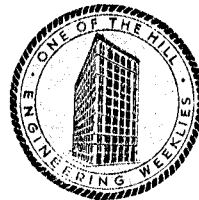




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The Yellow Pine District, Nev.

BY LEROY A. PALMER*

SYNOPSIS—The mining district about Goodsprings, Nev., was discovered in 1860 and produced lead ore. Gold and copper were found also. Zinc ore, the camp's mainstay now, was not recognized until 1906. The camp is gradually increasing in importance, and production is growing. Its features are discussed.

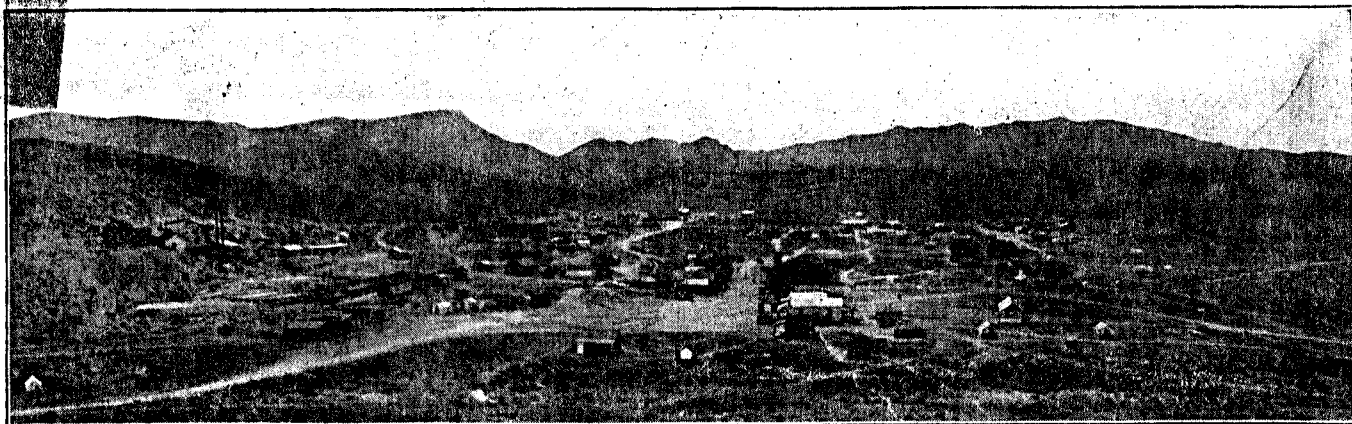
Toward the close of 1914 the Yellow Pine mining district, in the vicinity of Goodsprings, Nev., was working about 40 men, and its future appeared decidedly uncertain. Due to the extraordinary rise in the prices of lead and zinc, the principal products of the camp, 1916 opened with about 20 mines in operation and 400 men employed, with a monthly payroll of \$45,000 and a monthly output approximating \$400,000.

The first mining in this locality was at the Potosi, now the second largest producer of the district, which was

an engineer, who observed it while making a professional visit to the camp. These pages of the camp's history remind one of the awakening at Leadville, or the recognition of the "black iron" that was the source of much profanity among the ranches of what is now the Boulder tungsten district.

The district is about 15 mi. long and from 10 to 12 wide, toward the southern end of the Spring Mountain range and near the Nevada-California line. Goodsprings, the only town, is reached by an 8-mi. auto ride over good roads from Jean, Nev., on the Salt Lake route. The gold which, aside from that associated with the copper ores, once formed an important part of the production of the district, is found in altered igneous rocks, but no gold is produced now except as a byproduct.

The zinc-lead ores occur as replacement and fissure deposits in upper Carboniferous limestone. The two kinds of ore occur in the same orebodies, but usually with a fairly clear line of demarcation, so that it is frequently



THE TOWN OF GOODSPRINGS, CENTER OF THE YELLOW PINE MINING DISTRICT

discovered in 1860 by Mormon prospectors. This property produced rich lead ore that was mined by the Mormons and used by them in the manufacture of the bullets necessary in the border warfare of pioneer days.

Some gold and copper ores were found also, and gold and silver were associated with the copper and lead. So for years the district was a small but steady producer of these four metals, but the most momentous event of its history did not occur until 1906. Associated with the lead ores was a heavy gray-white material of unknown composition, considered worthless and commonly referred to as country rock. The credit of identifying this "country rock" as zinc ore seems to belong to Connie Brown,

possible to mine a practically clean high-grade product that needs no milling before being shipped to the smelter. The country has been subjected to fracturing and complex folding. The ores are found through a vertical range of 3,000 ft. in close proximity to the first and second folds. The eastern limit of the ore zone is a prominent fault that passes nearly through the town of Goodsprings. This fault shows particularly well just north-west of town where the displacement has been estimated at 4,000 and the red Permian sandstone can be seen at a geographic level several hundred feet lower than the white Pennsylvanian limestones.

At some pre-Tertiary time the limestones were intruded by quartz monzonite that is found as large irregular

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masses and sills which are cut by crossdikes of a similar material. Overlying the other rocks is a series of Tertiary basalt and andesite flows. The flows bear no relation to the orebodies of the district; in fact, with the exception of those of the Yellow Pine, these are not associated with any of the igneous rocks. In this mine the ores are found both in fissures and as replacements from 40 to 50 ft. from the intrusives. In no other mine of the district, however, is there any apparent connection between the orebodies and the igneous rocks.

While the lead and zinc mines are the mainstay of the district, there are two other deposits of interest and doubtless of future importance. One of these is the Boss, which presents an interesting study to the geologist and mineralogist. The commercial products of this mine are gold, silver, copper and platinum, but many of the rarer metals are found in small quantities. The copper occurs in the form of chalcocite, bornite, malachite and azurite. The platinum is presumably covellite. The ore is a replacement in the limestone in a mineralized zone proved to be 190 ft. wide, with lenses up to 28 ft. in width, the deposits occurring across the bedding planes. One such lens being developed at the time these notes were made showed a length of 265 ft., a width of 12 ft. and a depth of 112 ft., with neither top nor bottom in sight. An average of one orebody, estimated to contain 11,000 to 15,000 tons, is 6% copper, 1 oz. platinum and \$12 gold per ton. Other assays, not of picked samples, but of considerable bodies, have been 12% copper, $1\frac{1}{2}$ oz. platinum, 3 oz. silver and \$0.10 gold and $1\frac{1}{2}$ to 2% copper with 4 to 5 oz. each of gold and platinum.

Another deposit out of the ordinary for this district is at the Lavena mine, between Goodsprings and the Yellow Pine mine. The Lavena is on a dike of monzonite porphyry 250 ft. wide, similar to that of the Bingham copper deposits, throughout which are veinlets of quartz carrying pyrite, chalcopyrite and gold. One 2-ft. vein in the porphyry gives assays of 2 to 4% copper, 8 oz. silver and \$2.80 to \$10 gold. Development on this property is limited as yet, but at the lower levels there seems to be a general dissemination of the copper through the porphyry with the possibility of their being developed into a large body of low-grade ore.

SYSTEMS OF MINING EMPLOYED

Various systems of mining are in vogue in the district. The deposits are worked by vertical and inclined shafts, tunnels and opencuts. Some of the companies, such as the Yellow Pine, that have demonstrated the existence of bodies of ore of considerable size, have sunk comparatively deep shafts and are blocking out ore ahead. Others are following the method in general use in the eastern zinc districts, of making only a temporary opening and following the orebody through its various meanderings.

The Yellow Pine, the largest mine of the district, is square-setting. The lime walls are hard, but their general nature is such that the management considers this system best adapted to them. The mine is opened by an incline, on an angle of 35° to 40° , to a depth of 930 ft. on the slope. Levels are driven every 100 ft. The fissure deposits have an average strike of N 30° W with easterly dip, and the bedded deposits strike nearly due north with westerly dip. Some of the stopes attain considerable size—up to 100 ft. in width and 300 to 400 ft. in length. While it has been considered advisable to support these

stopes by means of square sets, light timbers only required, 6x8's and 8x8's being commonly used. When a stope is worked out, the timbers are drawn and filled with waste.

The mine is connected with the mill at Goodsprings and with the Salt Lake route at Jean by a narrow-gauge railroad operating a Shay and a gasoline locomotive. The Boss has opened up by means of tunnels, five of which have been driven or are in course of construction. The lowest will reach the vein at a vertical distance of 550 ft. The Boss uses no timber at all in stoping. The narrower deposits are worked without support, as the walls will stand while the ore is being removed. The larger deposits are worked by underground glory-holing.

The Sultan, next to the Yellow Pine the largest producer of the district proper, is working two glory holes by a typical milling system. One tunnel has been run in to a point 60 ft. below the surface and a raise driven to the orebody, which at the time these notes were made had been worked from the surface 100x20x30 ft. The other tunnel is connected by a 175-ft. raise to a glory hole 50x60x40 ft.

At the Anchor a short tunnel has been driven in and a shaft and winze sunk to 450 ft. below the surface. The



OPEN CUT AT MONTE CRISTO MINE

ore is in a replacement on an average dip of 38° and a maximum width of 32 ft. It is mined by a typical overhead stoping system, stulls alone being used to support the walls.

Many "gopher" methods are employed. At the Monte Cristo, leasers are taking out a high-grade, 37% zinc ore carrying less than 1% lead, by means of the opencut shown in the illustration.

About a mile up the cañon from the Monte Cristo and well up the mountainside, where a wagon road is hardly to be considered, is the Barnes, Hickman & Flesher lease on the Palace and Porter group, belonging to the Yellow Pine. This lease is following several bunches of high-grade zinc ore by means of short tunnels and opencuts. Shipments to the loading platform at the Monto Cristo is by means of burro train.

The lime, in which practically all of the development work is carried on, does not make for high costs. Among the companies operating systematically there is uniformity in the cost of the various kinds of development. Even at the larger mines much handwork is done, especially in the stopes. The Yellow Pine sank its main two-compartment

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shaft $5\frac{1}{2} \times 9\frac{1}{2}$ ft. in the clear, the last lift of 116 ft. at a cost of \$20 per ft., including timber. At the Anchor its single-compartment shaft, 5×7 ft., was sunk 200 ft. from the first tunnel level for \$11 per ft. The Yellow Pine was sunk with two shifts, one drilling and one mucking. Progress varied considerably, from 30 to 75 ft. per month. The work was done both by hand and with $3\frac{1}{4}$ -in. piston machines, 9 to 16 holes constituting a round. At this mine the drifts are an average of 4×7 ft. in cross-section and have been driven both by hand and with Temple-Ingersoll air-electric drills. Four to 16 holes are used to a round, and as high as 9 ft. has been broken with a round of four holes. This, of course, is unusual. Drifting costs at the Yellow Pine are \$5 to \$5.50 per ft., a fair average for the entire district, in which they run from \$4.50 to \$6.50.

With the exception of the Yellow Pine, costs of stoping and timbering are not available. These are \$3.15 and \$0.29 per ton respectively. It is probable that the other mines of the district are accomplishing this work at a lower figure, since the Yellow Pine is the only one in which it is necessary to resort to square-setting the entire deposit.

MILLING METHODS ADOPTED

The milling of the ores of the Goodsprings district presents an interesting variety of practice. The Yellow Pine has the only wet mill hereabouts, and it is probable that dry milling is more extensively applied here than in any other locality. Most of the mills are not concentrators, strictly speaking, but are separators, which separate one class of ore from another, making a variety of products, all of which are shipped and none rejected.

The Yellow Pine mill, which has a capacity of 100 tons per 24 hr. does not differ markedly from any other ore-dressing mill. The ore is fed over a grizzly to a jaw crusher, thence to rolls, impact screens, jigs and tables. Three products are made—lead concentrates, zinc concentrates and zinc slimes. The first two are trammed direct from the mill to the narrow-gage cars, but the slimes are settled in ponds before being shipped. The accompanying table gives an idea of the result of this system of treatment.

RESULTS OF TREATMENT OF ORES			
Class	Pb. %	Zn. %	Ag. Oz.
Mill head	10.2	31.8	5.4
Lead concentrates	53.2	13.75	28.1
Zinc concentrates	4.4	33.2	2.5
Zinc slime	7.3	35.1	4.0

Milling costs during 1915 were \$1.46 per ton. Two general systems of dry treatment are in vogue, the Plumb jig and the Stebbins table—both doing satisfactory work. The usual practice is to put the ore through a crusher and rolls, thence to impact screens or trommels, which return the oversize to the rolls and send the undersize to the concentrator. The various products are removed by screws or belts or by tramping. All machinery is kept tightly housed, and suction fans are used to draw off the dust; but, as has always been the case with the dry mills, the best that can be done in that respect is to alleviate the unpleasant condition to some extent.

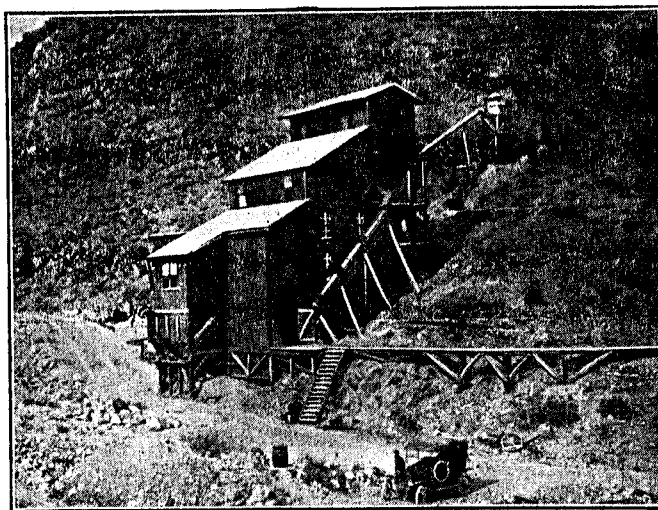
The dry mills are mostly of limited capacity and have been in operation but a comparatively short time, so there is not much definite data as to their operation. One of them, the Anchor, using a Stebbins table, takes heads carrying 24% zinc and 35% lead and makes 34% zinc and 67% lead concentrates. The zinc concentrates carry

6% lead, but the lead concentrates are practically clean. The mill dust will average about the same as the heads.

The work described is on the separation of a lead-zinc ore in which no rejection is made. In treating a straight lead ore, tailings are rejected and disposed of by tramping. A saving of 65% is effected, 35% going into the tailings and dust, mostly the latter, from which it is hoped to recover it.

About 20 mines in the district are making a gross output of 6,000 tons a month, the average at present prices being about \$65 a ton in lead and zinc. The Yellow Pine is the largest shipper. During 1915, with the mill out of commission for two months during which time only crude zinc ore was shipped, this company mined 18,400 tons. About 15% was shipped crude and the remainder milled. Gross receipts were \$850,000, of which \$700,000 was profit.

Next to the Yellow Pine the largest producer is the Potosí, which is employing 60 men and shipping 1,200



THE ANCHOR DRY-CONCENTRATING MILL

tons of crude zinc ore per month, although this mine is not considered within the Yellow Pine district proper.

Next to the Potosí is the Sultan, working 35 men and producing 360 tons per month. This mine is of interest in that it was opened only a year ago, commencing operations with three men, and has always paid its own way.

The other mines have still smaller outputs, some of the leases shipping a car or less a month. As an example of what some of the smaller mines are doing, the Bullion might be cited. This company is shipping monthly about 120 tons of lead concentrates carrying 62% lead and 6 oz. silver; 35 tons crude lead assaying 70% and 30 tons crude zinc assaying 38%. While the tonnage is not high, such values, coupled with the present high prices of the metals, make the output mount up in worth.

There seems to be plenty of ore in sight in the district. Mining and treatment conditions are not unfavorable, so it is reasonable to expect that the district will continue to produce while its metals command a fair price on the market.

Protected Thermoelements are discussed by Arthur W. Gray, in scientific paper No. 276 of the U. S. Bureau of Standards. It is pointed out that usually the wires of thermoelements are either entirely unprotected or else merely have portions adjacent to the junctions in glass or porcelain tubes. Believing that this is insufficient, Mr. Gray describes a type of mounting developed and used by the Bureau of Standards.

largest outcrop occurred; at lower levels, two other tunnels have been driven, the first of which, about 30 ft. lower than the upper tunnel, has encountered the main ore zone. The lowest tunnel is being driven at an elevation several hundred feet lower than the upper workings, and has not yet reached the main ore zone.

ORE RICHER IN PLATINUM THAN FIRST DISCOVERIES

The main of upper tunnel followed the ore for a distance of 200 ft. along its strike, in a northeasterly direction. The ore varies in thickness from 2 to 10 ft., the average being about 6 ft., and in appearance is a brownish granular mass, showing occasional streaks of hard quartzose material. Both walls of the ore are shattered limestone, and along these walls occurs an encasement of malachite, varying in thickness from a few inches to several feet. The main body of the ore zone carries little copper. An average of the ore, sampled at 5-ft. intervals for 200 ft. along the upper tunnel gave the following results: Gold, 1.13 oz. per ton; silver, 5.20 oz.; copper, 0.20%. These samples were not analyzed for metals of the platinum group, but H. K. Riddall, chemist for the Yellow Pine Mining Co., who analyzed the samples, reported that metals of the platinum group were present, this being the first report of the presence of these metals. It has since been learned that this ore contains 0.5 to 1 oz. of platinum per ton.

In June, 1914, a winze was started from the upper tunnel following the ore on its dip, and high-grade ore was encountered within a few feet. The appearance of the ore did not change materially except for the occurrence of small masses of a greenish tale within the vein. Some of these masses were sufficiently large to be mined separately, and two small shipments, aggregating about one ton, were forwarded to the American Smelting & Refining Co. at Murray, Utah. Their settlement analysis was as follows, platinum not being determined or paid for: Gold, 124.79 oz. per ton; silver, 23.9 oz.; lead, 1.05%; copper, 0.65%; insoluble, 73.2%; sulphur, 3.1%; iron, 6.7%.

On the same control sample of this shipment, Ledoux & Co., of New York, report the following analysis for metals of the platinum group: Platinum, 99.08 oz. per ton; palladium, 16 oz.; iridium, trace.

The winze has been sunk to a depth of about 35 ft., and drifts driven on the ore in both directions, developing a considerable tonnage of ore. A carload shipment of material from this development, without sorting, returned as follows: Gold, 8.752 oz. per ton; silver, 5.02 oz.; copper, 0.97%; insoluble, 80.7%.

On similar material from this location, Ledoux & Co. report as follows: Gold, 11.55 oz. per ton; platinum, 7.38 oz. Several carloads of material of about this class are now broken in the mine, pending negotiations for the satisfactory disposition of the ore.

RATIO OF PLATINUM TO GOLD

It has been fully determined that metals of the platinum group are present in all of the ore thus far developed. Ledoux & Co. state as their opinion that the metals are in the free state, "being apparently alloys of gold and platinum metals." It would also appear from numerous assays that the platinum metals bear a fixed ratio to the gold content, being in the proportion of about $\frac{2}{3}$ oz. platinum to 1 oz. gold. The ore is thoroughly oxidized, no sulphides having as yet been recognized, and the gold alloys have a "rusty" appearance, showing no colors

after panning until they have been thoroughly scrubbed or treated with acid.

The occurrence of the ore is especially peculiar in that it occurs entirely in limestone, the nearest known porphyry contact being about 600 ft. distant. The ore apparently follows the stratification of the limestone more or less regularly, indicating replacement, but appears to be confined in a fault zone about 60 ft. in width, following the fault planes along their strike. A gouge occurs along some of these fault planes, which is strongly indicative of porphyry, and metamorphism is noticeable in the adjacent limestone, indicating that an igneous intrusion may be closer to the orebody than is apparent from the present development. It is probable that the porphyry was the original source of the ore, the precious metals having been deposited in the crushed fault zone, with copper and iron sulphides, which since have been thoroughly oxidized. It is a noticeable fact that the malachite above described carries little gold or silver and no platinum metals are evident. A carload shipment of copper ore from the same workings contained 23.4% copper, but only 1.4 oz. silver and 0.16 oz. gold per ton.

From present development it would appear that the district bids fair to become an important producer of platinum. The Boss Gold Mining Co. has erected a tramway from its upper workings to the wagon road, and is in a position to maintain steady shipments as soon as satisfactory terms for the ore have been arranged. Some difficulties have been encountered, as the Western smelters appear unable to handle this class of ore to advantage, but it is hoped that satisfactory arrangements can be made with Eastern firms. The company is also conducting a series of tests on the lower-grade ore, and expects to erect an experimental plant for treatment of ore on the ground. Numerous other claims have been located in the vicinity, and are now under development. The Azurite Mining Co., whose ground adjoins that of the Boss, has developed some ore, although of somewhat different character from that of the Boss mine.

First-Aid Instruction in California

By LEWIS J. EDDY

Mine rescue and first-aid training instructions were given to miners at Grass Valley by U. S. mine rescue car No. 5 on Sept. 16. The car was not sent to Grass Valley on account of the fact that the railroad from Colfax to Grass Valley and Nevada City is narrow-gage. The car remained at Colfax but the equipment was shipped and the full complement of men went with the equipment. The work was in charge of E. Steidel, junior mining engineer, and George W. Riggs, first-aid instructor. Both operators and mine bosses, and the miners as well, showed a great deal of interest in the work as taught by the government men, and it has been planned that a half-shift tri-monthly practice will be inaugurated. Instructions were given miners at the North Star, the Brunswick, the Empire and the Champion. Practical demonstration of rescue training was successfully carried through in an abandoned end-drift on the level 28 of the North Star mine. A fire was kindled and the men under instruction were obliged to work under actual mining and mine-fire conditions. The smoke and gas generated by the timber fire extinguished the carbide lamps. The men