waters which produced the early andesite veins were unusually active and a large amount of vein formation is indicated. It is beyond question, therefore, that the veins thus far found are only a fraction of those which exist in the vicinity. These veins will be chiefly unoxidized, since they are protected from oxidation by capping rocks. In them undoubtedly large portions—probably much the larger portions—will be relatively barren quartz, in which shoots, chimneys, or irregular bunches of rich ore may be expected to a considerable depth.

These quartz veins, carrying silver and gold and occurring in Tertiary andesite, belong to a larger group of veins occurring in similar andesite and found along a north-south zone. These veins are exemplified by the Comstock in Nevada and by the important district of Pachuca in Mexico. Probably Pachuca is the nearest analogue, and its description, as given by the Mexican geologist, Ordoñez, may be of value in considering the characters of the Tonopah veins. Judging from these districts it is possible that in depth a rather larger proportion of the baser metals, such as copper, and possibly lead and zinc (although no traces of the last two have as yet been found in the veins), may come in, and that the values in gold and silver may decrease somewhat. This, however, if it happens, should do so at a considerable depth.

ORE DEPOSITS OF SILVER PEAK QUADRANGLE, NEVADA.

By J. E. Spurr.

INTRODUCTION.

Description.—The Silver Peak quadrangle is mostly in southwestern Nevada, adjacent to the California boundary; one corner of it lies in California. There are no railway or telegraph stations within the quadrangle; the nearest is at Candelaria, about 40 miles to the north of the old mining camp of Silver Peak.

The area includes the Silver Peak Range and the valley which lies east of it, together with some portions of outlying mountains, such as the Palmetto Mountains in the southern portion of the quadrangle and Lone Mountain in the northeast portion.

The climate, vegetation, water supply, and other conditions are those typical of the Great Basin region, in which the quadrangle lies. There is no permanent standing or running water of any importance, and for water supply the occasional springs have to be depended on. The valleys and lower mountain slopes are covered by sagebrush only, while on the upper slopes are nut pine (piñon) and other small trees or shrubs.

There are at present only a few hundred people within the quadrangle, and the occupations of all of these are connected with the mining industry. Although there is no very great amount of actual mining going on, some prospecting is being done. The region has been considerably mineralized. It is constantly attracting outside attention, and it is very possible that it may become the seat of a profitable mining industry if the conditions and cost of production can be so adjusted that a balance can be reckoned upon in favor of the mine operator.

GEOLOGY.

The general geology of the region has been examined for the Survey by Mr. H. W. Turner, whose report has not yet been published. His work shows that the chief rocks are Paleozoic limestones, granitic rocks of pre-Tertiary age (granites, diorites, etc.), with abundant Tertiary sediments, and Tertiary lavas, such as rhyolites, andesites, and basalts. As is the case in all this desert region, the Pleistocene wash

from the mountains, which floors the valleys and fringes the mountains, forms a conspicuous geological feature.

Ore deposits.—Ore deposits are known to exist in several different parts of the Silver Peak quadrangle. The chief districts are the Silver Peak district proper, near its central part, occupying the mountain spur known as Mineral Ridge, west of the camp of Silver Peak; the Lone Mountain district, in the northwestern corner, most but not all of which is within the quadrangle; the Windypah or Fesler district in the southern part of the Silver Peak Range; and what may be called the Palmetto district, on the northern slope of the mountain of that name. Not all of the Palmetto district is within the quadrangle.

All of these districts, and indeed all the ore deposits known, occur in close connection with large intrusive bodies of pre-Tertiary granitic rock. The ore bodies sometimes occur within the granitic rock, but more usually in the Paleozoic (Cambrian and Silurian) limestones into which it is intrusive, within a broad belt following the intrusive contact. They do not occur in the Tertiary rocks.

SILVER PEAK DISTRICT.

The Silver Peak district, which is the oldest and the most important, contains abandoned silver mines and gold mines which have been considerably worked but are still regarded as promising. The silver prospects were discovered in 1864, but were shortly left idle, and in 1867 they were opened up again and worked till 1869. It is currently reported that the profits were very small. A 10-stamp mill was finished in 1866. A lixiviation process was used, the ores being leached with salt. They have not been worked since.

The principal properties thus far developed, both silver and gold, belong to Mr. D. C. Blair, of New York. A 30-stamp mill for working the gold ores of the Blair mine was finished at Silver Peak in 1867, and was worked for two years. The mine was then idle till the early eighties, when it was leased for two or three years. Another long period of idleness ensued, and in 1893 another lease was given for one year. Immediately after this the mine became involved in litigation, which has only very recently been settled. Mining and milling in a small and intermittent way, meanwhile, has been conducted on a number of the veins, generally of minor importance, outside of the Blair properties.

It is estimated by persons who have been familiar with the history of the mining here that the silver mines have produced a gross value of $200,000, most of which came from the Pocatello and the Vanderbilt, while the Blair gold mine is estimated to have produced $1,080,000.

From the important Mary mine, situated near the Blair gold properties, Mr. John Chiatovich, the owner, has taken out and milled ore

worth $46,000; other mines have yielded $7,000 or $8,000. The Valentine Brothers have also taken out and milled several thousand dollars' worth of ore from properties controlled by them.

The Drinkwater group of mines, which is the most important part of the Blair gold properties, and which has produced practically all of the million dollars' worth of ore, as above stated, may be taken as typical of the gold veins which, though widespread and numerous, show a wonderful similarity of character. On the surface two adjacent veins outcrop, the Crowning Glory and the Drinkwater, the former the larger, the latter containing the greater quantity of good ore. The quality of the ore still left standing (only the richer portions having been removed for milling) has been more or less carefully determined a number of times. An exhaustive and careful sampling by Mr. George M. Maynard, of New York, gave the average assay value of the measurable reserves of the underlying Crowning Glory vein at $5 for a tonnage of 107,370, making a total value of $537,550. For the measurable reserves of the Drinkwater vein the average value was $9.18 for a tonnage of 4,558, and a total value of $42,118; making $579,668 for the measurable reserves of both mines. Mr. Maynard estimated the probable reserves of the mine at nearly as much, making a total value of measurable and probable reserves of approximately a million dollars.[a] Since Mr. Maynard's examination, several years ago, a considerable amount of new development work has been done which increases markedly both the measurable and the probable reserves.

Geologically, the veins of the Blair mines are interesting. Properly speaking, they are hardly veins, but flattened lenses of quartz occurring in a definite zone 100 feet or more in thickness. The lenses wedge out and disappear both horizontally and vertically, and their place is taken by overlapping lenses. The wall rock is a schist, derived chiefly from the metamorphism of an original limy shale or limestone. Frequently, also, the wall rock is a very siliceous granitic rock (alaskite) made up essentially of quartz and feldspar. This alaskite occurs in the schist in lenses similar to the quartz. There is, moreover, every transition between the alaskite and the quartz, and the schist has been, so to speak, saturated with this siliceous material, which forms seams and tiny lenses in it. The auriferous quartz lenses in the mine in many places run laterally into quartz-feldspar rock (alaskite). As a rule the values grow insignificant with the coming in of the feldspar, but occasionally high values may still be found.

The general conclusion is that here a series of fissile shales and thin-bedded limestones has been invaded by a very siliceous granitic intrusion which has metamorphosed the sediments to schists. The quartz has plainly the same origin and nature as the alaskite, both

[a] Communicated by Mr. Maynard.

being siliceous phases of a granitic magma. The gold in the quartz is usually free, sometimes associated with scattered galena. Greenstone or diorite dikes cut the veins or follow along them, but are of later age. Along the dikes there has been water circulation, resulting sometimes in impoverishment, sometimes in relative concentration, of the original values.

This zone of veins outcrops for a mile along the mountain side. At one point, some distance below the vein zone, free gold in fresh alaskite-pegmatite country rock was found.

In the main the other gold mines or prospects of the district have exactly the same geological relations.

LONE MOUNTAIN DISTRICT.

The ore deposits of this region are situated within a moderate distance of two masses of intrusive granitic rock, one of which makes up Lone Mountain Peak proper, while the other lies in the lower mountains to the south. The properties visited by the writer include the Paymaster, Esperanza, Utopia, and Alpine, the Weepah district, and numerous other mines and prospects. The first three mentioned all belong in the same class, being small, nonpersistent quartz veins in Cambrian limestone and slate. These veins are generally, but not always, parallel with the stratification. They follow crushed zones or selvages formed by movement in the limestones, possibly attendant upon faulting. The ore in the veins consists of small amounts of rich silver-copper sulphides, with some galena, pyrite, and secondary minerals such as chrysocolla, limonite, and probably chloro-bromides of silver.

The Alpine mine is situated near the contact of the Lone Mountain granite with a series of metamorphic marbles and some interbedded schists. In the marbles are seams of ore parallel with the stratification. Small quartz seams containing galena are low-grade silver ores. These lead into bodies of mixed galena and argentiferous lead carbonate, which widen out into irregular pockets and constitute the ore that is mined. The ore bodies follow a certain horizon around a hill, with lesser seams above and below. Diorite sheets and crosscutting dikes are frequent but are not in any way associated with the ore.

The area of intrusive granite above noted as lying south of the Lone Mountain granite is marked by considerable contact metamorphism in the limestone and shale into which it is intrusive. On its eastern side this contact metamorphism has been accompanied by some mineral deposition. There was here noted, interstratified with schistose slates and crystalline limestones, a metamorphosed belt about 60 feet wide and traceable for a long distance. This zone is characterized by epidote, garnet, chalcopyrite, calcite, magnetite, specular iron, pyrite, and galena, with certain secondary minerals—chrysocolla, limonite,

and others. Some of the material gives fair assays for silver, some shows gold, and some it is claimed contains a considerable quantity of tin, although this subject has not yet been investigated by the writer. Some silver ore from this zone was milled at Columbus twenty-five years ago.

Weepah is situated at the contact of the granitic mass last mentioned, on its south side. It was discovered in the early part of 1902 by an Indian, and was located by a rancher named James Darrough. The find caused some excitement, and at one time about 200 people were there. It was bonded to a company for examination, but was not further developed, and was deserted at the time of the writer's visit. The openings are very slight, consisting chiefly of a few pits showing bluish quartz mixed with limestone. From these were taken a few tons of ore showing high values in gold, with some silver, but the ore bodies could not be followed.

DISTRICT NEAR DYERS.

On the west side of the Silver Peak Range near Fish Lake Valley and 1 mile east of Dyers is a mineral district where some prospecting has been done, although at present it is deserted. In 1885 to 1887 this district was located and was the scene of a short-lived excitement, but was afterwards abandoned. Following the Tonopah discovery it was relocated, but no new work was done. One of the mines was relocated under the name of the West Tonopah, which is surprising, considering that it is about 50 miles from Tonopah as the crow flies. Nearly all the ores here are bedding-plane deposits, of the same type as many of those near Lone Mountain. They occur in the Silurian limestone, within a moderate distance of a small body of intrusive granite. Along the stratification occur bunches of quartz, which are discontinuous both in horizontal and vertical extent, fading out to absolutely nothing. The quartz contains black copper-silver sulphide, which, when oxidized, yields stains of copper carbonate, iron oxide, and silver chloride.

WINDYPAH OR FESLER DISTRICT.

This district, which has only recently been opened up, lies in the southwestern part of the quadrangle in the Silver Peak Range, east of Piper's ranch. An abandoned mine or prospect—the Good Hope—has existed for many years a number of miles northeast of the district, in the same geological position, but the camp mentioned was discovered in the winter of 1903 by J. G. Fesler. A great deal of prospecting has been done, but no actual mining. There is here a large body of granitic rock, intrusive into Silurian limestones, and the ores occur in both formations. The veins may be divided into three distinct classes:

(1) Segregations in alaskite, which is here locally intrusive into the

granitic rock. These show good gold values in segregated bunches of quartz and in the adjacent siliceous alaskite. The quartz lenses are limited in size and have not been proved to have any regular connection.

(2) Quartz veins in granite: These have formed along crushed or sheared zones. The amount of quartz is variable and the walls are ill defined. The mineralogical character is like the first class of deposits. The gold values are locally good, but all workings up to the present have been near the surface.

(3) Veins near the contact of granite and limestone: Noble silver quartz veins containing rich black sulphide, carrying copper, silver, and gold. These veins are very persistent, following the contact for miles, though different parts may not always be perfectly connected. Where noted, they follow the contact of alaskite dikes, which are probably border phases of the granitic inclusions. They do not have well-defined walls, and probably are to be regarded as replacements of the limestone along the dike contacts. Frequently a dike has such a vein on both sides, though more or less intermittently.

PALMETTO DISTRICT.

Such prospects of the Palmetto district as fall within the quadrangle were examined. The principal one is the old MacNamara, located in 1880. Although assessment work has been faithfully done upon these claims, they have not produced any shipping ore. The vein is near the contact of limestone with a large intrusive body of alaskite which itself is probably a border phase of a large granitic intrusion just south of this place. The ore occurs as quartz replacing and penetrating limestone on the under side of an alaskite dike. The limestone near the alaskite shows contact metamorphism, becoming altered to garnet, epidote, etc.

As an example of other prospects in the vicinity may be mentioned the Paymaster vein, which is a short distance south of the MacNamara, and, like it, runs in a northeasterly direction. This Paymaster must be distinguished from the Paymaster already mentioned as occurring in the Lone Mountain district. It was located eight or ten years ago, but was abandoned and relocated in 1902. The lead seems to be a long band in a contact metamorphic zone of the intrusive granite mass, this band being marked by garnet, specular iron, and auriferous quartz veins or lenses.

AURIFEROUS SAND DUNES.

A conspicuous bunch of large sand dunes appears in the southern portion of the quadrangle in the middle of Clayton Valley. These have been sampled as gold ores, and some relatively good assays have been obtained. As a consequence of this some very careful sampling

has been done, but with unsatisfactory results. It seems to be the general outcome of all investigations that, except locally, the sand of these dunes does not contain more than a trace of gold. The sample taken by the writer assayed a trace of gold and silver.

SUMMARY.

To sum up the ore deposits of the Silver Peak quadrangle it may be repeated that they are all connected with intrusive granitic rock and are either within this granite or (more often) in the Paleozoic limestone into which this is intrusive. The age of all the deposits is pre-Tertiary. The ores have been formed in part directly as ultra-siliceous segregations from the granite; in part by the action of solutions from the granite on the adjacent limestones. The most important district, the gold district of Silver Peak, belongs in the first class, and the others mainly in the second class. These others, except the Windypah district, as before stated, were prospected and abandoned years ago, and owe their recent activity directly to interest produced by the discovery of Tonopah. Many of the veins in them are not highly encouraging. However, some of the mines in the Lone Mountain district have recently produced considerable shipping ore; for example, the Alpine has shipped over $70,000 worth within the last year. Some of the prospects within the Windypah district appear worthy of investigation. The Silver Peak district proper is a vast treasury of low-grade gold ores.