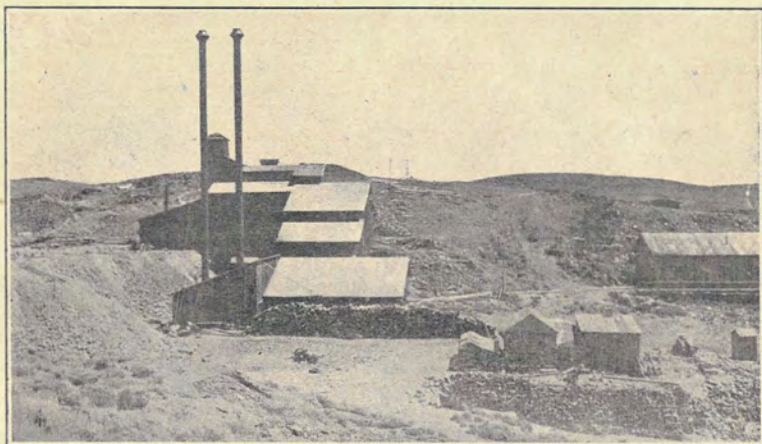


THE STATE OF WYOMING

GEOLOGIST'S OFFICE

BULLETIN NUMBER 20

Atlantic City, South Pass Gold Mining District



THE CARISSA MINE

ALBERT B. BARTLETT
STATE GEOLOGIST OF WYOMING

WITH NOTES ON GEOLOGY

BY

PROFESSOR J. J. RUNNER
UNIVERSITY OF IOWA, IOWA CITY, IA.

JULY 15, 1926

INTRODUCTION

Interest in mining is reviving in Wyoming, and many inquiries are being received for up-to-date information regarding the geology and present development of the South Pass-Atlantic City District.

Previous publications of the State Geologist's office are "A Brief Review of the South Pass Gold District," by H. C. Beeler, published in 1904, and reprinted in 1908, and "Atlantic City Gold Mining District," by L. W. Trumbull in 1914. United States Geological Survey Bulletin 626, by A. C. Spencer, in 1914, also covers this district.

In the early part of June, 1925, the State Geologist and Prof. J. J. Runner of Iowa University, spent a week in the district. The notes on geology and occurrence of ore are by Professor Runner, and grateful acknowledgment is made to him for this valuable contribution.

The writer is pleased to acknowledge the cooperation and assistance of Mr. Harry T. Curran, Superintendent of the Carissa Mine, to whom we are indebted for information on the power facilities of the camp and for an up-to-date report on the Carissa Mine, and to others who cooperated in the work.

Lack of funds prevented a detailed survey of the district, and this examination represents a reconnaissance only. In making this reconnaissance errors were found in the maps of Trumbull and Spencer, including an error in section numbering in Plate II of Bulletin 626.

The importance of the district as a gold camp with a past production of some five or six million dollars, and as Wyoming's best prospect of a large future producer of gold, easily justifies a complete detailed survey of the region, and further detailed study of the genesis of the ores.

Such efforts would undoubtedly result in information valuable in the search for commercial ore bodies and would tend to attract attention of competent and reliable mining operators, and would be of great assistance to all interested parties in developing the district.

An entire summer season should be spent in this district by a well-equipped party, in making this geological survey, and further laboratory studies would be required. The future prosperity of Wyoming depends, in a large measure, upon the development of its mineral resources, and it is hoped that the next Legislature will appropriate sufficient funds to permit a detailed examination of the district.

LOCATION

The district is situated in the south-central part of Fremont County, in central Wyoming, near the southern end of the Wind River range of mountains and 25 to 40 miles south of Lander, the county seat of Fremont County, United States Land Office and nearest railroad point.

TRANSPORTATION

The district can be reached from Lander, the terminus of the Chicago & Northwestern Railway, over a good auto road. It can also be reached over similar roads from Rock Springs on the main line of the Union Pacific system, 80 miles distant, or from Rawlins, 125 miles. Owing to the light winter snowfall, the road to Rock Springs could be kept open for the entire year with little effort.

ESTIMATED OUTPUT OF THE DISTRICT

LODE MINES

Miners Delight	\$1,200,000
Carissa	1,000,000
Caribou	500,000
Garfield	400,000
Victoria Regia	350,000
Franklin	300,000
Mary Ellen	125,000
Lone Star	40,000
Carrie Shields	35,000
Ground Hog	30,000
Other quartz mines, total of	157,000
Total	<hr/> \$4,137,000

HISTORY

Gold was first discovered in this region in 1842 and from that time until 1869 efforts were made to work the rich placers known to exist there, when the great rush to South Pass or "the Sweet-water mines," occurred in the latter year, and the placers rich enough to pay when worked on a limited, crude scale were promptly worked to the profitable point, and the miners then sought other opportunities in the newer fields of Colorado and Montana.

During the time the Carissa Lode was opened up and paid large returns, followed by the Miners Delight at Peabody Hill,

the Burr at Lewiston, and numerous other properties that were worked for a time with great success, but which were allowed to run down and were abandoned when the level of water and base ores were reached, with the exception of the Carissa, which has been kept in first-class condition.

In 1924 the Golden Gate Mine and Timber Co., a subsidiary of the Homestake of Lead, S. D., took options on the 1914 group of claims and did continuous development work until the shaft house was destroyed by fire in September, 1925.

THE CARISSA MINE

Beeler gives the following account of the Carissa.

The Carissa was located in 1867, and has been a phenomenal producer for many years, often under adverse circumstances of working and management, and is today the best known and deepest developed property in the South Pass District.

Here the high-grade ore occurs in quartz lenses, lying in the schist, having the same dip and strike as the schist, and these lenses occur at irregular intervals.

Associated with these quartz lenses are bodies of mineralized schist carrying pay values in gold, and lying between, or near, the quartz lenses have been found schist ores of very high grade, but with the usual intervals of lower grade materials in the same ore.

Formerly the development in this mine was confined to the high-grade lenses above noted, and the low-grade ores practically ignored, owing to lack of facilities for treating them profitably. A crosscut has been run west from the lower, or 400-foot level, and the occurrence condition of these low-grade ores determined. This crosscut is 180 feet long and cut through a series of quartz lenses and schist leads, varying greatly in value, the limits being stated to the State Geologist as running from a trace up to \$50 per ton in gold. The free condition of the gold remained unchanged, as in other parts of the mine, and the results of the milling of this ore showed a mill value of six dollars per ton in gold for the whole length of 180 feet.

This crosscutting is considered the most important work accomplished in the district for some years, as it demonstrates the existence of large bodies of low-grade ores, capable of treatment on a large scale, and indicates the course to be pursued in other mines of the district.

The present development in the Carissa consists of more than 2,500 feet of drifting, crosscuts, etc., with a shaft 384 feet deep, following the dip of the vein, equipped with hoist and necessary appliances for handling the ore on a limited scale. For extensive exploitation and development on a commercial scale, a new plant would be required and is fully warranted by the showing now made.

In the upper portion of the Carissa workings the usual oxidized ores were found and these were very rich, as shown by the early history of the mine. As development proceeded, the oxidized ores passed out and the sulphide forms came in, being mostly arsenical pyrites, but experience in milling these ores has shown that the free gold character of the ore still pertains, and on the lower level from 60 to 90 per cent of the gold values may be saved upon the plates. Ore is frequently encountered which shows free gold associated with pyrites, both in the quartz and in the adjacent schists.

The ore has been run through a ten-stamp mill, over amalgamating plates and concentrating tables, the concentrates being saved and the tailings being settled with a view of cyaniding, this process having been experimented with and found successful for these ores.

The full extent of the ores in this mine has not yet been developed, and will require a system of further development by sinking to still greater depths, crosscutting through and beyond the lenses now known to determine the full extent of the profitably mineralized zone, and drifts on the vein to get under the formation which showed great values on the surface, but which have been neglected in recent years. The development has simply proven beyond a reasonable doubt that a great mine exists here and with intelligent, extensive development and ore treatment may be made a great property.

The Carissa has been kept in first-class condition, has been thoroughly sampled, and numerous mill runs have been made on the ore. There are now 2,300 feet of drifts on the five levels, the fourth level is 775 feet long, the fifth level at a depth of 400 feet being 635 feet long.

Careful sampling shows that the property has 75,000 tons of ore measureable in three dimensions that will average \$7.75 per ton, average width of the vein 6.33 feet. There are 37,000 tons of probable ore of about the same average value as the ore in sight. Possible ore has been very conservatively estimated at 100,000 tons of \$7.75 ore with the possibility that the tonnage of ore could be doubled by including \$4.50 to \$5.00 ore by an all-amalgamation treatment.

The present mill is a ten-stamp, 950 pounds each, amalgamating plant that is in operative condition and can be used for large-sized tests if desirable. A long series of tests has been carried out on the Carissa ore, the results of which are available but which will not be given in this report. These tests demonstrate that a combination of amalgamation and cyanidation is definitely certain of success, while an all-amalgamation scheme by stage amalgamation may prove successful, will be cheaper and will make more ore available.

An estimate of development, mining and milling costs based upon local conditions shows that the Carissa can be operated at a very satisfactory profit by those experienced in that profession and properly financed. Structural conditions and underground factors indicate that the Carissa ore will continue to great depth and will not become refractory.

SOUTH PASS

At South Pass the Franklin, the Curry, the Carry Shields and others are lying idle for want of capital to push their further development, and any of these are worthy of a close investigation. The Copper Surprise, one mile north of the town, shows a strong lead carrying considerable copper pyrites, in addition to gold

values, and a shaft has been sunk to a depth of 135 feet on these showings.

Three miles north of South Pass four shafts have been sunk to a maximum depth of one hundred feet, in addition to other works, on an ore that shows gold and copper values.

Between South Pass and Atlantic are a number of properties which have been worked at various times, and a great deal of ore was shipped or milled from these properties that now lie idle. The Doc Barr, Richard Albert, and neighboring properties have shown up considerable good ore when worked and, while yet undeveloped, show conditions similar to the Carissa and merit extensive development along the lines indicated for the Carissa.

The Duncan property was operated for a time by inexperienced operators, their mill heads for the period averaging \$8.16 per ton, demonstrating that with a properly designed plant with low power costs, the property can be made to pay.

ATLANTIC

Atlantic City is situated in the central part of the working district, four miles east of South Pass, and came into existence during the opening of the Rock Creek Placers and the adjacent lodes, when the Jim Dyer, Big Atlantic and Huff Tunnel were all producing ores.

"At Atlantic City is the Dexter Mill, now part of the property of the Timba Bah Mining Company. This mill is an example of the kind of mine management that furnishes the topic for so many stories and jokes among real mining men. The mill, costing several times its value, was built beside the townsite and the manager's office, although there was no mine near and the slope was too slight to allow material to be handled by gravity. After the completion of the mill, ore was hauled in wagons from various prospects in the district. Twelve thousand tons of five to thirty dollar ore were milled, and the cleanup gave six thousand dollars off the plates and absolutely nothing from the cyanide plant. After the company had sold seven hundred thousand dollars' worth of stock, it became bankrupt. Fraud and ignorance played about equal parts in the management of the company's affairs. The whole affair naturally was no help to the reputation of the district." (Trumbull: Bull. No. 7.)

Atlantic is surrounded by promising properties, nearly all of which have been developed to a slight extent, mostly on the high grade ores, but with an occasional small working on the adjacent lower grade ores, and it is worthy of note that this latter work has uniformly been successful.

The Dexter Tunnel was driven to prospect a section of this ground reaching a length of 1,400 feet, and cut three blind leads of low-grade ore before work was suspended.

Several well-known mines and leads lie ahead of this work, the Bryan mine having produced some of the richest ore of the district, though only a small saving was made of the values at that time. The Mormon Crevice and Poiree Estate properties are similar properties with small development on rich lenses.

Near the Bryan is the Garfield Mine, having a shaft and levels run on some rich ore lenses and some further work on the low-grade ores noted in the usual connection with the rich lenses.



SHAFT HOUSE ON THE 1914 GROUP NEAR ATLANTIC OPERATED BY THE
GOLDEN GATE MINE AND TIMBER COMPANY

The Tabor Grand, near the Duncan, shows the characteristic lens condition, but no deep work has been attempted. The ore was milled in a Huntington mill with some success and later the Dexter mill at Atlantic.

Above Atlantic on Rock Creek is the Ground Hog group, nine patented claims now owned by the Arnott Realty Co., Alvin Phillips, manager. It shows characteristics similar to the Carissa and is considered one of the best properties of the district. Continuous development has been carried on for the past ten or twenty years with encouraging results.

The property includes also seven unpatented claims on the north on which 2,000 feet of work has been done. On the patented claims are 4,000 feet of development, mainly in tunnels. The mineralized area is mainly between the Mammoth and Big Atlantic veins and the development is said to have disclosed a big tonnage of \$5.00 and \$6.00 ore, with \$16.00 to \$20.00 ore in some of the workings.

Northeast of Atlantic, the Golden Gate Mine and Timber Co., a subsidiary of the Homestake of Lead, S. D., worked from May, 1924, to September, 1925, at which time the shaft house was de-

stroyed by fire, on the 1914 group of claims owned by Tom McGrath and associates. This company ran 800 feet of drift and 120 feet of cross-cuts on the 100-foot level, and deepened the shaft from 200 feet to 300 feet, having done in all 1,500 feet of drifting on the 100 and 200 foot levels. Results were said to be encouraging. The ore is in a series of lenticular bodies along a shear zone in diorite, the values being in quartz. This zone is between the Big Atlantic and Mammoth dykes, about 600 feet distant from each.

The Timba Bah Mining Co., successors to the Dexter M. & M. Company, which was active from 1902 to 1906, has been in litigation most of the time since, but is now ready for operations. Mr. Charles Sykes is resident director. The mill is a 20-stamp mill.

In addition to the Dexter Mill, which can be used as an experimental plant for the ores of the district, or which can be purchased and put on other property, the company owns the Atlantic townsite, ten patented placer claims on Rock Creek, water rights from Christina Lake and Granier Ditch, seven patented lode claims, eleven unpatented lode claims, and one unpatented placer claim. Also owns in the Lewiston district twenty claims, all patented but two.

MINERS DELIGHT

Peabody Hill is the most prominent landmark of the eastern end of the district, and on the east side the most famous mine in Wyoming was found in 1867 by Owens, Holbrook and others, and which produced over \$1,000,000 in gold from a very limited portion of its area.

The first owners made no effort to mine carefully, but simply gophered through the vein where the gold was the thickest and milled whatever they took out in a rough stamp mill, paying little attention to the percentage saved.

This vein was a fissure from four to six feet wide, running alongside a dyke of coarsely crystalline porphyry and the mining was done by open cuts and shallow shafts.

Later work was done in a more careful manner, and a shaft sunk to a depth of 275 feet, drifts were run at intervals and ore taken from the first vein and the "blanket vein" opened up later, but passing by the lower grades of milling ore of the mine.

The property has laid idle for many years but operations have again been resumed and development is in progress. There is much evidence that the Miners Delight will work out into a great mine, if properly financed and if managed by experienced operators, as the veins are strong and well defined, the ore shoots so far have been large and profitable, and the work at the Carissa has shown that the ores continue with depth and the values are permanent.

LEWISTON

At this camp, which was opened up in 1879 with the discovery of the Burr Mine, development has been slow for the past few years. The Burr shows the same lens condition before noted and was very rich, some of the showiest specimen ore of this region being produced here. This ore was free milling and very easily handled, much of it being worked in a hand mortar, but no mining, aside from the work of the original lens was attempted.

The Bullion Mine, Iron Duke, Ruby, and a number of others have produced heavily, but have not been worked steadily for a number of years. Experiments have been made at the Bullion Mine with cyaniding the Lewiston ores, with success, but the results have not been given out for publication.

This camp is coming back in a lively manner, the Burr property having been acquired by Mr. Charles Paige of Sand Springs, Oklahoma and contracts are being let for sinking a double compartment shaft, to be followed by further development. H. P. Griswold is superintendent.

Water has been a handicap on this property for the earlier operators. The old records on the Jumbo, which is now full of water, are reported to show that the shaft assays from \$6.00 to \$57.00 per ton, 76 feet deep and a 400-foot drift assays \$13.00 to \$15.00, which should be very attractive under modern operating methods.

On the Mill claim and Helen group is a very good mill, built in 1915 by a company represented by H. H. Olmstead, which is now owned by Eric Ediin of Lander.

The Hidden Hand, which has produced some wonderfully rich picture ore in the past, is now being opened up. A circular stamp mill is being installed and the dump will be first treated, as it is believed to run \$40.00 per ton.

East of Strawberry Creek are ten veins reported to carry milling ore running \$4.00 per ton or better in a zone one mile wide and two and a half miles long. Two miles north is another zone one-fourth mile wide and three-fourths mile long, with two veins reported to run \$3.00 to \$30.00 per ton.

West of Strawberry Creek the mineralized zone is at least a half mile wide and a mile long, with veins running \$4.00 per ton or better, including the high-grade Hidden Hand.

PLACERS

The placers of the district are credited with a production of \$1,725,000* as follows:

*From Jamison's Mineral Resources of Fremont Co., State Geologist's Office, 1911.

Meadow Gulch Placers.....	\$1,000,000
Yankee Gulch Placers.....	500,000
Spring Gulch Placers.....	30,000
Promise Gulch Placers.....	30,000
Smith Gulch Placers.....	20,000
Red Canyon Placers.....	20,000
Atlantic Gulch Placers.....	15,000
Beaver Creek Placers.....	10,000
Other Placers	100,000
	<hr/>
	\$1,725,000

These gulches were all worked at various times by the crude methods of early days, and some wonderfully rich finds or pockets were opened in these gravels.

The most important placer operations in the district at present are being carried on by the Titanic Gold Producing Company, backed by Casper and Denver capital, southeast of Lewiston, along Sweetwater River at the mouth of Burr gulch, on an area of 1,440 acres.

Operations include pumping station, pipe lines, ditch and sluices, all installed recently. It is stated that the area being operated averages fully a dollar per cubic yard.

In Big Atlantic Gulch, two and a half miles east of Atlantic, Dr. W. G. Burnett and associates of Casper have been carrying on tests for the past two years and report very encouraging results, sluicing gravel from test pits. The property includes placer claims and leases on two and a half miles of Big Atlantic Gulch, also lands on Promise, Smith, Long, O'Mara and Little Atlantic Gulches, a total of 1,610 acres.

The Platte River Sand and Gravel Co. of Casper has taken a lease on the A. C. Croft placer claims and is planning to bring in a steam shovel or drag line if tests justify it. This joins the Timba Bah placers on Rock Creek about eight miles below Atlantic.

Preliminary operations on placers below Miners Delight are being carried on by Ed Stork.

There is no question that the flat-lying placers along the creeks will eventually be worked at a profit. The early operations were by crude and wasteful methods, no modern methods have ever been attempted to this time, but full investigations with this in view are justified.

Development of the placers, as well as the lode claims, has been somewhat retarded by unreasonable prices and terms put on the property by the owners. These owners should plainly understand that they cannot secure development unless the deal is made attractive. To properly equip a property and put it in successful operation will cost upwards of \$100,000 in nearly every case, and

prudent investors will not advance such sums without having a reasonable chance to make money. If the placer owner will offer his property for a small royalty, but specifying a minimum annual rental, he will secure quicker action and better results in the end than by insisting on a big cash payment, especially where the value of the property is still more or less problematical.

ORES AND TREATMENT

The following chapter is taken in full from the Bulletin by Beeler:

ORES AND TREATMENT

In the past, the attention of the owner and miner has been directed to the high-grade ores, but it is upon the great bodies of low-grade ores which certainly exist in this vicinity that the district must depend in the future for the permanent prosperity of the mines, although it is to be expected that other lenses, fully as rich as those of the past, will be opened up and go to swell the production record of the district.

The grade of ore of the South Pass District has certainly been remarkably high, and had proper care been used in handling or testing the ores, the percentage of values saved would have been equally high, but it is a fact, in many instances, that ores were sent to the nearest mill without regard to the fitness of the proposed treatment for the ore in question, and when the values were not saved in that mill the mine was turned down.

It is admitted that the process of stamping and amalgamating the free gold values is suited to the ores of some of the mines of the district, especially the Carissa, as the mill figures for that mine readily show, but it should be stated with all possible emphasis that this method is not suitable for *all* the ores of the district.

Numerous instances have been stated on good authority, where different lots of ores have been milled and only 10 to 30 per cent of the assay values saved, the balance going into the tailings dump or washed into the creeks.

Various reasons have been assigned for this state of affairs, and samples of ores examined have shown the gold in several forms, which left no doubt as to the variety or scope of the processes needed for treatment.

Space does not permit discussion of the ores here, but it may be mentioned that the "brittle gold" and "crystallized gold" often spoken of in this locality, have been found to be partially oxidized tellurium minerals, which, of course, are not suited to stamping in their natural state and are wasted by such methods, the tailings values almost equalling the original ore values in well-defined instances.

"Rusty gold" is common and difficult of saving by amalgamation as usual, but may be handled with proper precaution.

No one process has yet been found which would successfully treat all the ores of the district, and before any property is taken up a thorough test at some well-equipped and reliable testing works should be made on as large an amount as convenient, of the same grade or kind it is proposed to treat, and works then designed and constructed by some skilled designer according to the results actually obtained by this treatment. In these tests especial attention should be given to the saving and handling of the fines, of which an unusual amount is often produced from the nature of the minerals noted in these ores.

Attempts have been made at different times to treat the old mine dumps by the cyanide process, in some instances with success, but in a

number of cases the people handling the work were not familiar with the process and the experiment did not succeed, owing to the fact that the ores were not properly crushed or handled, but it is believed that this process, conducted by competent cyanide millmen and with proper precautions determined by actual experiment on the ore to be treated, will undoubtedly be found to be adapted for a large amount of ore in this district.

The Dexter mill provides a local plant where these experiments can be made on a large scale and should be a great factor in the opening up and prosperity of the whole locality.

LABORATORY TESTS

The samples were selected in quantities varying from two to seventy-five pounds, the majority being a sack of ore. These were taken to the School of Mines laboratory, crushed with a Dodge crusher, sampled with a large quantity ground fine enough to pass through a 100-mesh sieve. The samples were ground fine so that the assays would agree upon the pulp and make it possible to do good work. Crushing an ore so it will pass through a 100-mesh sieve will increase the percentage of gold to be collected by either the free-milling process or any wet method.

After the samples had been prepared they were subjected to the following tests:

1. Assayed to find their entire value.
2. Tested by free-milling process.
3. Tailings from free-milling process were assayed.
4. Tailings from free-milling process were treated with cyanide.
5. Cyanide tailings were assayed.
6. The raw ore was treated by a chlorination process.
7. Chlorination tailings were assayed.

The tests were conducted in the following manner:

The sample was assayed by using one A. T. for a charge. The ores being very low grade in silver, no attention was paid to the silver values except in one instance. A small piece of c. p. silver foil was usually added to the assay to decrease the fineness of the button so that they could be parted as they were taken from the cupel. These ores all having a silicious gangue, there was no difficulty experienced in making any of the assays. For free-milling tests, two pounds of ore that had been crushed to 100-mesh were introduced into a Case-Buck's amalgamating mortar, together with mercury and enough water to make a good pulp. The mortar was then rotated for one-half hour. The pulp was then transferred to a gold pan, the mercury and amalgam collected and the tailings dried for assaying.

In assaying tailings one A. T. was used, and in most cases a small piece of c. p. silver foil was added to facilitate parting.

In making the cyanide tests the pulp was carefully examined for detrimental compounds, and in no instance were any detected. This would be very difficult if the tailings contained sulphides of iron and arsenic and were allowed to stand for any length of time in a dump. Sulphides oxidize very rapidly and produce sulphates and sulphuric acid, which seriously interfere with the cyanide process. Tests were made in solutions of various strengths to find out if possible the most economical strength to use. It was found that .30 per cent was ample in every case, and in no instance was this amount consumed. The cyanide tests were made by taking a half pound of the dried tailings from the free-milling process and placing them in a liter flask and filling flask half full of cyanide solution. These flasks were agitated occasionally through the day and at the end of twenty-four hours were emptied upon a filter. The

tailings were allowed to drain, then thoroughly washed with three applications of warm water and dried.

The cyanide tailings were assayed by using one A. T. in the usual way.

The chlorination tests were made, with one exception, upon the ores without any preliminary treatment. In conducting the tests about a half pound of ore was placed in a liter flask that was provided with a stopper. Sufficient water was added to form a pulp, then enough bleaching powder to produce more chlorine than would be necessary to dissolve the gold. This was thoroughly mixed and a small amount of sulphuric acid added and the bottle was tightly corked. The bottle was shaken occasionally, and after twenty-four hours was emptied upon a filter and washed until chlorine free. The tailings were dried and assayed in the usual way.

The results from these various tests are much more flattering than one might naturally expect, but at the same time prove conclusively that no mining man should attempt to save the gold values in the ore of Sweet-water District by the free-milling process alone.

That those interested may have a better understanding of the tests made, I append here a very brief statement in connection with each sample and occasionally make a few comments on the treatment.

No. 1. Diana Mine. Atlantic. Sample taken, one sack. Assay, 1.5 ozs. of gold per ton. Tailings after free-milling test assayed .27 oz. of gold per ton, making a saving by amalgamation of 82 per cent. The cyanide tailings were assayed and found to contain only a trace of gold. In practice the owners cannot expect to extract 82 per cent by amalgamation on account of coarse crushing. They can, however, depend upon cyanide to save the gold left behind by amalgamation and effect a saving of nearly 100 per cent.

Tailings from the chlorination process assayed .55 oz. of gold per ton, which was a saving of a little less than 65 per cent of the gold values. This ore is of sufficient value to work by the chlorination process, but would have to be roasted before one could expect to make a good gold saving.

No. 2. King Solomon Mine. Atlantic. Sample taken, one sack. Assay, .162 oz. of gold per ton. Tailings from the free-milling test assayed .061 of an ounce of gold per ton. The amount of gold saved was only 62.3 per cent, which was very low. The tailings were treated with cyanide, after which they assayed .01 of an ounce of gold per ton, which practically made a complete saving. A sample of this ore treated by a chlorination process yielded only 73.82 per cent of the original value. On account of this being a low-grade ore, chlorination would be impossible. Amalgamation followed by cyanide process should effect a saving of upwards of 95 per cent of the gold value.

No. 3. Garfield Mine. Atlantic. One sack of ore taken as a sample. Ore assayed .99 of an ounce of gold per ton. Tailings from the free-milling test assayed .072 oz., thus saving 92.7 per cent of the gold. The cyanide removed the last trace of gold from the tailings. The combined methods made a perfect saving. The ore was then tested by the chlorination process, which extracted 95.1 per cent of the gold. Amalgamation followed by cyaniding should work this ore without the least trouble. Chlorination would also work it but the ore would have to remain for a long time under the influence of the chlorine gas.

No. 6. Caribou Mine. Lander, Wyoming. One sack of ore taken. Assay value, .61 of an oz. of gold per ton. Tailings assayed .13 of an oz. of gold per ton. Saving effected by free-milling test, 78.7 per cent. After this the tailings were treated with cyanide and they did not assay a trace of gold. The chlorination test saved 71.2 per cent of gold. This ore contained a very small percentage of sulphides and could not be successfully treated by chlorination, unless roasted.

No. 8. Victoria Regia Mine. Atlantic. One sack ore taken. Sample assayed .65 of an oz. of gold per ton. Tailings after free-milling test assayed .12 of an oz. of gold per ton. Free-milling process saved 81.5 per cent of the gold. The tailings from the cyanide test assayed .025 of an ounce of gold values. I have no doubt that the cyanide would make a complete extraction could it be given additional time, say 48 in place of 24 hours.

The chlorination test was not a success, since it extracted only 77 per cent of the gold values. In this instance there were no sulphides and the poor extraction was not accounted for.

No. 9. Rustler Mine. Atlantic. One sack of ore taken. Sample assayed .171 of an oz. of gold per ton. Tailings from the free-milling test assayed .012 of an oz. of gold per ton. The cyanide test extracted the last trace of gold from the tailings. In ores of this class, when 94 per cent of the gold value can be saved in the mill and there is nothing in the ore to concentrate, there is no chance to make additional saving on account of the low-grade tailings, which would not pay the expense of the cyaniding. On account of this ore being very low grade it will be impossible to work it by any process unless found in vast quantities, easily accessible and under favorable conditions. The chlorination test was not made.

No. 17. The Carissa Mine. South Pass. Sample taken was a rich sulphide, weighing only two pounds, but was typical of the rich ore found in this mine. It assayed 171 ozs. of gold per ton and 17.08 ozs. of silver. The tailings from the free-milling test assayed 21 ounces of gold per ton. These were treated with chlorination after being roasted and the combined processes made a saving of 97.8 per cent. This cannot be considered satisfactory for an ore of this grade. Cyanide was not applied to this sample on account of the high percentage of sulphides. The gold was not quite coarse in the specimen and in ordinary stamp milling practice the saving would not be as high as in the test. On account of the sulphides and especially a small percentage of arsenic, this ore slimed very badly and also had a very bad effect upon the mercury. Losses may be looked for in slimes and in flour mercury. In my opinion ores of this class should never be milled. It is a serious mistake to attempt to bring up the average value of the milling ore by including such very rich shoots. Rich ores should be sacked and shipped to a smelter. Lower grades of this class can be milled, provided the mill is provided with gold-slime saving devices and concentrators. The concentrates can be successfully handled by barrel chlorination.

No. 18. The Carissa Mine. South Pass. Sample weighed five pounds and was typical ore from this property. Ore assayed 1.24 ounces of gold per ton. The free-milling test extracted 79.83 per cent of the gold values. The tailings from the free-milling test, after being cyanided, assayed .041 of an ounce of gold per ton, making the saving by the combined processes 96.7 per cent. The same ore, chloridized without roasting, yielded only 56.45 per cent of the gold it contained. This same sample was from below the oxidized zone and contained pyrites of iron and arsenopyrite and for this reason could not be successfully handled with chlorination unless roasted. The success of the free-milling process, followed with cyaniding, seems sufficient for ores of this class.

No. 19. The St. Louis Mine. Atlantic. Sample, five pounds. Ore assayed 10.44 ozs. of gold per ton and was taken from near the surface. The gold in this sample was remarkably free. The free-milling test extracted 92.04 per cent of the gold. The tailings, although rich, yielded almost perfectly to the cyanide, the combined processes making a saving of 99.99 per cent. The same pulp chloridized showed a saving of only 67.24 per cent of the gold. This sample was very high-grade ore, but demonstrates very nicely how the ore can be successfully treated.

No. 20. Bryan Timba Bah. Sample weighed ten pounds and was oxidized ore. Pulp assayed 2.16 oz. of gold per ton. Free-milling test extracted 94.9 per cent of the gold. The tailings, after being treated with cyanide, assayed only a trace of gold. The pulp was treated with chlorine, which also extracted all of the gold. This is an example where the ores are near the surface and are practically free milling.

No. 21. St. Louis Mine. Atlantic. Sample weighed eight pounds and assayed .36 of an oz. of gold per ton. The free-milling test extracted 83.33 per cent of the gold, and the tailings, after being treated with cyanide, assayed only a trace, making the saving nearly 100 per cent. This ore also chloridized exceedingly well, since only a trace of gold was left in the tailings. This sample was taken from the fines of the mine and represents the oxidized ore.

No. 22. Timba Bah. Sample weighed ten pounds and assayed .92 of an oz. of gold per ton. The free-milling process extracted 94.02 per cent of this ore. The tailings, after being treated with cyanide, assayed only a trace of gold. The pulp was treated with chlorine, after which the tailings assayed only a trace of gold. This is another sample of an oxidized ore that can be easily handled by any of the above processes.

This completes a statement of the tests made. All of the miners and prospectors had equal opportunities to take advantage of this laboratory work and in case any one's ores have not been tested it has been their own fault.

This chapter has been included in this report for the reason that it gives data regarding ores from many properties which cannot now be examined. The assay records are reliable. The names of some of the properties have been changed and cannot be identified upon the attached map. As this report is of the district in general and not of the individual properties of the district, the exact place from which the samples were taken is of minor importance. The important thing is that ores from various places in the district, both high and low grade, gave a splendid saving under cyanide test.

FUEL AND POWER*

POWER: There are several sources within or close to the district from which power may be obtained. However, the placing of Diesel or semi-Diesel engines at the mine would be the cheapest first-cost plant, and available cheap oil would allow power production at a figure well under the cost of power in the average mining camp. Several Diesel engine companies have submitted figures to show that power can be produced here at a cost ranging from \$40.00 to \$55.00 per H. P. year, depending upon the price of oil. Crude oil can be purchased at the Dallas field, about 23 miles distant, or an oil especially adapted for Diesel engines can be had from Lander at $3\frac{1}{2}$ c per gallon. An experienced Casper truck operator has offered to contract hauling to the mine for \$1.50 per barrel. The Worthington Pump and Machinery Corporation has recently placed on the market an improved engine that costs about

*From report of H. T. Curran on Clarissa Mine, January 31, 1925.

the same per horsepower as a steam plant, and they claim that it is more economical to operate than previous oil engines. I am convinced that the maximum cost of power produced on the property by oil engines will not exceed \$50 per H. P. year.

Undeveloped water power is available on Sweetwater River, about nine miles southwest of the mine, and on Little Popo Agie River, about fifteen miles northwest. The minimum flow of the Little Popo Agie will develop about 900 H. P. A diversion canal two and a half miles long will deliver the water at a point where an effective head of 750 feet can be obtained.

Buffalo Basin Oil and Gas Field is located 30 miles southeast of South Pass, and at the present time it produces a large volume of gas which is going to waste. I understand that this gas can be had for four cents per thousand.

WATER: The property is supplied with good water from Hermit Creek by means of a pump station located on company ground and through a pipe line 1,400 feet long with a vertical raise of 160 feet. The mine furnishes a little water, 3,000 gallons every twenty-four hours during the dry season, that can be used for milling purposes.

TIMBER AND OTHER SUPPLIES: Timber for all purposes can be obtained from the national forest at points located from ten to fifteen miles from the mine. By placing a sawmill in the forest, dimension timber should be delivered at the mine for a total cost of \$20 per thousand.

Limestone, surrounded by plenty of scrub timber for burning purpose, is found on the Lander road within ten miles of the mine. This is an important item in a cyanide mill.

Ribs of hard, tough silicious slate are found in the vein walls that often assay up to \$3 per ton, and this material can be dressed to make excellent tube mill pebbles. The gold in this rock should cover the cost of mining and preparation for the tube mill. This is also an important item when a mill is located at considerable distance from a railway.

LABOR. Skilled labor would have to be brought into the district for large operations. Wages at the present time average about the same as in the mining camps of the Black Hills of South Dakota and the district is free of labor unions.

CLIMATE: Climatic conditions are much the same as those of the Northern Black Hills. The summers are dry and cool, the falls are generally open up to November, and the winters and springs are often marked by considerable snowfall, which is much heavier from South Pass toward Lander than it is in the direction of Rock Springs.

CONCLUSIONS

1. The bonanza discoveries, which resulted in the production of several million dollars worth of gold, were surface enrichments of veins that, according to developments on the Carissa, should become profitable low-grade propositions continuing to great depth.

2. The Carissa has been developed to a point where it is ready to become a profitable mine.

3. There are a number of other promising properties which justify the expenditure of money and further development. It is believed that many of these will become productive and that the camp will become one of the important gold camps of the United States when developed. Developing these properties is not a poor man's proposition; owners of properties should realize that it will take a tremendous expenditure of money to develop the properties and to put them into successful operation. Therefore, the owners should offer their property at prices and terms which will be productive.

4. The placers of the district have produced some very rich pockets and are believed to be of a grade which can be profitably worked in large-scale operations.

NOTES ON THE GOLD-QUARTZ VEINS OF THE
ATLANTIC CITY-SOUTH PASS
DISTRICT, WYOMING

BY PROF. J. J. RUNNER

INTRODUCTION

During the early part of June, 1925, the writer, in company with Mr. A. B. Bartlett, State Geologist, spent several days in the vicinity of Atlantic City and South Pass in southern Fremont County, Wyoming, in a rather hasty examination of some of the gold-bearing veins of the district. It was the writer's purpose to obtain, if possible, any new geological data that might supplement the very excellent reports of W. C. Knight, L. W. Trumbull¹ and A. C. Spencer.² Trumbull and Spencer have set forth the facts regarding the larger geological features of the district and have described the characteristics of the gold-bearing veins in some detail. It seems impracticable in these brief notes to review the findings of these earlier workers only in so far as the writer's

¹Atlantic City Gold Mining District, Wyoming Geological Survey Bulletin No. 7.

²The Atlantic Gold District and the North Laramie Mountains, U. S. Geological Survey Bulletin No. 626.

own observations were sufficiently detailed to check them or to supplement them in some way.

In the field, observations were confined to surface exposures and to mine dumps except at the Carissa and on the Victory and Liberty claims, and were, for the most part, along two belts; one in sections 1, 11 and 12 of T. 29 N., R. 100 W. from the Caribou to the Ground Hog, and the other in sections 14, 15, 21, 20 and 19 from the Mary Ellen through the Duncan and Mono claims to the Franklin. Representative specimens of the country rocks and ores were collected, sectioned and studied in the laboratory with the aid of the petrographic microscope. Ores were crushed, powdered, concentrated and separated into mineral groups by means of heavy solutions. The minerals were then identified with the aid of the binocular microscope. The study of polished sections of ore with the metallurgical microscope failed to reveal the true relationships of the gold to the other ore minerals for the reason that the few surfaces polished seemed to contain no gold. Further studies of this kind are recommended.

The most significant problems upon which these brief studies have thrown additional light and which will be discussed here are: (1) the nature of the rocks with which the gold is associated, and (2) the relationships of the mineralization to these rocks. Other problems which will be briefly discussed deal with the mineralogy of the veins and with their possible association with zones of shearing.

THE NATURE AND ORIGIN OF THE AMPHIBOLITES

In describing the rocks of the Atlantic City-South Pass District Spencer makes mention of rocks³ that prior to metamorphism were shales, sandstones and beds somewhat calcareous, but no limestones were found. In his treatment of the intrusive rocks he describes diorite⁴ in part as follows:

"The most abundant intrusive rocks occurring within the general area of the metamorphosed sediments now appear as amphibolite. The name is commonly used to include hornblende-bearing rocks in which the hornblende (and in many rocks other essential mineral constituents) has been formed as the result of a thorough metamorphism of basic igneous rocks. It is often impossible to determine whether the original rock was a gabbro, diabase, or diorite. The mineral composition of rocks of this sort occurring in the Atlantic district is like that of diorite and it will be convenient to use this name for them."

On his geologic map⁵ Spencer indicates an area of "diorite" extending northeastward from the approximate center of section 20, through sections 21, 16, 15, 14 and 13, of T. 29 N., R. 100 W., and another from the southwestern portion of section 10 northeastward through sections 11 and 1 of T. 29 N., R. 100 W.

³Spencer, A. C., op. cit. p. 14.

⁴Spencer, A. C., op. cit. p. 19.

⁵Spencer, A. C., op. cit. Plate I.

Specimens of fresh material were taken by the author from several places along these "diorite" dikes and studied in thin section under the microscope. Of the six specimens studied, one is of undoubted igneous origin and probably was derived from diorite, one other is probably of igneous origin, one of possible igneous origin, and the other three are almost certainly derived, in part at least, from impure limestone. In the true diorites the lime-soda feldspars have altered in part to zoisite, epidote, hornblende, secondary albite and some chlorite. A small amount of augite in the original rocks has altered to hornblende. Quartz and titanite also occur. The primary minerals are sheared and broken and with the secondary minerals form an excellent schistose cleavage. One specimen of doubtful origin contains much hornblende, fine grained quartz, magnetite, and a minute amount of albite, calcite, zoisite and epidote and is probably of igneous origin. The other specimen of doubtful origin consists largely of fibrous actinolite and contains biotite and titanite. The lack of feldspar, epidote and zoisite and the presence of actinolite and much biotite together with a banded structure make it of doubtful igneous origin. The three specimens that contain sedimentary materials are well banded and consist of layers rich in carbonates and quartz, some rich in biotite and quartz and others rich in amphibole. Diopside has replaced the carbonates and hornblende has replaced diopside, carbonates and biotite. The carbonates, and to some extent the diopside, have been sheared and broken and the hornblende has grown parallel to the direction of shearing giving the rocks a schistose structure. The flakes of biotite likewise parallel the schistosity. In these latter rocks there are layers that contain minute amounts of zoisite, and epidote which suggest derivation from feldspars but the banded nature of the rock and the dominant mineral content make them appear to be almost certainly sedimentary in origin. The conclusion reached is, therefore, that the amphibolites are, in part, igneous, perhaps dioritic, and in part sedimentary, the latter derived from an impure limestone by high temperature metamorphism.

THE RELATION OF THE QUARTZ VEINS TO THE IGNEOUS INTRUSIVES

Two classes of igneous intrusives of the district were studied with respect to their relations to the gold-quartz veins—the diorites and the granites. A claim map of the district shows a striking coincidence between the location of claims and the distribution of the amphibolites. It would be a natural supposition that inasmuch as high temperature gold-quartz veins are of igneous origin that the relationship here mentioned points to the dioritic amphibolites as the source of the gold-bearing veins. There are reasons, however, for doubting this.

As mentioned under the description of the amphibolites those of igneous origin are much sheared and greatly altered, indicating that they were intruded before the movements that developed the schistosity had ceased. The quartz veins studied show no such amount of shearing nor do the sulphides in them appear broken or distorted. It will seem, therefore, that the ores were introduced after the period of movements had ceased rather than before.

Another possible source of the gold-quartz veins is the granites that crop out in great masses west of South Pass City and in smaller masses near the Mary Ellen claim in sec. 14, T. 29 N., R. 100 W. and elsewhere. Sections of this granite show that the rock has been under strain but has not been sheared—the same is true of the vein quartz. On the Franklin claim in sec. 19, T. 29 N., R. 100 W., coarse-grained pegmatitic granite and fine aplitic dikes belonging to the granites of the Wind River range are closely associated with gold-bearing quartz veins. On the Carissa property in section 20 pegmatitic granite was observed to grade into quartz veins by a falling off of feldspar and mica. Sections of veins from the Carissa show abundant tourmaline, muscovite, biotite and apatite, all common granitic constituents. Other veins from the 1914 No. 2 claim in section 1 show abundant tourmaline. Structurally and mineralogically, then, the quartz veins resemble the granites and related pegmatites and in the same respects differ from the diorites. It is, therefore, concluded that the more probable origin of the veins is from the granites which are believed from their distribution to underlie much of the region examined.

What, then, is the explanation for the coincidence in position between the amphibolites and claims of the district in the two belts mentioned above? As has been pointed out some of the amphibolites in each belt are believed to be metamorphosed impure limestones. A rock of this composition is a readily replaceable one by high temperature solutions and these solutions readily cause recrystallization into such minerals as are found in some of the amphibolites. Masses of calcium carbonate were found on the 1914 No. 2 claim, to the north of the Carissa and on the Duncan claim in contact with vein quartz with a development of contact metamorphic minerals and much silicification of the carbonates. Aluminous slaty rocks at the Carissa were found to be highly silicified and sericitized at the borders of the quartz veins. Quartz veins at the same place enclose abundant shreds of material containing biotite, chlorite and some amphibole, indicating that sedimentary material has been assimilated and replaced. That the border material should be profoundly affected by high temperature solutions is a characteristic feature of such an environment and does not prove that the veins are replacement veins but there is considerable ground for belief in such an hypothesis in view of

the nature of the easily replaceable rock. Much more work must be done before this can be proved.

Another possible explanation of the relationship in position between prospects and amphibolites is that the two areas of amphibolites studied might be in zones of extensive fracturing and possibly faulting. Strain effects in vein quartz, the fragmental nature of some of the host rock and frequent slickensides in the same rocks indicate movement but no sufficient amount of such characters were observed to warrant the assumption of extensive movements along shear zones that may have been followed by the veins. This matter should likewise be carefully tested before definite conclusions can be drawn.

THE MINERALOGY OF THE VEINS

This matter has been indirectly alluded to in various places above, but it seems well to summarize the matter here. In the veins the prominent minerals that have been recognized are: calcite, quartz, biotite, muscovite, diopside, actinolite, hornblende, chlorite, tourmaline, apatite, magnetite, arsenopyrite, pyrrhotite, pyrite and free gold. Such an association is typical of high temperature veins.

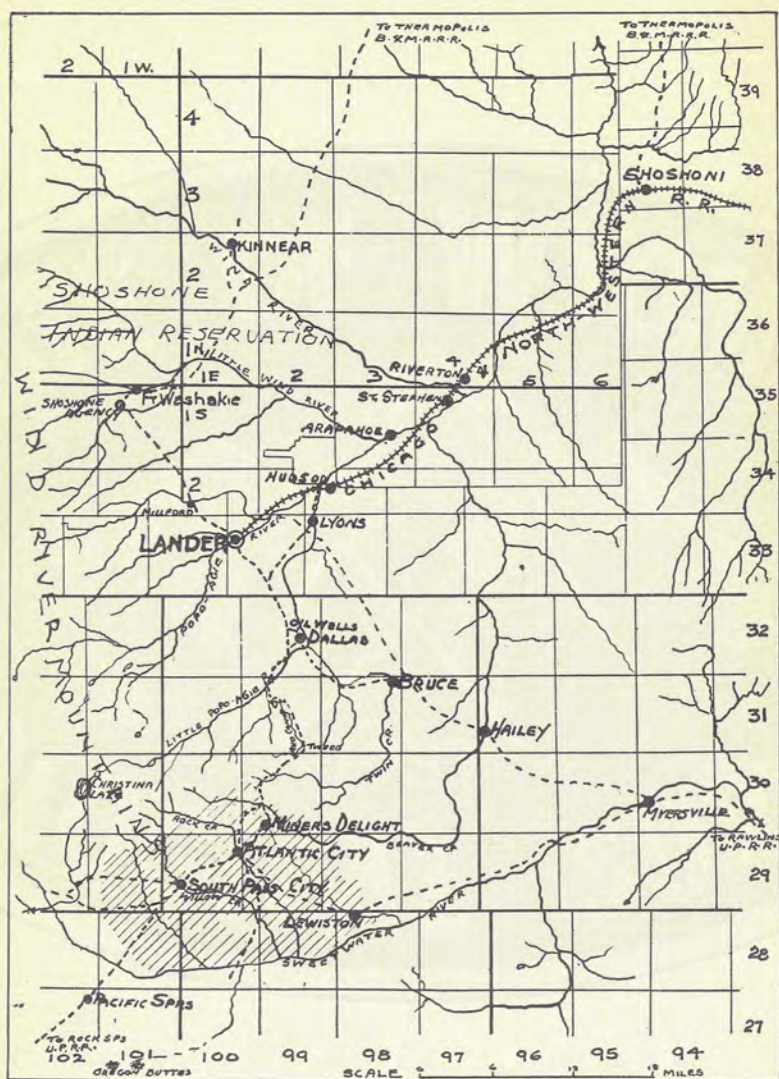
PROBABLE EXTENT OF THE GOLD LODES

The significance of high temperature veins has been pointed out by Spencer in the following words:⁶ " * * * the present topographic surface is a chance surface due to erosion, without significant relation to the ore deposits, and that, on the whole, the deposits must be as abundant at any depth that might be chosen for consideration as they are at the existing surface."

The author would add to this that if the lodes should prove to be replacement deposits in limestones in part, that a considerable zone of country rock outside the main veins might prove worthy of considerable attention. In regard to the occurrence of gold in the country rock Spencer quotes W. C. Knight as saying:⁷ "Quartz associated with some of the sulphides usually contains the most of the values. In many instances, however, the schists are especially rich. This was especially marked at the Carissa. In the ore stoped it was the rule that the schist clinging to the quartz was gold-bearing, and often there were wires and pellets of gold scattered through the mass. During the last ten years I have assayed schists from this district that contained from two to ten ounces of gold per ton."

⁶Spencer, A. C., op. cit. pp. 33 and 34.

⁷Spencer, A. C., op. cit. p. 29.



OUTLINE MAP OF CENTRAL FREMONT COUNTY, WYOMING, SHOWING GENERAL SITUATION OF THE SOUTH PASS GOLD DISTRICT
Shaded area indicates outline of the District

