1925

The fissure system of El Potosi Mine of El Potosi Mining Company, Santa Eulalia, Chihuahua, Mexico

Carl E. Millikan

THE FISSURE SYSTEM OF EL POTOSI MINE

OF

EL POTOSI MINING COMPANY, SANTA EULALIA, CHIHUAHUA, MEXICO.

BY

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A

THESIS

submitted to the faculty of the

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in partial fulfillment of the work required for the

degree of

ENGINEER OF MINES.

Chihuahua, Chih., Mexico.

1925

Approved by C. V. Forbes

Professor of Mining.

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THE FISSURE SYSTEM OF EL POTOSI MINE.

Introduction.

The property of El Potosi Mining Company, consisting of 82.75 pertenencias, or approximately 206 acres, is situated in the municipality of Santa Eulalia, Chihuahua, Mexico, about 30 kilometers south-east of the City of Chihuahua. The mine is connected to the smelter of the American Smelting and Refining Company, and to the general offices of the company at the Hacienda Robinson on the outskirts of the city of Chihuahua, by a narrow gage railroad owned by El Potosi Mining Co. The Minerál Railroad (Ferrocarril Minerál de Chihuahua) connects Santa Eulalia and Chihuahua City. A wagon road runs between the mine and Chihuahua. There is, also, telephone and telegraph service between the mine and the outside.

The camp is located in the Santa Eulalia Mountains, about 6,000 feet above sea level. The climate is arid. Vegetation is limited to thorny bushes and cactus. Water supply is pumped a distance of about 25 kilometers from the Hacienda Robinson to the camp. The pumping plant is the property of the company, and supplies water to three other companies in the camp.

The company owns various surface rights, railroad rights of way, and a mill site upon which is being erected a 500-ton gravity and flotation concentrator. The mine and railroad are in process of electrification and at this time are about three-fourths completed.

History.#

The history of the camp reads like that of many other silver-mining camps of Mexico. It is said that the deposits of Santa Eulalia were discovered about the year 1591 by the Spaniards, however, official records of the state date the discovery around 1703, which is 12 years later than the founding of the City of Chihuahua, now the capitol of the state.

History states that bandits fleeing the town of Chihuahua, sought safety in the hills to the east, and one day noticed a stream of molten metal running out of the hearth upon which they had built an exceptionally hot fire. The metal was discovered to be silver.

The bandits induced the padres in Chihuahua to give them absolution in return for being shown silver enough to build the largest church in all America. The result is the Cathedral of Chihuahua, which may have been the largest church of those days, and the mining district of Santa Eulalia.

#Prescott.A.I.M.E.Trans.Vol.LI.1915.Main Mineral Zone of Santa Eulalia District.

The first 86 years of the district,from 1705 to 1791 showed reported for taxation,112,000,000 dollars worth of metals,and it is easy to assume that the figures do not represent the total value of metals extracted. Some investigators are inclined to believe that nearly five hundred million dollars worth of metals have been extracted from mines of the district to date.

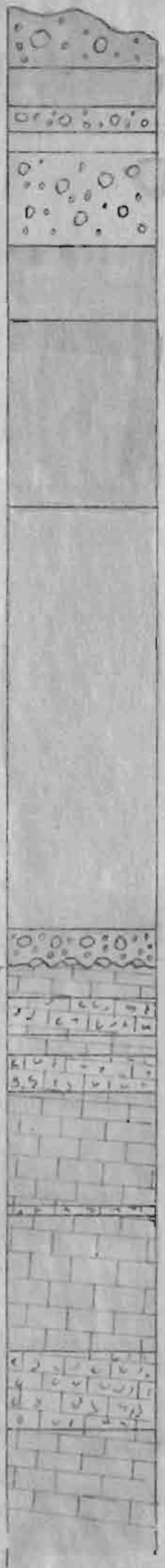
The Santa Eulalia district produces in the neighborhood of 30,000 tons of ore per month,of which the Potosi contributes a third.

Other companies in the district,and adjoining El Potosi are;The American Smelting and Refining Company, The Peñoles Company,The Exploration Company of London, besides numerous small companies operating small mines scattered around within five or six miles of El Potosi.

Surface Geology.

In the Santa Eulalia district,the limestones are exposed in but few places,hence the entire study of the country rock must come from the mines working in the district.

The limestones are overlain by a series of flows and tuffs,presumably from the Sierra Madre which lies to the west,approximating 1200 feet in thickness.These volcanics are of the Tertiary.They are economically unim-



	4th Conglomerate	Few Mts.
	4th Tuff	20± Mts.
	3rd Conglomerate	10-15 Mts.
	3rd Tuff	10 Mts.
	2nd Conglomerate	50 Mts.
	2nd Tuff	40 Mts.
	Rhyolite Flow	100 Mts.
Tertiary Volcanics	Lower Tuff	225 Mts.
	Lower Conglomerate	20 Mts.
	Blue Ls.	Variable Depth.
	Fossil. Ls.	10 Mts.
	Blue Ls.	11½ Mts.
	Fossil. Ls.	30 Mts.
	Blue Ls.	47 Mts.
Mesozoic Limestone, Comanchian.	Fossil. Ls.	2 Mts.
	Blue Ls.	83 Mts.
	Fossil. Ls.	37½ Mts.
	Blue Ls. Extent Not Known	

Geologic Column
El Potosi Mng. Co.
April, 1925. C.E.M.

Legend

Geologic Symbols

Limestone

Upper Conglomerate

Rhyolite Tuff

Rhyolite Dikes

Second Tuff

Second Conglomerate

Quartz Tuff

Third Conglomerate

Fourth Tuff

Rhyolite Dikes

Porphyritic Andesite Dikes

Manganese Stain on Rock

Topographic and Geologic Map of El Potosi Mining Co. Chihuahua, Mexico. Scale - 1:2500. From Spurr & Co. By C.E.P.

portant.Some time previous to the laying down of the capping,or,at the close of the Cretaceous,the uplifting of the country formed the Santa Eulalia Mountains,and exposed them to erosion for sufficient time to permit the removal of approximately 2500 feet of shale and several hundred feet of interbedded shale and limestones.

Upon this eroded surface of limestone were laid down successive layers of andesitic and rhyolitic tuffs and flows with conglomerates intervening,until eight distinct layers are recognised.

The capping is cut by andesitic and rhyolitic dikes which are post-mineral.They are practically unaltered,both on the surface and underground in parts removed from ore deposition,but in the region of orebodies,the andesitic dikes are altered to Kaolin,and the rhyolitic dikes are even more altered.

General Structure.

The oldest limestone is the lower Cretaceous,Comanchian series,for the most part of a dark bluish-gray color. Altho in the United States the series are not of very great thickness,at the Rio Grande they have been noted to measure 4,000 feet,and in the central part of Mexico they have attained a thickness of 20,000 feet.

In most parts of the country,the limestone is con-

formably overlain by a shale which is believed to be over 3,000 feet in thickness.However,erosion has removed all of this shale in the Santa Eulalia district,and the limestone is unconformably capped by the porphyry.

The general structure of the limestones is in the form of a broad anticline with the axis in a northerly direction at the crest of the sierra,and a gentle pitch to the south.The Santa Eulalia district occupies the western limb of the anticline,which dips off to the southwest from 5 to 15 degrees.

The anticline is traversed in many directions by fissures of varying degrees of size and importance.They will be discussed at greater length later in this report.

Orebodies. Type Deposits.

The orebodies of the Santa Eulalia district are of two main types;the chimney and the manto,or blanket deposits. They are typical replacement deposits. The chimney type is roughly circular to elliptical in shape where the mineralizing solutions have crept out along fissures. They stand nearly vertical and in some instances have,with some stepping, attained huge proportions.

The manto type is a broad,flat,nearly horizontal bed,never very thick,often averaging but a man's height in thickness. They are formed by the horizontal flow of the mineralizing solutions,and are always connected to the

chimney type. The lateral extent of the mantos varies to a maximum disclosed in El Potosi,so far,of approximately 3,000 square meters.

Classes of Ores.

The classes of ores are of two main divisions;the carbonates and the sulfides. The carbonates,being the oxidation product of the sulfides,run about 50% higher in value than the original sulfides,and in some cases of high grade ore recovered from the ore-thieves ("gambusinos") the assays showed 750 ounces of silver and 70% lead per ton.

The carbonates and sulfides have been found interbedded in a few cases,in a very peculiar manner. Stoping was started in carbonate ore in one particular stope,run downward and encountered sulfides with no zone of mixture or alteration,passed thru the sulfide to encounter carbonates, thru which to pass to again encounter sulfides and end up in carbonate ore. Geologists have failed to advance a reason for the abrupt changes from one to the other class of ore.

MINING METHODS.

Underhand stoping is employed in El Potosi mine without the aid of any timbering whatsoever. Stoping is started at the top of an orebody.The back is carefully cleaned of loose slabs and all the ore is recovered.Unsupported stopes of great width are not uncommon. One stope in particular has a length of 700 feet,width of 150 feet,and height of 250 feet without any timber.

FOSSIL HORIZONS.

There have been recognized in El Potosi mine, two regions or beds of fossil limestones. They have been termed "Favorable Limestone Horizons" in that they have been recognized to have a direct bearing on the deposition of ores. Due either to a chemical or physical peculiarity, these fossil beds have been the region of the "manto" type of ore deposition. Between the fossil beds are the chimney deposits.

The fossil horizons are of uniform thickness thruout the district. They have a uniform dip and strike and are parallel to the bedding of the country rock. The analysis of the limestone is as follows. Silica, 0.5%; Iron, 0.7%; Manganese, 3.8%; CaO, 51.00%; magnesium, 0.30%; and Alumina, 0.42%.

The limestone is a light gray in color, is crystalline in form and is often marbleized. Fresh pieces of the rock emit a faint odor of hydrogen sulfide when struck, probably due to the alteration or oxidation of the fossils. Seldom is a distinct form revealed to classify the fossil.

As discussed later in this report, the intersections of fissures in the favorable limestone beds are the most likely regions for the depositions.

THE VERTICAL SECTIONS.

When the company first decided to pursue a program of prospecting with the diamond drill on a more scientific basis than in the past,it was found that vertical sections would be required along the most important fissures.The North-South group of fissures have been,for some time,recognised as being the most important of all those traversing the district.In order to determine the most favorable regions for the location of the bases for drilling, the "Favorable" fossiliferous limestone beds were to be projected onto the sections.

The writer spent some three months studying the fissures underground. Notes were taken profusely in all sections of the mine in order to plot accurately the positions and physical characteristics of the fissures,their trend thru the stopes,and their behavior on intersecting other fissures. The most difficult part of the work was the tracing their progress thru the orebodies. The mineralization,in most cases,obscured the passage of the zone into the limestone walls. The plotting of the notes on the stope maps and the subsequent drawing of the sections on a scale of 1 to 1000 progressed more rapidly.

Upon completion of the sections,the Assistant Superintendent,Mr.H.A.Walker,and the writer spent some time underground tracing the contacts of the fossil beds with

the unfavorable gray limestone. Distances from plotted transit station plugs and elevations of the points along the contacts gave a basis for the projection of the beds onto the sections already made. Simple proportion,checked thru several different directions,gave the contacts along the sections. The contact was drawn thru several control points and then projected across the sections into parts of the mine not visited. Where these projections cut drifts,raises or stopes,gave points for observation and checking. These projected points were then visited and found to check very closely with the actual condition underground.Maps of the other companies were also studied to give further check on the work done.

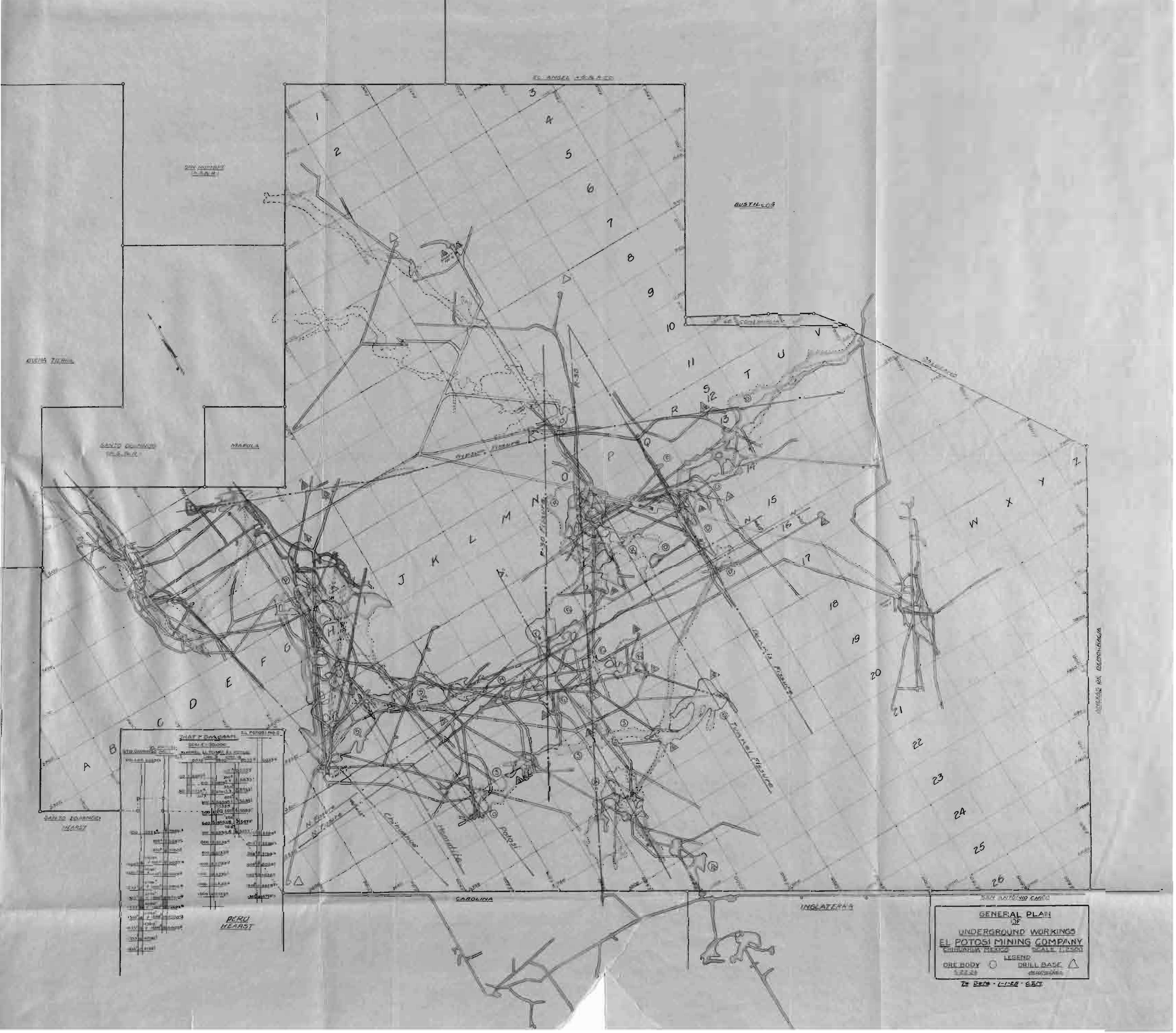
In the same manner,each vertical section was completed with the favorable limestone horizons. Where the different mining companies of the district recognised but two favorable horizons,the investigation in El Potosi disclosed four.The upper favorable horizon which had been recognised as being one bed was actually proven to consist of two fossil beds separated by an unfavorable bed of 38 feet in thickness. Another fossil bed was discovered to exist 47 meters (155 feet) below the second strata of the upper favorable horizon. This bed had never been recognised in other parts of the camp. Its thinness,however, makes this bed of little importance,and it can be ignored

as far as its effect on ore deposition is concerned.

The sections being completed, the location of drill bases was next considered. Drilling for the intersections of the fissures in the favorable limestone horizons was started. Drifts were started with the same objective in view. One drift is now nearing the intersection of the "Dennis" fissure with the "R-30", on the first level of Shaft #3, and the face at present is in a mixture of carbonate ore, gouge, and broken limestone. This one instance seems to support the contention that the intersections in the favorable horizons are of the utmost importance.

The vertical sections were also used as a means of arriving at ore reserve calculations. The plan and section of an orebody are the basis for assuming the extension of ore, along with knowledge gained from raises and drifts near the orebody under consideration.

The sections accompanying this report are reduced, by means of the pantograph, from the working sections on a scale of 1:1000 to the size of 1:2500. The section thru the "Chihuahua" fissure was adapted from the geological report of Spurr & Company to the American Smelting & Refining Company. It is included in order to show the relation between the capping and the country rock, and the relation between the different shafts tapping the orebodies.


GENERAL PLAN
OF
UNDERGROUND WORKINGS
EL POTOSI MINING COMPANY
LEGEND
ORE BODY
DRILL BASE
SHAFT DIAGRAM
BUSTILLOS
BUENA TIERRA
MAPULA
CAROLINA
INGLATERRA
SAN ANTONIO CHICO
PERU
HEARST
SANTO DOMINGO
HEARST
Potosi
Chihuahua

FISSURE SYSTEMS.

As mentioned before, the anticline forming the Sierra of Santa Eulalia is traversed by a network of fissures varying from major importance to negligible. Some of the fissures cut the porphyry capping, while the greater majority do not, hence relatively denote their ages. The fissures are remarkable for their persistence and uniformity of physical properties, probably due to the fact that the limestones are of general uniformity of character, and that the uplifting was gentle, not being marked by strong folding. Nearly all the fissures stand vertical, or nearly so, the one notable exception being the "N" fissure, discussed later. Of the various systems of fissures traversing El Potosi property, the only one studied to date is the North-South system. The work of mapping the others remains for future disposal.

THE NORTH-SOUTH SYSTEM.

The most important system of fissures in the mine is the North-South system, which is approximately parallel to the axis of the anticline and is genetically related to it. As named on the accompanying map, the more important fissures of this system are; The "Dennis", the "Tunnel", the "A-North", and the "Hematite". They are pre-mineral fissures. They do not cut the capping. The N-S fissures mark the strike of most of the orebodies of the mine.

There is no orebody of any importance in El Potosi mine that does not have a N-S fissure running thru it. This system of fissures cuts thru every chimney,and is the strike of all true mantos.

The North-South fissures with their related N 10 E to N 10 W fissures were the solution channels of the hot ascending waters which bore the minerals in solution. Where they were intersected by cross fissures are the regions of ore deposition of sufficient size to make an orebody of economic importance.

THE "DENNIS" FISSURE.

The fissure furthest East of the N-S system is the "Dennis". This fissure is practically vertical. It is due north and south. The fissure is for the most part characterised by carbonate ore of shipping grade. On the "Dennis" are the orebodies; "G" on the 3rd and 4th levels, "B" on the 7th level,and the "E" on the 6th,7th,and 8th.

The "G" orebody,where the Dennis has its effect, has produced in the neighborhood of 10,000 tons of sulfide and carbonate ores,and is still working on a reserve estimated at 3,000 tons.The stope has produced both sulfide and carbonate ores as described on Page 6 of this report.

The "B" orebody is a small pocket,having produced around 6,000 tons of carbonate ore. The grade has been good.

Meters Above Sea Level

1800

1700

1600

1500

1400

1300

Gypsum

Porphyry Capping

G

D

P

L

DENNIS FISSURE

N-S Section Looking East

Scale 1:2500

April, 192[illegible]

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The "D" with its reserve is credited with 45,000 tons of very good grade carbonate ore. It is the largest stope on the "Dennis" Fissure.

With the exception of the "B" orebody, the stopes are found at the intersection of the Dennis and the "N" fissures.

As the intersection of the North-South fissures with cross fissures has been the location of orebodies, as proven by the development of the mine, the intersection of the Dennis with more cross fissures is a matter of considerable interest to the company. In the northern part of the property, at or near the region of Block Q-9, is the presumed intersection of the Dennis with the R-30. A little further to the north is the presumed intersection with the F-30. To the south, the Dennis should intersect the "J" fissure that runs thru the "J" and "Q" orebodies about N 70-80 W in or near Block Q-20. These three intersections should prove of considerable interest to the property. In fact, the company has long since realized the importance of the possible intersections and now development drifts along the Dennis toward the regions is being prosecuted with all possible speed. The drifts are being driven on three levels and are all in the "Favorable" limestone.

THE "TUNNEL" FISSURE.

The "Tunnel" fissure parallels the "Dennis" and is

Meters Above Sea Level

1800

1700

1600

1500

1400

1300

Porphyry Capping

Gypsum

R30

N"

Cave

T

R

D

L7

L4

L6

L9

L10

L11

5100

5200

5300

5400

5500

5600

TUNNEL FISSURE

N-S Section Looking East

Scale 1:2500

0 25 50 75 100

Mts.

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about 90 meters to the west. The "Tunnel" also is practically vertical, is due north and south, and has developed both carbonate and sulfide ore. The "E" orebody in the upper workings of the mine, the Tunnel orebody on the Tunnel level, the "R" orebody extending between the Tunnel and the 7th levels, and the "D" orebody between the 8th and the 9th levels, and the "Q" orebody on the 9th, 10th, and 11th levels are the orebodies that owe their being to the "Tunnel" fissure.

The "E" orebody is found at the intersection of the Tunnel and a N 30 W fissure. The Tunnel orebody was produced at the intersection of the Tunnel and the R-30. The "R" orebody is found at the intersection of the Tunnel, the "N" and the R-30 fissures. The "D" at the Tunnel and "N", and the "Q" is at the intersection of the Tunnel and the "J" fissures. The Tunnel fissure has been responsible for huge tonnages of carbonate ore and some sulfide.

THE "A-NORTH" FISSURE.

The "A-North" fissure has to its credit the b and e sections of the "F" orebody; the "A" carbonate orebody; the "A" sulfide orebody; and a side shoot of the "J" orebody, on the 10th level of Shaft #1 district. The "Fb" is the scene of the intersection of the "A" and "N" fissures. The "A" orebodies are at the intersections of the "A-North" fissure with the "R-30" and two parallel related fissures. To the north of

Meters Above Sea Level

1800

1700

1600

1500

1400

1300

Porphyry Capping

"N"

Gypsum

R.30

L8

Fd

Fb

Fc

L9

A Lim.

L10

A Mont.

L11

Andesite Dike

5200 5300 5400 5500 5600 5700 5800

"A" NORTH FISSURE.

N-S Section Looking East.

Scale 1:2500.

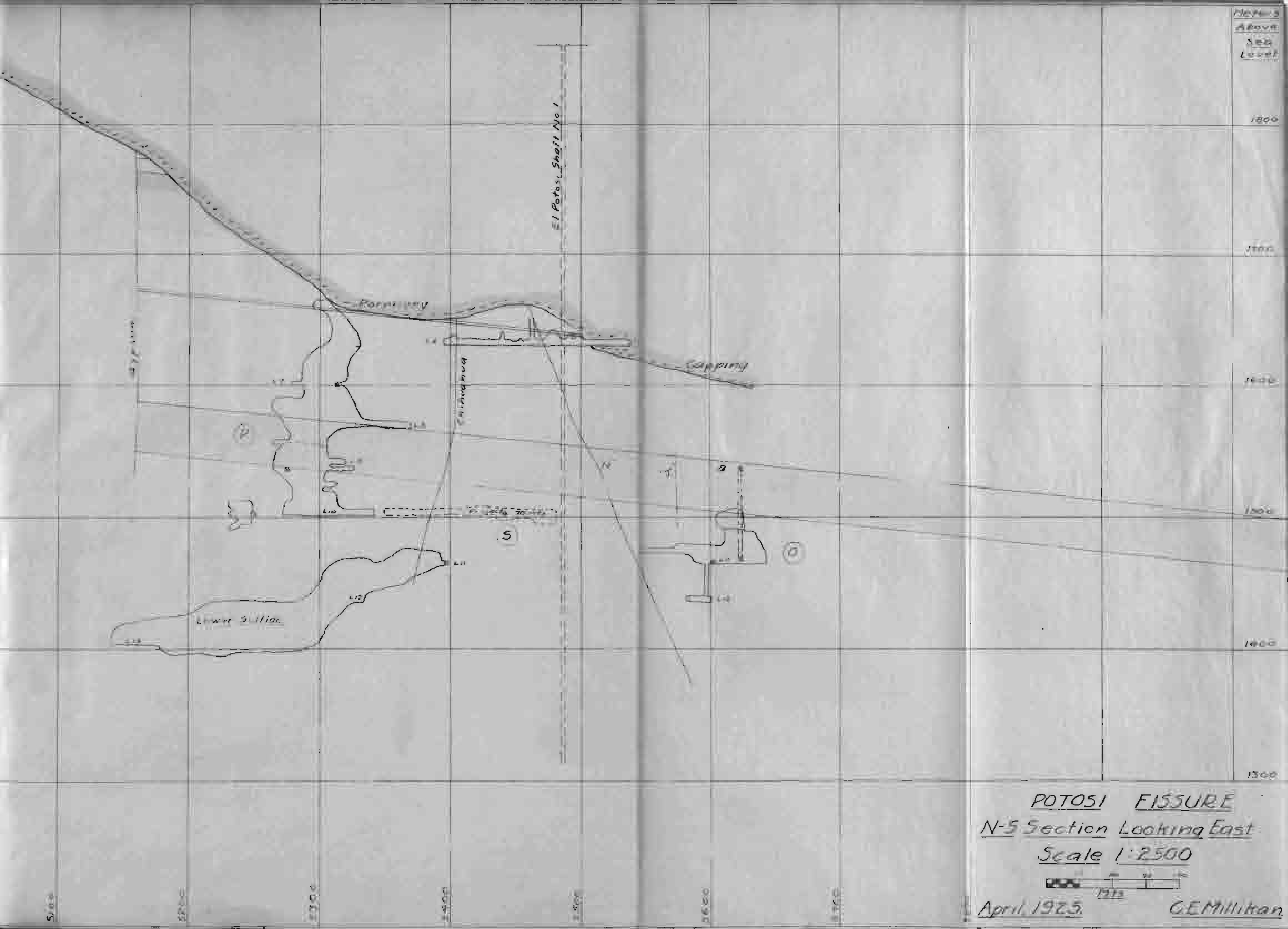
25 50 75 100 Mts

April, 1925 C.E. Millikan.

the "F" orebody lies undeveloped 70,000 square meters of country. It is quite probable that there will not be any ore found in that region because of the lack of a cross-fissure to intersect the "A-North".Diamond drilling has not disclosed anything of interest.

THE HEMATITE AND POTOSI FISSURES.

The "Hematite" and the "Potosi" fissures are studied as one fissure,their relation to each other having been discovered to be very close. The two fissures intersect in the north-west part of the property,and are crossed by the "Gypsum",a post-mineral fissure. The "Gypsum-Hematite-Potosi" intersection is the cause of the great "Chorro" orebody of that region. The "Gypsum" has dragged the mineralization out laterally. The other two fissures, being nearly vertical,intersect in a vertical chimney of great proportions. These two fissures run thru orebodies for over three hundred meters. There remains sulfide ore in the south wall of the "S" sulfide orebody. Just south of the "S" orebody in the south-western part of the property,may be seen the probable intersection of the"Potosi"and "N" fissures,and of the "Hematite" and the "N" fissures. A little further to the south may be seen the probable intersection of the "Hematite" and "Potosi" with the "J" fissure. These two regions of intersections should prove of immense interest to the company as the possible loci of great



POTOSI FISSURE

N-S Section Looking East

Scale 1:2500

April, 1925.

C.E. Milliken

orebodies,especially in view of the fact that there remains sulfide ore in the south wall of the "S" orebody.

The "Potosi" and the "Hematite" fissures are the parents of the"Chorro" chimney,as stated,the immense "Lower Sulfide" orebody,the "S" sulfide orebody,which has a reserve of 900,000 tons of ore amenable to concentration,and the "O" orebody which is at the intersection of the "Potosi" and the "J" fissures.

THE CHIHUAHUA FISSURE.

The "Chihuahua" fissure is not a member of the N-S group of fissures. However,great caves filled with ore of lead and zinc sulfides have been found along this fissure, and its intersections with other fissures to the south are of great importance in view of its possibility of being an oremaker of no small proportion. Nothing definite can be said of the "Chihuahua" fissure because as yet there has been no opportunity of detailed study along its extent. The upper levels where the fissure has been studied are already developed,and the lower levels have been under water for considerable length of time. with the opening up of the lower levels,which is now going on,opportunity will present itself for much work in respect to the "Chihuahua".

THE GYPSUM AND TIE "N" FISSURES.

Of the cross fissures,the two outstanding ones of

Meters Above Sea Level

1800

1700

1600

1500

1400

1300

Surface

Fissure

Mined

Adopted From Geological Report For A.S.&R.Co. By Spurr & Co.

CHIHUAHUA FISSURE

N-S Section Looking East

Scale 1 2300

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all around interest and importance are the "Gypsum" and the "N" fissures. Both are fault fissures. Both run thru orebodies of great size,yet neither is a pre-mineralization fissure.

The "Gypsum" fissure is so named because of the great amount of gypsum found thruout its length in all parts of the mine where it has been cut. It invariably presents a seepage of water. Caves on the "Gypsum" fissure have been of great beauty owing to the stalactites and stalagmites of pure gypsum found. One cave,the "Gypsum" cave,when opened,presented a fairyland-like scene. Pure dazzling white,filled with crystals of all shapes and sizes,it was a bonanza for specimens of everything - but ore. Later,a little carbonate ore was found at the extreme eastern end of the cave. Its extent has not been determined.

However,where the "Gypsum" fissure has crossed N-S fissures,it has extended the mineralization laterally and made orebodies. The "Gypsum" fissure has a crushed zone for several feet on either side of the main fissure zone,and is a true fault fissure.The fault is normal and the displacement is but a few feet.

The "N" fissure is also a fault fissure,with a lesser displacement than the "Gypsum". Unlike the "Gypsum",the "N" can be found to carry a little value in silver and lead in almost any place it is cut. The "N" is a post-mineral fiss-

"N" FISSURE

E-W Section Looking North

Scale 1:2500

April, 1925 G.E. Millikan

ure,but is of great importance in El Potosi ground.Rich carbonate ores have been found at the intersection of the "N" fissure with those of the N-S group. The "N" is not a vertical fissure. Its average dip is close to 65 degrees. It presents a uniformly sameness of appearance in nearly all parts of the mine where it has been exposed by development.

SUMMARY.

The fissures traversing the country were the means of mineralizing the district. The North-South system of fissures have been determined to be pre-mineral, hence the most important. Their intersections with cross fissures are the regions of orebodies, and the intersections have always produced ore of mineable quantity. Especially important are the intersections of fissures in the "favorable" (fossiliferous) limestone beds. The favorable limestones are easily recognizable and can be traced thru all parts of the district because of their distinctiveness and the uniformity of the structure of the region. Due to their chemical or physical properties, which make them favorable for the deposition of ore in manto-type bodies, the fossil beds present definite regions for prospecting, and should ore be discovered, chimney deposits should be found close by, between the beds of fossil or favorable limestone.

Intersections of fissures in the favorable limestone beds present a restricted region for immediate prospecting or development, which reduces expenditures for development to a minimum in that more intelligent search may be carried on, than promiscous search without reference to probabilities.

Without doubt, the most economical prospecting can be accomplished by means of the diamond drill. Bases for drill-

ing should be located with reference to the favorable limestones within reasonable reach of the intersections of the North-South group of fissures with cross-fissures, and a systematic search instituted for mineralization. Where deemed more advisable, drifts or raises could be driven with a view of cutting probable intersections.

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ACKNOWLEDGMENT.

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Carl E. Nicholas.

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