. and Sci. Press, vol. 99, p. 568, 1909.

The largest producer, the Round Mountain Mining Co., has published the following figures of its output since 1910:

Production of the Round Mountain Mining Co.

[From annual reports of the company.]

Period.	Lode mining.		Placer mining.	
	Tons mined.	Value of bullion recovered.	Cubic yards.	Value of bullion recovered.
Apr. 1, 1910, to Mar. 31, 1911	36,252	$302,680		
Apr. 1, 1911, to Mar. 31, 1912	54,915	389,582		
Apr. 1, 1912, to Mar. 31, 1913	57,360	318,985	[a]218,818	[a]$339,583
Apr. 1, 1913, to Mar. 31, 1914	57,187	260,200		
Apr. 1, 1914, to Mar. 31, 1915	48,230	275,544		
Apr. 1, 1915, to Mar. 31, 1916	48,929	241,505	53,422	59,498
Apr. 1, 1916, to Dec. 31, 1916	15,523	115,508	122,055	80,415
1917	12,118	78,483	127,788	142,978
1918	2,151	78,330	71,367	68,324
1919	3,278	115,855	62,640	46,258
1920	5,891	90,827	64,665	56,277
	341,834	2,267,499	720,755	793,333

[a] Operations by lessees, 1906 to 1915.

GEOLOGY.

The accompanying geologic map (fig. 59) is the result of a hasty reconnaissance of the southern part of the Toquima Range. The topographic base for the portion west of the 117th meridian is taken from the Tonopah map of the United States Geological Survey, which is published on a scale of 1 : 250,000. For the portion east of that meridian a rough sketch map was made by the writer.

The rocks in the neighborhood of Round Mountain consist of Paleozoic sediments, granitic rocks of probable Mesozoic age, and later Tertiary igneous rocks and lake beds.

The Paleozoic rocks are for the most part dark limestones, which are interbedded with black jasper, and dark slaty schist, chiefly of Ordovician age. Ordovician fossils (graptolites) were found on the ridge north of Mariposa Creek, about 4 miles south of Round Mountain, and the underlying rocks in this locality closely resemble the series of Ordovician sediments of the Manhattan district. Sedimentary rocks, consisting chiefly of schist and thin beds of crystalline limestone, occur in the valley of Jefferson Creek, about 4 miles northeast of Round Mountain. These rocks are lithologically similar to the series mapped as Cambrian in the Manhattan district.[7] Owing, however, to the alteration by igneous metamorphism, this correlation is doubtful.

The Paleozoic rocks are even more intensely folded than those in the Manhattan district, but the short time spent in the vicinity of Round Mountain did not allow any attempt to unravel the complexities of their structure.

[7] Ferguson, H. G., Placer deposits of the Manhattan district, Nev.: U. S. Geol. Survey Bull. 640, p. 168, 1917; The limestone ores of Manhattan, Nev.: Econ. Geology, vol. 16, p. 4, 1921.

Granitic rocks occupy a large part of the Toquima Range and are intrusive into the Paleozoic sediments. No data bearing on the time of intrusion could be obtained in the Toquima Range, but the rock is probably of Cretaceous or possibly early Tertiary age. Microscopic examination of specimens from the vicinity of Round Mountain shows that the rock is here a microcline granite.

The principal Tertiary rock of the district is a porphyritic rhyolite, close to quartz latite in mineral composition, which forms Round

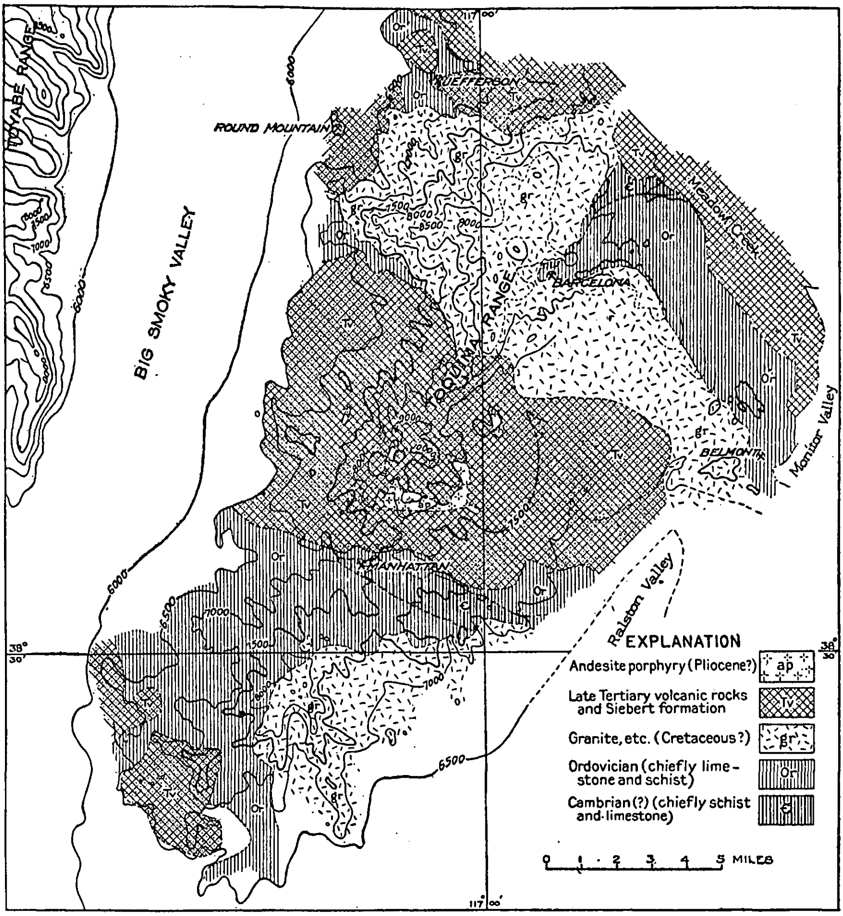

FIGURE 59.—Geologic map of the southern part of the Toquima Range, Nev.

Mountain, two hills to the south, and a hill to the east in which is the Fairview mine. This rock contains abundant phenocrysts of quartz, orthoclase, oligoclase, and biotite. The quartz occurs in deeply corroded crystals, the largest of which are 2.5 millimeters in diameter. Many of the feldspar crystals and some of the quartz are broken as if by flow of the groundmass after crystallization of the phenocrysts. The biotite occurs in small, regular plates but is very pale, apparently as a result of later bleaching by acid waters. The phenocrysts grade down in size to the microlites that form part of the groundmass. The groundmass is in part glassy but in places shows irregular polarization, which is apparently due to devitrification.

Fine-grained tuffaceous sandstone, which is intruded by rhyolite, occurs only in a small patch on the summit of Round Mountain. This rock closely resembles certain phases of the lake beds of the Tonopah district, which Spurr called Siebert tuff,[8] and similar rocks of the Manhattan district.[9] The Siebert formation is probably of upper Miocene age.[10]

The central part of the Toquima Range shows remnants of a mature topography nearly destroyed by the more recent drainage to the desert valleys. This older topography has been noted by Ball [11] and Meinzer [12] in the neighboring ranges. Ball considers it of late Pliocene age.

The detrital desert wash of Big Smoky Valley laps against the spurs of the range. The boundary between rock and valley fill is irregular, and there is no evidence of any recent faulting on the east side of the valley. On the west side, however, the bold front of the Toyabe Range is clearly formed by a large fault of comparatively recent date.[13]

ORE DEPOSITS.

The ore deposits of the Round Mountain district belong to two periods. The earlier of these periods followed the granite intrusion and is characterized by tungsten ores. To the later period belong the gold-bearing veins of late Tertiary age.

TUNGSTEN.

Ore deposits clearly dependent on the granitic intrusions have been mined in different parts of the Toquima Range. The most notable are those of the silver mines of Belmont and Barcelona, on the eastern flank. These are quartz veins carrying sulphides, which traverse the sedimentary rocks close to the granite contact. A silver mine in the slates north of Mariposa Creek, which was worked many years ago, probably belongs to this type.

In the Round Mountain district the ores formed as a result of the granite intrusion are represented by small veins in the granite that

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[8] Spurr, J. E., Geology of the Tonopah mining district, Nev.: U. S. Geol. Survey Prof. Paper 42, p. 51, 1905.

[9] Ferguson, H. G., The limestone ores of the Manhattan district: Econ. Geology, vol. 16, p. 6, 1921.

[10] Knopf, Adolph, The Divide silver district, Nev.: U. S. Geol. Survey Bull. 715, p. 153, 1921.

[11] Ball, S. H., A geologic reconnaissance in southwestern Nevada and eastern California: U. S. Geol. Survey Bull. 308, pp. 16-17, 99, 119, 161, 202, 1907.

[12] Meinzer, O. E., Geology and water resources of the Big Smoky, Clayton, and Alkali Spring valleys, Nev.: U. S. Geol. Survey Water-Supply Paper 423, pp. 22-24, 1917.

[13] Meinzer, O. E., op. cit., p. 22.

carry small quantities of the manganese tungstate huebnerite. These veins have been known since 1907, but the early attempts to develop them were unsuccessful. In 1915 a small quantity of tungsten ore was produced by working residual surface material with dry-washing machines. During the war the high price of tungsten led to greater development, but at the time of the writer's second visit, in 1919, mining had ceased. The only lode workings visited by the writer were those on the hills south of Shoshone Creek, on the claims of E. L. Stevenson and C. Schuppy, about 2 miles southeast of Round Mountain. The veins are within the area of microcline granite, which in this vicinity shows a particularly even and regular texture, the aplitic phase that is so prominent near the contact at Manhattan being absent. A few small pegmatite dikes are found near the contact of slate and granite. These pegmatites show little variety in mineral composition and consist chiefly of quartz and feldspar. The quartz veins which carry the huebnerite range from thin stringers to masses 1½ feet in width and have a generally parallel strike, between north and N. 20° E., and a dip in most places rather less than 45° E. Development work had not been carried far enough to determine the extent of any of the veins, but so far as could be seen they are not continuous over long distances. In some places the veins are close enough together to give a banded appearance to the granite.

Mineralogically the veins are comparatively simple. Huebnerite is the only metallic mineral present, except in a few veins close to the slate contact, where a little tetrahedrite also occurs. The quartz is coarsely crystalline, with rather rare vugs. The sharp huebnerite crystals inclosed in the quartz suggest that the crystallization of these minerals was simultaneous or that the quartz was slightly later. Muscovite is present in nearly all the veins but is usually confined to a narrow band close to the walls. Fluorite, in complex delicate pink crystals, was seen in nearly all the veins, usually as crystals on the faces of projecting quartz pyramids in the vugs and more rarely as poorly defined streaks in the central parts of the veins. A very slight amount of oxidation is shown by minute amounts of manganese oxide stain and small specks of yellow tungstite. Concentrates from these deposits, from the old mill on Shoshone Creek, showed, aside from a little magnetite derived from the granite, only huebnerite and fluorite. On the ridge southeast of the town Mr. Schuppy was working a residual placer with a dry-washing machine. Here the concentrates contain monazite but no fluorite. The larger fragments of quartz carry huebnerite and are sharp and angular; rounded pebbles are entirely lacking. Although the small outcrop of bedrock uncovered below the 2 or 3 feet of placer ground mined seems to be granite of the usual type, it is thought probable that the deposit mined at this place represents the decomposition products of a huebnerite-bearing vein closely allied to a pegmatite. The huebnerite appears to have been deposited under changing conditions of temperature and pressure which ranged from those under which the pegmatite-like veins were formed, as in the Schuppy placer, through those under which the emanations from the granitic magma formed quartz veins without admixture of sulphides, to a final slight overlap of the stage of sulphide deposition, as shown by the presence of tetrahedrite in one of the veins.

GOLD.

LODES.

The profitable gold deposits are confined to the rhyolite on Round Mountain and the neighboring hill to the east. The hills south of Round Mountain consist of similar rock but appear to be barren.

The veins on Round Mountain are now all owned by the Round Mountain Mining Co., and those on the hill to the east by the Fairview Mining Co., which is under the same management. The principal veins on Round Mountain are known as the Los Gazabo and the Keane. The Los Gazabo crops out on the south flank of Round Mountain. It strikes westward and dips about 15° N. It has yielded ore for 900 feet down the dip, or less than 350 feet vertically below the outcrop. The Keane vein dips to the south and has proved productive only in the lower levels. The Mariposa vein lies north of the Keane and dips gently to the south. Several rich stringers have been encountered at depth on the footwall side of the Los Gazabo. In the so-called sheeted zone, on the west side of the hill, and the stringer section east of the shaft small veinlets occur so close together that the entire deposit has been mined by the glory-hole method. Very rich ore has been taken from small veins which crop out near the top of Round Mountain and on Stebbins Hill. These veins do not appear to extend to any great depth, as an adit driven at a depth of about 400 feet below their outcrop gave negative results. Most of the ore on Fairview Hill has come from small stringers parallel to a well-marked fault, which strikes about west and dips 60° S.

The grade of ore mined differs according to the method of mining adopted. From 1910 to 1917, when the Round Mountain Co. for the most part mined its own ores, a large tonnage could be handled economically, and the average value of bullion recovered per ton of ore was between $6 and $7. In 1918 and 1919 the leasing system was chiefly used, and small rich streaks were followed by the lessees. During this period the average value of bullion recovered per ton of ore mined was $35.77. In 1920 the recovered value per ton of ore mined on company account was $4.73 and that mined by lessees $52.68.

The range of ore deposition is comparatively shallow. The deepest ore mined, from the 900-foot level of the Sunnyside mine (about 300 feet below the collar of the shaft), is above the water level and about 700 feet below the top of Round Mountain. Elsewhere in the district the productive zone appears to be even shallower.

Free gold is the only valuable mineral obtained, for although auriferous pyrite is present in some veins the quantity is too small to warrant concentration or cyanidation. The gold is intercrystallized with quartz or associated with limonite and minor manganese oxide in small fissures in which quartz may be lacking, and both types of occurrence may be present in the same vein.

The primary quartz veins are for the most part not continuous over long distances. The Keane vein and apparently also the primary veins of the Fairview seem to have followed preexisting faults. These veins generally do not exceed a few inches in width, and much of the high-grade ore from the top of Round Mountain came from veins scarcely over an inch wide.

The primary metallic minerals present are gold, pyrite, and rarely realgar. The gangue consists essentially of quartz together with accessory adularia and alunite and rarely fluorite.

Free gold of primary origin occurs irregularly in the quartz veins. As a rule the average tenor of these veins is not high, though here and there they contain small but extremely rich shoots. In one of the richest specimens collected the volume of the gold as measured in a thin section is as much as 30 per cent of the mass. The gold in the rich ore is coarse enough to be readily seen with the naked eye, and large masses are occasionally found. As a rule the gold rests on the projecting quartz crystals in drusy cavities and is distinctly crystalline, usually in fairly well defined octahedrons and more complex forms. In high-grade ore of this type from the Fairview mine the coarser quartz on the walls of the vein contained no gold, but the inner portion consisted of very fine interlocking quartz grains in which gold occurs as rather thick plates arranged in graphic texture (fig. 60). In veins of this type in many places the gold shows a distinct greenish tinge, in contrast to the yellow gold that is associated with limonite.

The rich ore that contains crystalline gold, although iron stained in places, is not commonly associated with iron oxide. Indeed, some of the best examples of "specimen ore" from the small veins on the top of Round Mountain show no iron stains whatever.

Gold on adularia was observed in specimens from the rich veinlets on the top of Round Mountain. In a specimen from the Keane vein small specks of gold are inclosed in alunite.

A small amount of pyrite is found in the ore. As even the deepest workings are above the water level, little of this mineral remains unaltered, but here and there pseudomorphs of limonite retain the form of the original crystals of pyrite. In a few places, where the veins happen to be exceptionally tight, the pyrite is unoxidized. Among the great number of small, closely spaced veins which compose the "stringer" section of the Sunnyside mine there are several in which very minute cubes of pyrite are thickly scattered through the fine-grained quartz. Oxidized pyrite occurs irregularly in the country rock close to the veins. In the Fairview mine a clayey gouge, which was apparently formed by faulting before mineralization occurred, contains minute crystals of pyrite.

Minute specks of realgar were found in ore from the 700-foot level on the Keane vein. This mineral appears to be contemporaneous with the quartz, and as no other arsenic-bearing sulphide, such as arsenopyrite, was found, the realgar is thought to be primary.

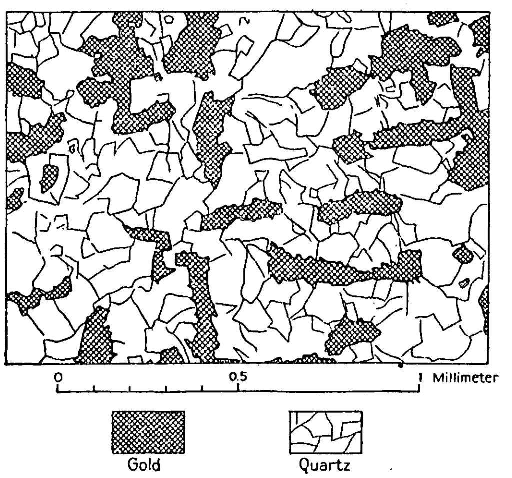

FIGURE 60.—Primary ore from Fairview mine, Round Mountain, Nev. (camera lucida drawing).

The principal gangue mineral is quartz, which occurs in a variety of forms. Most of the veins show a rough-banded texture, as their walls are lined with little elongate crystals, beneath which is fine-grained granular quartz. Here and there small drusy vugs occur, but the quartz is not noticeably cavernous. In a few places a small amount of later quartz has been deposited on the surfaces of the earlier quartz crystals. Quartz replacing lamellar calcite, usually a common feature of ore deposits of this type, is very rare at Round Mountain.

Most of the primary veins are narrow and show comb structure. The quartz crystals stand normal to the walls of the fissure, and small vugs are common. In some veins, however, the quartz has a dense porcelain-like texture, which under the microscope shows a mosaic of fine, angular interlocking grains.

Adularia is present as a minor gangue mineral, usually in small crystals on the projecting quartz crystals of the vugs. In general, it appears to be associated with the high-grade ore.

Alunite in minutely crystalline masses occurs in some of the veins but has not been observed in the altered country rock. Commonly it forms a partial filling of small drusy vugs in the quartz, and in one place it was closely associated with crystalline gold. Specimens of massive white alunite in which a little quartz is intergrown were collected from the Keane vein on the 800-foot level of the Sunnyside mine. The alunite appears to have formed a little later than most of the quartz of the veins but has all the appearance of a primary vein mineral.

A little fluorite was found in one of the minor veins of the Sunnyside mine.

Alteration of the rhyolite by the solutions which deposited the primary ore has not been widespread. As already stated, a little pyrite occurs in places in the country rock close to the vein. All the thin sections of rhyolite from Round Mountain showed more or less sericitization of the feldspar. There is also a slight silicification close to the veins. Apparently silicification was contemporaneous with the vein filling and slightly later than sericitization, for in one specimen quartz and a little gold replace part of the feldspar crystal that had previously been partly sericitized.

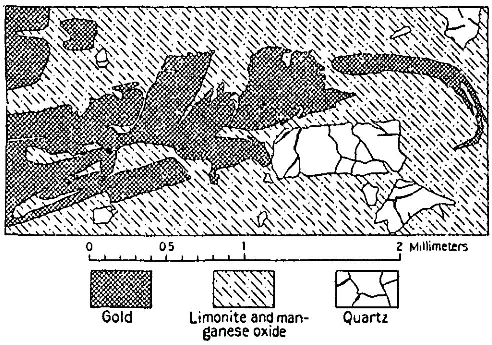

FIGURE 61.—Secondary ore from Sunnyside mine, Round Mountain, Nev. (camera-lucida drawing).

After the primary quartz veins were deposited, new fissures were formed. This later fissuring was probably as extensive as the original fissuring, but for the most part the later fissures did not follow closely the original veins. The supergene waters that oxidized the auriferous pyrite in general followed the new channels, which crossed the older veins at many points, and iron oxide and secondary gold were deposited along these newly formed fissures.

The result is a second type of vein which consists of a fissure filled chiefly with mixed oxides of iron and manganese, the iron in excess of the manganese. Commonly the adjoining country rock is shattered for some distance from the major fissure, and in many places the smaller parallel fissures are the more productive. Crushed fragments of vein quartz occur here and there, but in some of these fissures no gangue minerals other than limonite and pyrolusite are present. The gold is usually inclosed in limonite or manganese oxide, in the middle of the fissure (fig. 61). The gold in these veins differs from that of the quartz veins in that distinct individual crystals are absent, and it occurs in small thin plates or delicate flat feathery crystals, that never show the greenish tinge commonly seen in the gold from the quartz veins.

Polished sections of the secondary ore show that the gold was deposited both contemporaneously with and slightly later than the accompanying limonite and pyrolusite. In places a small piece of gold forms the nucleus around which botryoidal pyrolusite has been deposited. Elsewhere what appear to the naked eye as small plumes of rusty gold are seen under magnification to be intimate intergrowths of gold and limonite. In a few specimens small threads of gold cross the banded oxides.

Some of the secondary gold seems to consist of two varieties—an earlier pale-yellow gold and a small amount of a deeper-yellow gold, which has been deposited around the edges of the first. The intergrowth of gold and iron oxide, however, is in places extremely intricate, so that possibly the apparent rim of darker gold is due to an intergrowth of gold and iron oxide so fine as to lie beyond the limit of microscopic observation.

Besides the gold present in those fissures in which quartz is lacking, in some places the quartz of the primary veins has been crushed and a small amount of gold deposited subsequent to this crushing.

The wall rock of the secondary fissures is deeply stained with iron oxide for several inches from the fissure. Close to the fissure the rock has been almost completely replaced, leaving only the original quartz phenocrysts in a matrix of limonite or more rarely hematite. In places the altered wall rock shows alternate bands of limonite and hematite.

Kaolinization of portions of the feldspar phenocrysts that had escaped sericitization appears to have been contemporaneous with the deposition of the oxide-filled fissures. In a few places microscopic grains of a mineral that appears to be jarosite are present in the altered rhyolite close to the fissure. A little halloysite in open spaces in the quartz veins on the top of Round Mountain may also belong to this period.

The large amount of limonite in these fissures suggests that the secondary gold originally occurred in pyrite, which has now been oxidized, and actual solution of the free gold of the primary veins probably took place only on a very small scale, if at all.

As already stated, manganese oxide is present in many of the rich oxide stringers. It ordinarily forms a thin streak in the middle of the fissure and commonly incloses the gold. Barren fissures filled with sooty pyrolusite were cut in the adit of the Sunnyside mine.

Scorodite, an iron arsenate, occurs in minute green crystals in minute open spaces of the primary quartz veins near the realgar and in the secondary fissures as thin crusts associated with limonite.

In many places the two types of ore grade into each other. The quartz-vein phase is present, but reopening of the fissure along one wall has formed a channel in which limonite and manganese oxide, together with free gold, have been deposited.

It is believed that the gold-quartz veins represent the ore essentially as it was originally deposited and that the gold in the later fissures in all probability owes its occurrence to secondary deposition by supergene waters and was presumably derived from the primary auriferous pyrite. At some period after the deposition of the quartz and primary gold, which probably took place not far from the surface, renewed fissuring, which only in part followed the earlier fissures, gave opportunity for supergene water to deposit gold dissolved out of the original deposits. In many of the richest veins both types of mineralization appear to have occurred, for in places the later fissuring, which provided channels for the supergene gold-bearing waters, followed the same general lines of weakness defined by the early fissures in which the primary gold-bearing quartz was deposited.

The bullion produced by the mines of Round Mountain contains a considerable admixture of silver. The fineness of the gold, according to bullion returns seen by the writer, ranges from 574 to 696. To some extent the purer gold seems to be associated with the later fissures, in which the leafy gold, presumed to be secondary, is dominant. Observations on this point were not, however, sufficiently detailed to permit any definite conclusions.

Apparently the greater part of the ore from the deeper workings, as in the lower levels on the Los Gazabo vein, is secondary. The larger part of the primary ore, such as that found on the top of Round Mountain, came from the higher levels, although primary ore from the Keane vein has been mined to as great depths as the secondary ore of the Los Gazabo. This generalization, however, like the last, lacks sufficient field observation.

PLACERS.

The veins of Round Mountain and the neighboring hill to the southeast have yielded placers, which are in places exceedingly rich. Most of the placer production has come from the immediate vicinity of Round Mountain, but placers have also been mined in the low ground south of the ridge between the Fairview and Sunnyside mines.

In the early days of the camp good returns were obtained from surface material on the slopes of Round Mountain worked by dry-washing machines. Water, however, was soon brought from Jefferson and Shoshone creeks and hydraulic mining commenced. This supply was insufficient, and in 1915 the Round Mountain Co. completed the installation of a 9-mile pipe line to bring water from Jett Canyon, in the Toyabe Range. Even this pipe line did not supply sufficient water for hydraulic operations throughout the year, and the length of the mining season varies with the amount of winter snowfall in the mountains. Under ordinary circumstances placer operations can not be continued later than July.

The placer gravel at the Sunnyside mine is composed of coarse, angular rhyolitic wash, without definite bedding. Where it is being mined near the hill the maximum depth is about 30 feet, but it deepens toward the valley. Out into the valley, however, the angular rhyolitic talus is covered by roughly stratified material containing an admixture of granite pebbles and boulders unsorted in size. This material carries far less gold than the angular unstratified rhyolitic material beneath it. The following results obtained by prospecting the ground toward Smoky Valley, south of the main tailrace, supplied by the courtesy of Mr. L. D. Gordon, of the Round Mountain Co., show the increase in gold content below the lower stratified material.

Gold content of placer ground south of main tailrace of Round Mountain Co.

Depth (feet).	Value per cubic yard.	Cubic yards.
0-10	$0.202	40,000
10-20	.233	40,000
20-30	.642	40,000
30-40	1.70	35,000
40-50	2.89	28,000
50-60	3.55	3,000

The grade of bedrock toward the valley is about 4 per cent and that of the surface is somewhat less, so that the deposits become thicker to the west. Some shafts sunk in the valley west of Round Mountain to depths of 100 to 200 feet indicate the possibility of old stream channels along bedrock, which may prove profitable. These channels were presumably formed during an earlier, more humid period of permanent streams.

Although the gold is found in workable amount throughout the unsorted material, in places the material that rests directly on bedrock is extraordinarily rich. The writer has seen six small egg pans of gravel taken just above bedrock that yielded 0.4 ounce of gold.

The gold is angular and coarse and shows no evidence of any transportation. Nearly all the nuggets carry particles of either quartz or siliceous limonite attached to their surfaces. Besides the gold, the concentrates contain only a little finely divided magnetite and small grains of limonite and manganese oxide. As far as appears from the inspection of a few nuggets, the two types of gold—that of the quartz veins and that which occurs in the limonite fissures—are about equally represented.

On the Red Top claim in the wash to the east the rhyolitic material is to some extent contaminated with granite wash, and a little huebnerite and monazite, together with rare specks of native copper, were found.

The angular material of the Round Mountain placers, particularly that near bedrock, is in places cemented by a limy deposit into a hard conglomerate. In places small cavities between the pebbles have been filled with crystalline calcite. The gradual break-up of this hardpan in the sluice boxes prevents any marked concentration of gold in the upper boxes.

Large angular boulders are present. Apparently these boulders are less common immediately above bedrock than a few feet higher. Nearly all the material in the lower unstratified part of the Round Mountain placers consists of rhyolite, mixed with pieces of tuffaceous sandstone similar to that found on the top of the hill. The proportion of this material in the placers seems to be in excess of the present relative volumes of the two rocks and indicates that formerly the tuff had a greater extent above the intrusive.

In places, as near the Sunnyside shaft, small veins have been exposed on bedrock, and gold from these veins, as well as from those that have been explored on the hills, has fed the placers. On the Blue Jacket claim such veins are now being prospected by the Fairview Extension Co.

The purity of the placer gold is only slightly higher than that of the lodes. During the years 1908–1912, 1915, 1916, and 1919 the production of the lode mines, as given on the table on page 385, amounted to 137,061 ounces of gold and 88,331 ounces of silver, equivalent to 60.8 per cent gold in the total. Figures for placer production are available for the years 1909–1912 and 1915–1919. During these periods the placer mines produced 27,614 ounces of gold and 16,549 ounces of silver; the percentage of gold was 62.6. This difference may indicate a slightly larger proportion of secondary gold in the placers or may be due to a slight solution of a portion of the silver. Under present conditions, however, action by ground water must be practically negligible.

AGE OF ORE DEPOSITION.

If the writer is correct in his assumption that the small remnant of tuffaceous sandstone on the top of Round Mountain is the equivalent of the lake beds of the Tonopah district, called Siebert tuff by Spurr,[14] then it follows that the age of the deposits must be upper Miocene or later, and they are consequently younger than the productive veins of the Tonopah district and possibly contemporaneous

[14] Spurr, J. E., Geology of the Tonopah mining district, Nev.: U. S. Geol. Survey Prof. Paper 42, pp 51–54, 1905.

with the veins of the "third period" [15] of Tonopah. They may be of approximately the same age as the mineralization at Manhattan,[16] Goldfield,[17] and Divide.[18]

Primary mineralization probably took place prior to the development of the late Pliocene erosion surface and was genetically connected with the intrusion of rhyolite. If so, the primary fissures may have been formed as a result of readjustments due to the cooling of the intrusive at its margin.

The later fissuring, which furnished the channels in which the supergene waters deposited their gold, may date from early Pleistocene time and is possibly contemporaneous with the movement which produced the fault scarp along the front of the Toyabe Range, 9 miles to the west. The oxidation of the pyrite and redeposition of the gold probably took place during a period of comparatively humid climate, for the process was apparently complete before the deposition of the fanglomerate, which constitutes the upper part of the placer ground surrounding the mountain. Indications of such a climate in Pleistocene time are found in the presence of lakes in Big Smoky Valley [19] and of the Pleistocene fossils of Manhattan Gulch.[20]

The early drainage from the deposits probably flowed through permanent streams into Lake Toyabe. Increasing aridity of climate permitted the formation of the long, flat talus slope carrying the greater part of the placer gold mined to-day, and this talus slope in turn, as the hills wore back from the desert valley, was partly buried under the roughly stratified fanglomerate, which forms the upper part of the placer ground.

MINES AND PROSPECTS.

SUNNYSIDE MINE.

The veins on Round Mountain were discovered in 1906 and for several years were worked by a number of independent companies, of which the Sunnyside, Antelope, and Sphinx were the most productive. The irregular and complex nature of the vein system inevitably gave rise to litigation, which continued until the various properties were acquired by the Round Mountain Mining Co., the owner of the Sunnyside mine. Since the beginning of its operations this company has produced from lode mining alone approximately $3,000,000 and in addition about $1,000,000 from placers. Between

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[15] Spurr, J. E., Geology and ore deposition at Tonopah, Nev.: Econ. Geology, vol. 10, pp. 751-758, 1915.

[16] Ferguson, H. G., The limestone ores of Manhattan, Nev.: Econ. Geology, vol. 16, p. 32, 1921.

[17] Ransome, F. L., Geology and ore deposits of Goldfield, Nev.: U. S. Geol. Survey Prof. Paper 66, p. 175, 1909.

[18] Knopf, Adolph, The Divide silver district, Nev.: U. S. Geol. Survey Bull. 715, pp. 162-164, 1921.

[19] Meinzer, O. E., op. cit., p. 30.

[20] Ferguson, H. G., Placer deposits of the Manhattan district, Nev.: U. S. Geol. Survey Bull. 640, p. 182, 1917.

the years 1910 and 1920 over 340,000 tons of ore which yielded bullion to a value of $2,267,500 was mined.[21]

The property comprises a large number of claims, and several veins have been worked. The most productive vein is the Los Gazabo, which has been worked to a depth of 1,000 feet on the dip, or about 330 feet vertically below the collar of the shaft. This vein outcrops on the south flank of Round Mountain and dips northward beneath the hill at an average angle of about 15°. The strike is approximately east and west, but marked irregularities are present. The Combination vein, which has been mined in workings farther to the east, is probably a continuation of the Los Gazabo, separated from it by a barren interval, though the outcrop can not be traced and there is as yet no underground connection. The ore for the most part consists of limonite that incloses free gold, with almost no quartz, but on the 800-foot level a little quartz and pyrite are present.

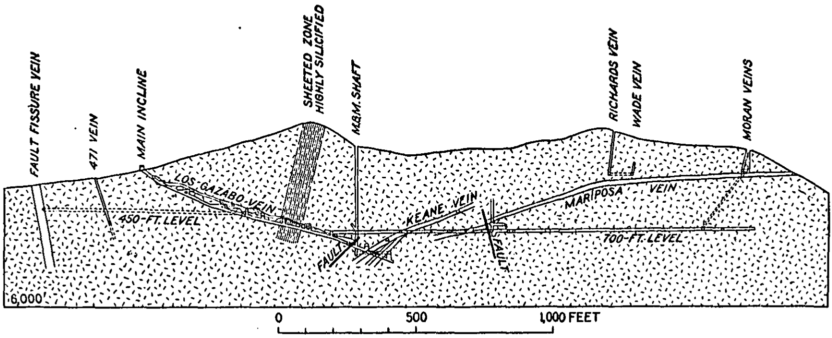

FIGURE 62.—Section through Sunnyside mine, Round Mountain, Nev. (By R. H. Ernest.)

The Keane vein, which has been worked in the lower levels of the mine, has an extremely irregular strike, though in general it trends nearly east and west and has a southerly dip, which ranges on different levels from 15° to 40°. In the region of the junction of the Keane and Los Gazabo the venation is irregular, and it is not certain whether the Keane continues in depth below the Los Gazabo. The ore commonly consists of drusy quartz carrying crystalline gold, and small amounts of alunite, pyrite, and realgar are present. Oxide minerals are not prominent.

The Mariposa vein is approximately parallel to the Keane vein and lies a short distance to the north. Near the outcrop its dip is nearly horizontal, but where intersected by the long crosscut on the 700-foot level it has a southerly dip of about 30°. Much quartz is present, but there has been later crushing and deposition of secondary gold. Other minor veins have been mined to some extent. These veins strike in a northwesterly direction and dip steeply to the northeast.

[21] Round Mountain Mining Co. annual reports.

The most productive of them occur on the footwall side of the Los Gazabo. Several steeply dipping veins have been prospected on Stebbins Hill and near the summit of Round Mountain. They do not appear, however, to continue below the flat-lying Mariposa vein.

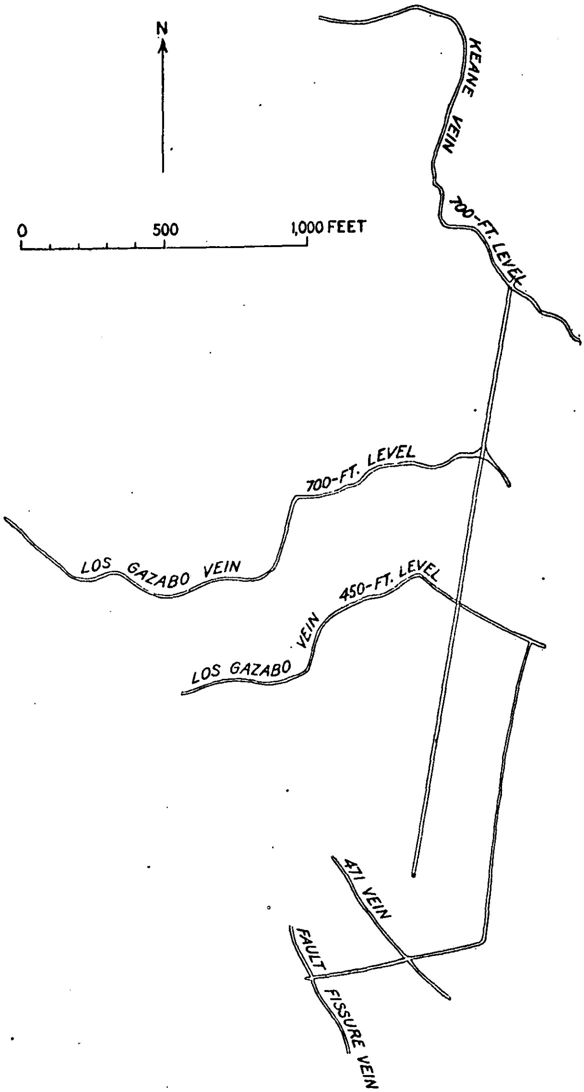

FIGURE 63.—Map of part of underground workings, Sunnyside mine, Round Mountain, Nev., showing parts of Keane and Los Gazabo veins.

The section given in figure 62, which is furnished by Mr. R. H. Ernest, former superintendent, shows the relative positions of the different veins.

Besides these principal veins, there are a multitude of small stringers, which are rarely workable individually for any considerable distance, though some of them are extremely rich at their junction with the main vein. In several places on the property small veinlets occur close enough together to have justified mining as a whole, by glory-hole methods, before costs reached their present level. Such localities include the "sheeted zone" on the western side of the hill, the old glory-hole workings north of the main shaft, and the "stringer section" about 1,500 feet east of the shaft.

The following notes on the low-grade ores of the Sunnyside mine are derived from the report of Mr. R. H. Ernest, former superintendent, for the year 1916.[22]

The No. 2 stringer section lies in the footwall of the Los Gazabo vein. It consists of vertical stringers, intersected by others almost horizontal. A section 400 feet by 300 feet is exposed in two large glory holes. From September, 1910, to January, 1915, 232,142 tons of material that had an average tenor of $2.78 a ton was mined; of this material 61,098 tons that had a tenor of $7.40 was sent to the mill, and 171,044 tons that averaged $1.13 was rejected. The material was crushed and screened, and the coarser part rejected. Afterward a system of selective mining was adopted, and 8,340 tons of ore whose average tenor was $19.67 a ton was mined in 1915 and 1916.

No. 3 glory hole lies a short distance southeast of the main shaft. The mineralized area measures 260 by 110 feet at the surface and includes the outcrop of the Los Gazabo vein. The ore consists of closely spaced vertical quartz veinlets. The sheeted zone extends downward to about 40 feet above the 450-foot level, or about 100 feet in vertical depth. Above the 135-foot level 28,458 tons that had an average tenor of $1.88 a ton was mined, and of this material 8,547 tons of fines averaging $4.45 was sent to the mill and the remainder rejected.

The Great Western and Black Hawk sheeted zone outcrops as a prominent ridge, as it is highly silicified and more resistant to erosion than the surrounding rhyolite. It consists of a network of intersecting vertical quartz stringers. High-grade ore has been found in many places near the surface, and pockets and streaks of high-grade ore occur at the intersections of individual stringers with the Los Gazabo vein. A glory hole at the intersection of this sheeted zone with the Los Gazabo yielded a large tonnage of ore, of which the part milled assayed from $4 to $10 a ton. This zone has also been opened up on the 700-foot level at a depth of 150 feet below the surface.

The so-called Great Western fissure is a similar zone from 6 to 45 feet in width, which has been traced for a distance of 2,200 feet. Over 4,000 tons of ore which assayed between $4 and $5 was mined. Underground development work indicates that the entire zone has a tenor of about $2 a ton.

[22] Round Mountain Mining Co. Tenth and Eleventh Ann. Repts., Dec. 31, 1916.

A silicified zone, which assays from $1.50 to $3 a ton, has been developed along the footwall of the Keane vein for a distance of 300 by 120 feet.

The "921" section consists of a silicified zone 90 feet wide between the 700 and 950 foot levels between the Keane and Mariposa veins. The 7,248 tons of ore mined had an assay value of $4.98 a ton. The zone as developed on the 950-foot level occupied an area approximately 100 feet square, the material from which assayed from $2.50 to $3 a ton. On the 900-foot level a drift on one of the rich streaks produced ore ranging from $8 to $100 a ton.

Another zone of low-grade ore about 30 feet wide stretches along the footwall of the Los Gazabo vein from above the 400-foot level to the 800-foot level. High-grade pockets were found at the intersection of the small stringers with the Los Gazabo vein. The whole of the mineralized zone assays from $3 to over $4 a ton; the tenor gradually decreases on the footwall side.

The irregular course of the Los Gazabo vein is well shown in the workings on the 700-foot level (about 230 feet vertically below the shaft collar). For about 700 feet westward from the shaft the vein holds fairly well to its normal strike and dip, but at this point there is a sharp change both in direction and dip, and for about 250 feet the vein trends north and south and dips vertically. Beyond this place it resumes its normal easterly strike and flat northerly dip. On the 450-foot level (80 feet vertically above the 700-foot level) there is a similar elbow but less pronounced, and it lies farther to the eastward. Divergence, due to the same north-south line, is likewise shown on the Keane vein about 900 feet to the north. The Los Gazabo vein shows a second sharp turn at the point of intersection with the Fault vein. This vein has been worked to some extent on the 450-foot level but was not generally found profitable except where it was joined by the Los Gazabo. At the junction the Los Gazabo assumes the strike and dip (about 70° NE.) of the stronger fissure and continues in this direction for about 400 feet. On the 700-foot level the end of this segment had not been reached at the time of the writer's visit, but on the 800-foot level (30 feet vertically below the 700-foot level) the continuation of the vein on its normal course has been followed. The same turn in the course of the vein at the intersection with the Fault vein has been shown in the surface workings on the western side of the hill, but here the change in direction and dip continues for only about 60 feet.

The Keane vein, so far as known, does not outcrop at the surface, but the steeply dipping veins on Stebbins Hill may quite possibly branch off from it. The strike is approximately east and west, and the dip is at a low angle to the south, but like the other veins in the district it shows many irregularities both of strike and dip. The principal departure from the normal course is along a continuation of the same north-south line that is followed by the Los Gazabo in its first sharp turn. On the Keane vein the northerly course is followed for about 600 feet, but the westward continuation of the normal course shows an apparent offset to the north opposite to that of the Los Gazabo, as if the portion west of the north-south section had been dropped down. On the 800 and 900 foot levels the Keane and Los Gazabo veins come close together, but instead of a definite line of intersection the country rock is cut by innumerable little gold-bearing quartz stringers which were close enough together to permit the entire mass to be mined. The Keane vein does not appear to continue below the Los Gazabo.

The Mariposa vein has been worked chiefly in the upper levels. On the 700-foot level it is parallel to the Keane in both strike and dip, but near its outcrop it is much flatter. The small veins on Stebbins Hill do not continue below the Mariposa and may be branches of that vein.

The 471 and Fault Fissure veins are parallel. The strike is about northwest and the dip steep, as a rule about 70° NE. The 471 vein has been found workable only on the 450 and 600 foot levels of the Sunnyside. Except for a short distance it does not seem to follow a very pronounced fissure, for it does not alter the course of the Los Gazabo vein at the point where it should intersect that vein to the northwest, and to the southeast it appears to lose its identity in the eastern "stringer section." The Fault Fissure vein, on the other hand, follows a well-defined fissure, extending from a point beyond the stringer section of the southeast workings to the western edge of the hill. Where it intersects the flat-dipping Los Gazabo vein it has diverted that vein from its course in the manner described above.

The sheeted zone on the western side of the hill and the two stringer sections, one near the shaft and the other 1,500 feet to the east, represent areas in which the rock instead of yielding to stress along a few definite planes is split by innumerable little fissures, which were filled with quartz. In the sheeted zone these fissures are for the most part closely spaced, nearly vertical veinlets that have a general easterly strike. In the stringer sections, however, they occur as steeply dipping fissures which intersect at right angles, and these in turn are crossed by nearly horizontal veinlets. The three sets seem to follow joint planes of the rhyolite. The eastern stringer section in particular shows a well-marked horizontal veinlet, which is offset by a vertical easterly series, and nearly vertical stringers that have a northerly trend also occur.

The mineralized veins as well as the small veinlets which constitute the sheeted zone and the stringer sections are believed to represent contemporaneous fissuring and to form an irregular cognate fissure system, in which the irregularity and multiplicity of the fissures are due to the comparative nearness to the surface at the time of fissuring. Postmineral movement is shown in a few small transverse faults and in the presence of gouge along one wall of the larger veins.

The ore is everywhere oxidized, and only very rarely has any pyrite been found, although in many places the oxidized material retains the crystal form of pyrite. The mine is dry, except in the workings to the west, where water from the hydraulic mining on the surface has penetrated the lowest workings along the Los Gazabo vein and the many small fissures. Quartz does not form a large part of any of the veins with the exception of the Keane vein. The ore from the Los Gazabo vein consists almost entirely of limonite and manganese oxide together with minor amounts of quartz and of altered rhyolite, deeply impregnated with limonite. A little purple fluorite was observed on the Fault vein on the 450-foot level, and a small cluster of aragonite crystals was taken from one of the upper levels on the Los Gazabo vein.

Even in the freshest specimens from the neighborhood of the veins a considerable alteration of the country rock can be observed. Comparatively fresh rhyolite from the long crosscut on the 700-foot level shows complete sericitization of the feldspars and a bleaching of the biotite, accompanied by the introduction of a little pyrite.

FAIRVIEW MINE.

The Fairview mine, on the hill east of Round Mountain, is similar to the Sunnyside in general type. The rock is rhyolite, identical in appearance with that of Round Mountain. The shaft cuts the underlying granite at about 200 feet in depth, and the same contact was intersected by a drift from the bottom of the shaft on the Daisy claim at a depth of 250 feet. The contact here is marked by a fault which strikes about north and dips at a low angle to the west.

The principal output has been derived from two adits in the hill above the shaft, known as the 110 and 250 foot levels.

The 110-foot level shows a well-marked fault which has an average strike of about N. 80° W. and a dip of 60° S. Although a little ore was found in places this major fault was not marked by productive material. Parallel to this fault and from 30 to 60 feet to the north occur sets of small, closely spaced stringers which yielded ore from this level to the surface. The lower limit appears to be a series of small slips, which dip from 10° to 30° NE. Small quartz veins rich in free gold have been mined, but the majority of the productive stringers above these veins are not distinct quartz veins, though crushed quartz is present in many places, but small fault planes, which show much iron oxide and are in places highly manganiferous. The gold occurs free in this material and is not associated with quartz. The inclosing rhyolite is bleached and iron-stained for an inch or two from each stringer but otherwise shows no marked alteration.

On the 250-foot level, farther down the hill, the ore occurs in similar stringers, but not as rich as those on the 110-foot level, and here it lies to the south of the principal fault. Definite quartz veins are lacking, though small amounts of crushed quartz are encountered in the ore and small comby quartz veins have been cut. According to the annual reports of the Fairview Round Mountain Mines Co. the production has been as follows:

Ore produced by Fairview mine, 1906–1919.

	Tons milled.	Value of bullion recovered.
1906–1917	....	$85,000
1918	8,808	178,801
1919	8,693	296,466
		480,267

FAIRVIEW EXTENSION PROSPECT.

The exposed bedrock on the old Llewellyn placer has recently been prospected with a view to lode mining. Several small shafts on small stringers which strike about N. 60° W. have yielded encouraging results, and in 1919 a shaft was being sunk on the best defined of these stringers. The ore appears to be similar to that of the Fairview.

The group of claims owned by the Fairview Extension Mining Co. had produced ore approximating $80,000 in value prior to July, 1919. In December, 1919, the mill of the Round Mountain Co. treated 102 tons of ore from these claims which gave a net recovery of $1,532. A large portion of this tonnage was obtained by screening a waste dump left by a former lessee.[23]

MONTE CRISTO PROSPECT.

The Monte Cristo prospect lies about a mile east of Round Mountain. It was visited in 1915 but not in 1919. The country rock is granite of the usual type, and the lode consiste of a fault zone which strikes N. 80° W. and dips 80° S. A streak of clayey gouge from 1 to 3 inches in width constitutes the ore. This gouge contains an irregular amount of rather coarse gold, very feathery in appearance, which was evidently deposited after the movement which formed the gouge. The gold is light in color and is said to be worth $12.55 an ounce. A little manganese oxide is also present. No definite vein quartz

[23] Fairview Extension Mining Co. First Ann. Rept., 1920.

was seen, but small broken fragments of quartz crystals occur throughout the gouge. A depth of 100 feet has been reached in the workings, and the lode has been explored for a distance of 150 feet. The presence of feathery gold in the midst of a finely comminuted gouge is believed to be due to secondary deposition. At the time of the writer's visit, in 1915, 20 tons of ore, which yielded about $2,000, had been milled.

SUMMARY.

The Paleozoic sediments of the Round Mountain district have been intruded by granite of Cretaceous or possibly early Tertiary age. This granite represents a phase of the great granodiorite intrusion which is to-day exposed over a large part of the Toquima Range. Closely following this intrusion quartz veins carrying the manganese tungstate huebnerite were formed in the granite. These veins have been exploited to some extent.

In Miocene (probably upper Miocene) time the region was covered by the bedded tuffs, shale, and sandstone of the Siebert formation. After these deposits were laid down there came a large intrusion of rhyolite. This intrusion appears to have reached a level comparatively near the surface. Numerous small fissures were formed in the newly solidified rhyolite, and these were filled with solutions derived from the rhyolite, which gave rise to the primary quartz veins carrying free gold. The primary vein filling consists of quartz with minor adularia and alunite, free gold considerably alloyed with silver, a small amount of auriferous pyrite, and a very little realgar. The alteration of the wall rock consisted of sericitization of the feldspars, the introduction of some pyrite, and slight silicification near the walls of the veins. The period of ore deposition must have been late Miocene or Pliocene. Other productive ore deposits of Nevada belong to the same general period and appear to be genetically related to intrusives of post-Siebert age.

After a period of erosion, renewed fissuring took place. This fissuring may have been contemporaneous with the Pleistocene faulting, which formed the scarp of the Toyabe Range, facing Big Smoky Valley on the west. Some of these fissures followed the quartz veins already formed and others crossed them in all directions. Oxidation of the pyrite took place during a period in which the climate was more humid than the present and the water level not so greatly depressed. The surface waters followed the newly formed fissures, and iron and manganese oxides, together with gold derived from the auriferous pyrite, were deposited along these channels, which in many places were distinct from the quartz veins. It is not certain to what extent solution of the free gold of the primary veins contributed to the formation of the secondary fissure filling.

The placer deposits were formed under conditions of climate and topography similar to those of the present. In the Sunnyside placers angular rhyolitic talus carries most of the gold. This talus is overlain by roughly stratified fanglomerate, the result of successive floods rather than steady stream deposition. The fanglomerate forms nearly the whole of the Red Jacket ground.