[READ BEFORE THE COLORADO SCIENTIFIC SOCIETY, IN DENVER, JANUARY 6, 1900.]

"NOTES ON MINING AND SMELTING IN THE STATE OF DURANGO, MEXICO."

By H. Van F. Firman.

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Read at the meeting of the Society, January 6, 1900.

The properties of the Compania Minera de Peñoles consist mainly of the silver-lead mines which are situated about nine kilometres south of the town of Mapimi; the hacienda and smelting works at Mapimi; a narrow gauge railway, twenty-four kilometres in length which connects Bermejillo with Mapimi, and a narrow gauge railway which connects the smelting works with the mines. This latter railway is an ordinary surface road for a distance of five and one-half kilometres from Mapimi to Cambia, where it changes to a rack-road system, similar to the Pike's Peak Cog Railway, for a distance of three and six-tenths kilometres to Ojuela. The terminus of the rack-road, and the principal mining camp, is at Ojuela, where the main power plant, mine offices, etc., are located.

The Ojuela and San Ignacio mines, located at Ojuela, are separated from the South Camp, where are located the Socovon, San Judas, Santa Rita, etc., by a deep arroya. The two camps have been connected by a suspension bridge the construction of which was completed in November 1899. This bridge has a span of over one thousand feet and is two hundred and fifty-four feet above the bottom of the arroya. The ore, from the South Camp, is transported across the bridge in steel cars, having a capacity of about one thousand pounds, which are operated by a tail-rope system. When the cars arrive at Ojuela their contents are dumped into storage bins, whence the ore is drawn off into railway cars which run in on a level below the storage bins.

A tunnel is being driven into the southern mountain so as to connect the bridge railway with most of the mines of this section. When this system is completed —it is in partial operation now — the ore will be hoisted from the different shafts and winzes in buckets operated by electric hoists. The contents of the buckets are dumped into small bins whence the ore is drawn off into the bridge cars.

Prior to the construction of the suspension bridge all the ore from the South Camp was transported on burros, over a winding trail to Cambia, where it was loaded on the railway cars. The bridge also greatly facilitates the transportation of workmen and supplies to and from the South Camp.

According to tradition, these remarkable ore bodies were discovered and worked by the Spaniards more than three hundred years ago. Some of the old workings extend to depths of nearly one thousand feet.

The country adjacent to the ore bodies consists of limestones which are generally horizontal, or have but a slight dip, unless locally disturbed by faults and the intrusion of volcanic dykes. Many of the hills and mountains surrounding the sedimentary area are of volcanic origin. Adjacent to the ore bodies the limestones are nearly horizontal to the east but to the west are badly faulted and twisted by a volcanic dyke which intersects the formation. This volcanic intrusion antedates and has had much to do with the deposition of the ore. However, the ore bodies are apparently a replacement of the limestones by ores carrying lead, silver, gold, iron, arsenic, antimony, sulphur and occasionally copper. The ore bodies of the North, or Ojuela Camp, are apparently irregular masses replacing the limestone. The bottom of the great stope of the Ojuela mine is twenty-two hundred and fifty feet below the surface. On the twenty-two hundred foot level this stope is one hundred and sixty-eight timber sets (about one thousand feet) across. The ground above has been stoped continuously, by the present company, for a height of about one thousand feet. The

ore bodies of the South Camp occur along a distinct break, or so-called vein, but here also the ore bodies assume the form of more or less irregular masses and are apparently replacements of the limestone.

The ores are generally oxidized, the only sulphide minerals so far encountered in any considerable quantities being galena and occasionally boulangerite. Local pockets of other sulphides have been encountered, but invariably have changed to oxidized ores below. The ores contain cerussite, anglesite, galena, boulangerite, and various oxidized iron, lead, arsenic, antimony and sulphur compounds.

The following table presents average partial analysis of the various ores as they are "bedded" at the smelting works:

Name of Ore Mixture.	*SiO_2%*	*Fe_2O_3%*	*Al_2O_3%*	*$CaCO_3$%*	*As%*	*Pb%*	*Ag. ozs. per ton.*
Ojuela	7·	30·	10·	9·	6·	23·	18·
San Ignacio	3·	35·	12·	6·	11·	13·	13·
Socovon	1·	35·	12·	5·	9·	20·	23·
Rescates	50·	12·	10·	18·	.....	2·	35·

In addition to the constituents given in the table the ores carry considerable percentages of antimony and small amounts of gold, copper, manganese, zinc and sulphur. The ores designated as Rescates are low grade siliceous silver ores which are purchased to flux the basic lead ores mined by the company.

These ores present a smelting problem which is somewhat unique. They are extremely basic and carry large amounts of alumina, arsenic, antimony and some sulphur. Until recently the Rescates were not available for fluxing material. The following is an average analysis of about six hundred thousand pounds of base bullion resulting from the smelting of these ores: Ph 88·6 %; Sb 4·8 %; As 3·6%. In these lots the antimony varied from 2·7 to 6·7 per cent., and the arsenic from 2·3 to 5·13 per cent.

The silver contents of the bullion varies from 125 to 200 ounces per ton. The gold contents average about 1·4 ounces per ton.

Owing to the extremely base character of the bullion, and the large amount of speiss produced, the ordinary practice of lead smelting has undergone certain modifications at these works. Operating with the ordinary type of lead blast-furnace, having a deep crucible and an external lead-well, it was found to be practically impossible to keep the connection between the crucible and lead-well open. Another difficulty was encountered from the accumulation of speiss accretions in the hearth of the furnace. To overcome these difficulties the lead-wells were abandoned and the crucibles were filled up with brickwork so as to form a shallow hearth having a gentle slope from the rear to the front of the furnace. With this modified furnace the slag and speiss —there is practically no matte produced.—are tapped in the usual way into settling pots, the slag overflowing into slag pots. At intervals of about two hours the settling pot is removed and the furnace is tapped, about five inches below the slag tap hole, for bullion. The slag and speiss which invariably accompany the tap of bullion are allowed to partially chill, when a bent iron hook is inserted. When the crust has solidified it is removed by means of the iron hook. The bullion, after paddling and skimming to remove most of the dross, is ladled into moulds.

This method proved to be so well adapted to the treatment of the ores that in designing the new plant, which was built about two years ago, the furnaces were built without lead-wells and with a shallow sloping hearth. These furnaces have a separate tap for the bullion which is located on the side near the front end (between the first and second tuyeres) of the furnace and is six inches below the slag tap. These furnaces are thirty-six by one hundred inches in cross section at the tuyeres, have a smelting column of eleven and one-half feet, and are provided with electric-welded steel water jackets.

The slags are somewhat unique and worthy of mention. I

tried various mixtures, which produced slags having the following range of composition: SiO_2 23% to 32%; FeO 27% to 42%; CaO 10% to 24%;, but the best results were obtained with a slag having approximately the following composition: SiO_2 28%; FeO 35%; CaO 15% and Al_2O_3 12% to 14%. These slags ran well, causing little or no trouble with the lead tap and generally no trouble from hearth accretions. Whilst not so low in silver and lead as some of the other slags they proved to be best suited to the conditions as they existed. The average valuable metal contents of these slags was a little less than one ounce of silver per ton and about one and one-half per cent. lead.

The speiss naturally varies somewhat in composition, but the following analysis represents the average for two weeks run under the writer's management.

Fe	43·4%
As	31·0%
Pb	13·2%
Ag	31·0 ozs. per ton.
Au	0·22 " " "

In addition to the above constituents the speiss contains considerable quantities of antimony, copper and sulphur. Whilst this undesirable by-product is of sufficient value in gold, silver and lead to apparently warrant its retreatment for the extraction of these metals such a course is impossible under existing conditions. This speiss problem would appear, at a first glance, to practically prohibit the economical reduction of the ores. However, with careful management less than 25 per cent. of the arsenic is reduced to speiss. Another undesirable by-product is the large quantity of flue-dust. As this carries over 30 per cent. arsenic it can not be retreated at a profit.

At present there are ten blast furnaces, four of the old and six of the new type. The four old furnaces will shortly be replaced by four furnaces of the later type. Numerous other improvements are being made which will greatly lessen the cost and facilitate the handling of ores and by-products.

[No. 1 of 1900.]

BULLETIN

OF THE

COLORADO SCIENTIFIC SOCIETY.

The one hundred and sixty-sixth regular meeting of the Society was held in its rooms in the Boston Building, Denver, Saturday evening, January 6, 1900.

E. LeNeve Foster, President, in the Chair.

The minutes of the preceding meeting were read and approved.

The chair appointed Messrs. D. W. Campbell and L. S. Austin tellers to count the ballots for officers for the year 1900. Upon their report the following were declared unanimously elected.

President, Ernest LeNeve Foster; First Vice President, Frederic Knight; Second Vice-President, A. L. Collins; Treasurer, Henry A. Vezin; Secretary, C. W. Comstock; Corresponding Secretary and Librarian, T. L. Wilkinson.

Members of Executive Committee: G. L. Cannon, Regis Chauvenet, R. C. Hills, Harry A. Lee, Richard Pearce.

The Secretary announced the election to membership by the Executive Committee of Louis B. Carr, of Ouray.

Mr. H. Van F. Furman read a paper entitled "Notes on Mining and Smelting in the State of Durango, Mexico." Mr. Furman exhibited a number of specimens of the arsenical ores which he had been obliged to smelt and which had resulted in the unusuul practices described in his paper. He stated that he had not had time to determine all the minerals existing in these ores.

Mr. Furman's paper was informally discussed at some length.

The meeting then adjourned.

CHARLES W. COMSTOCK,
Secretary.