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The Mining Industry of Bolivia

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SYNOPSIS—Bolivia has no seacoast. Three-fourths of its area is little known. Remainder high tableland and mountains; cold, dry, barren; present wealth chiefly mineral. Principal values tin and silver. Copper likely to be second. Bismuth important. Also tungsten and antimony. Value of latter in 1915 over $4,000,000. Mineral deposits mainly in eastern range—gold in north, copper near Corocoro, lead and zinc in south. Tin most widely distributed, bismuth often associated, antimony in other veins in vicinity.

There are two countries in South America without seacoast—Bolivia and Paraguay; but the latter has direct connections with the sea by means of navigable rivers, so that Bolivia stands unique as the truly inland country of that continent. As regards climate, topography, natural resources, population and development, Bolivia consists of two distinct parts—the *altiplanicie,* or high plateau and the bordering mountain ranges, and the region to the east of the main Andean chain known as the *yungas* and the country beyond. The latter portion, constituting nearly three-fourths of the total area of about 500,000 sq.mi., is comparatively inaccessible, for the most part little known, much of it inhabited by savage Indian tribes and, though destined to be of great agricultural value in years to come, today produces only relatively small quantities of rubber, coca, cocoa, coffee, etc. It is a region of no present importance in the Bolivian mining industry.

The *altiplanicie* is a high tableland nearly 500 mi. long and over 100 mi. wide with an almost constant altitude of about 12,500 ft. At its northern end, on the boundary between Bolivia and Peru, is Lake Titicaca, the highest body of navigable water in the world. To cross the lake by steamer requires more than twelve hours. This tableland divides the Andes into two distinct chains that bound it on the east and west respectively, the highest peaks rising above it to elevations of 20,000 ft. and more. It is from this part that the mineral production of Bolivia is derived. So highly did the great Peruvian scientist, Raimondi, regard the mineral wealth of this region that he referred to it in most extravagant terms as "a table of silver supported by columns of gold." Climatic and living conditions are most rigorous here. Though lying within the tropics, the climate, on account of the high altitude, is anything but tropical. There is a dry season and a rainy season, but the latter is rainy only in comparison with the former. The total rainfall is small, with the result that low temperature and aridity combined make a very barren and desolate-looking country. In fact, it would be incapable of supporting even its present sparse population if it were not for the wealth derived from its mines; and this portion of Bolivia, which today is really *Bolivia,* would become an almost uninhabited waste if its mineral wealth should reach exhaustion.

PAY DAY AT UNCIA TIN MINE

TYPICAL INDIAN MINERS OF BOLIVIA

That Bolivia is distinctly a mining country is attested by the fact that three-fourths of her revenue from export duties is obtained from those levied on her mineral products. Though it has been subject to considerable fluctuations, particularly in the case of the individual metals, the mineral production of Bolivia has been gradually increasing in recent years. In the accompanying table the output of the various metals is given for the past six years and, for purposes of comparison, the average annual production for the periods 1900 to 1902 and 1910 to 1914 is shown separately.

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This table shows a number of very interesting changes that have taken place in the mining industry of Bolivia during recent years. First of all it shows a great revival of that industry during 1915 after its almost complete paralysis during the latter half of 1914. The extent of this paralysis is indicated not only by the decrease of one-third in the value of the exports of mineral products during 1914 over those of 1913, but even more in the decrease in export duties derived from them, which amounted to more than 50%. In 1915 the value of the exports was nearly thirty million dollars, a figure only a little less than that of 1913 (which represents a maximum) and greater than those of the preceding years. This record was achieved, however, only through unusual production of several of the rarer metals.

Gold mining in Bolivia does not and never has amounted to much, notwithstanding the fact that gold was the objective of the Spaniards and that the search for it led to the discovery and colonization of the West Coast countries. Bolivia has achieved its greatest fame as a silver producer and in the colonial days proved a veritable treasure house for the Spaniards. Potosi, Colquechaca and Oruro literally poured wealth into the Spanish coffers in those days, and the richest of all was Potosi. It is claimed for the Cerro Rico de Potosi, the hill on which the mines are located, that it has furnished more metallic wealth than any other area of equal size in the world, its production being estimated at over $2,000,000,000 in silver, of which more than $200,000,000 went to the Spanish Crown as taxes. Silver mining is rapidly declining in Bolivia, however, and whereas from 1900 to 1902 it contributed nearly 54% of the total metallic production of the country, during the five years 1910-14 it averaged only 6.3% and in 1915 only 3.7%. Not only has there been this great relative decrease, but the absolute decrease was from $5,300,000 in 1900 to $1,092,647 in 1915.

In recent years copper has become the most important of all the metals, and most of the countries that have shown great increases in their mineral production have been those with great copper resources that have been developed. The fact that Bolivia has not become a great copper-producing country accounts for the slow increase in the value of the products of her mines. However, the value of the copper output has shown a constant rise, fairly rapid in the last few years, so that the 1915 production was nearly ten times that of 1900 and from two to three times that of the years immediately preceding 1915. It is hoped that the copper-mining industry may be still further stimulated through the advent of American capital in the Corocoro district, as properties there have been investigated by American engineers. If these properties are acquired, it will mark the first large investment of American capital in a Bolivian mining enterprise and again emphasize the attractiveness of South American copper deposits over deposits of the other metals.

In common with the other South American countries, the lead- and zinc-mining industries have undergone but little development. As was explained in the article on Peruvian mining[1], this does not mean there is a dearth of such deposits, but rather that with high costs and a limited amount of capital the deposits of the more valuable metals are developed first and lead and zinc must await more favorable conditions and times.

Whereas Bolivia was famous in years gone by as a silver producer, her fame as a mining country today rests on her tin-mining industry. Tin has been worked in Bolivia for many years, but the importance of the tin deposits was not realized until the last decade of the past century, when she rapidly became the most important (lode) tin-producing country in the world. By 1900 the value of her tin output had reached 3⅓ million dollars and constituted 37% of all her mineral production. During the five years 1910-14 it averaged over 20 million dollars and constituted 83% of her total mineral production. The maximum output was reached in 1913, when it amounted to over 26 million dollars. After dropping to 16½ millions in 1914, it rose again to over 19 millions in 1915, but owing to a great increase in production of certain of the other metals, it made up only two-thirds of the total value of the 1915 production of metals. As regards the future of Bolivian tin mining, the concensus of opinion seems to be that the maximum has been reached and that new finds will not be more than adequate to compensate the exhaustion of older deposits. The prospects are favorable for the continuance of the present production for some years to come, so that tin mining will continue for a long time to be the most important branch of Bolivian mining; but it is to be expected that its relative prominence will suffer because of the development of other branches.

In addition to the metals mentioned, notable amounts of bismuth, antimony and tungsten are produced. The most important of these has been bismuth, the production of which has undergone an almost constant increase. Furthermore, Bolivia is by far the world's most important producer of bismuth ores. From a little over $100,000 in 1900, the value of the output increased to nearly $1,100,-

STATISTICS OF BOLIVIAN MINERAL PRODUCTION

	Gold		Silver		Copper		Lead		Zinc	
Year	Dollars	Oz.	Dollars	Oz.	Dollars	Metric Tons	Dollars	Metric Tons	Dollars	Metric Tons
1915	.....	....	1,092,647	2,475,884	.....	.....	.....	.....	.....	.....
1914	118,695	5,790	984,686	2,325,916	1,728,441	3,874	60,489	1,555	54,417	3,755
1913	61,664	3,008	1,083,406	2,613,794	1,278,870	4,020	137,377	1,765	86,829	7,367
1912	51,619	2,518	1,673,393	3,985,177	1,318,745	4,707	83,649	1,075	128,400	8,961
1911	35,985	1,770	1,785,115	4,112,540	555,230	2,950	9,162	343	144,938	9,798
1910	.....	....	2,130,976	4,597,331	695,312	3,212	276	30	169,264	11,897
Annual Average										
1910-14	66,991	3,362	1,531,555	3,526,952	1,115,321	3,753	58,191	954	116,830	8,356
1900-02	39,323	.....	5,070,120	.....	544,376	.....	6,533	...	825	.....

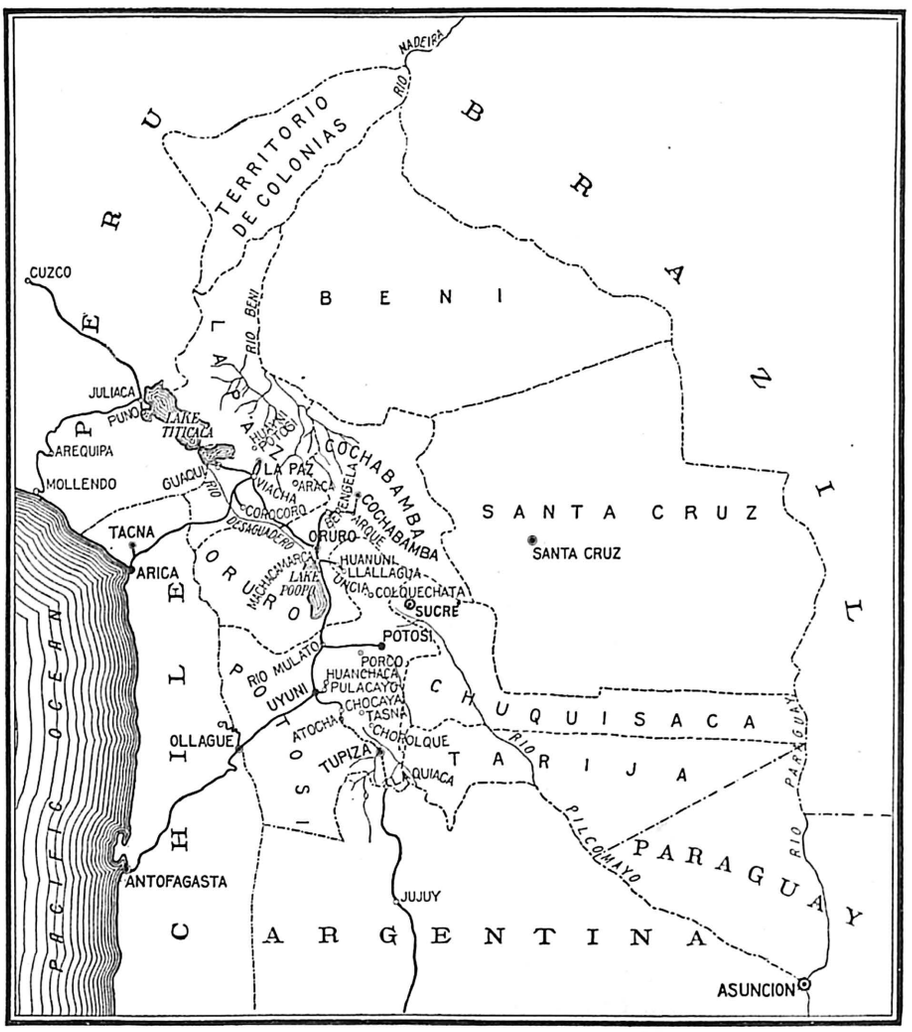
	Tin		Bismuth		Antimony		Tungsten		
Year	Dollars	Metric Tons	Dollars	Metric Tons	Dollars	Metric Tons	Dollars	Metric Tons	Total Value
1915	19,268,862	39,312	1,071,125	568	4,216,050	13,085	293,462	499	29,762,967
1914	16,529,119	37,260	924,899	438	11,913	186	166,654	276	20,579,613
1913	26,375,244	44,595	774,991	390	4,829	62	161,641	283	30,964,857
1912	23,438,987	38,614	783,784	382	8,886	91	202,220	476	27,689,683
1911	20,482,336	37,073	819,518	415	26,622	312	89,956	292	23,948,862
1910	14,399,417	38,548	748,411	311	37,774	525	55,109	210	18,236,539
Annual Average									
1910-14	20,245,021	39,218	810,321	387	18,005	235	135,116	307	24,283,911
1900-02	3,468,606	.....	264,400	...	16,814	...	6,571	...	9,417,568

[1] "Eng. and Min. Journ.," Vol. 101, May 13, 1916, p. 848.

000 in 1915, and in that year barely fell short of the value of the silver production. While no great rise in this industry can be expected, by reason of the limited demand for bismuth and the fact that the Bolivian output supplies such a large part of the market, the indications are that it is well capable of holding its own. Tungsten is a metal subject to great fluctuations in price and consequently the output of tungsten ores fluctuates greatly. With this fact in mind and also that in 1913 an export duty became effective, the figures of production indicate a slow growth of the tungsten-mining industry, with considerable latent possibilities for expansion. The 1915 output was the greatest recorded and the abnormally high prices now prevailing will certainly establish a new high record in 1916. The most phenomenal showing made in the Bolivian mining industry in 1915 was that of antimony. It, likewise, is subject to great fluctuations, due to instability in price, but had never achieved any great importance in Bolivia. From 186 tons in 1914 the high prices prevailing in 1915 were responsible for an increase in that year to 13,085 tons, with a value of $4,216,050, which exceeds that of any other metal except tin. Before the end of the year the demand for ore had already slackened, and the 1916 figures are not likely to equal those for 1915.

In the past silver and tin have been the principal products of the Bolivian mines, and since 1900 they have constituted jointly 90% of the total value. Owing to the increasing importance of copper mining and more particularly to the unusual activity in that of the rarer metals in 1915, these two metals made up only a little over 70% of the total in that year. In the future silver is likely to yield its place to copper, and tin and copper will be the most important metals produced in Bolivia. The 1915 rank of antimony is only temporary, but there is the possibility that bismuth may outrank silver and compel the latter to drop to fourth place. Opposed to this is the view that silver mining has declined to a large extent, on account of neglect due to the greater attractiveness of tin mining during the development of that industry, and that from now on attention will revert to silver mining and greater activity may be anticipated in it. There is no basis for expecting a great increase in the output of the other metals, so that the increase in Bolivia's metal output will be determined largely by the course of copper mining in that country. The mineral deposits of Bolivia are found principally in the eastern range of the Andes from Lake Titicaca to the Argentine border, a belt having a length of about 500 mi. There are a few isolated groups of hills with the *altiplanicie*, geologically a part of that range, that are likewise mineralized; as for example, the Oruro hills. The western range, which lies principally in Chile, is characterized by recent volcanic activity and has not been so generally mineralized. Its most important deposits are the nonmetallic deposits of sulphur and borax that lie chiefly in Chile. Extending longitudinally across the *altiplanicie* is the copper belt in which Corocoro lies. Consequently most of the mining districts of Bolivia are found within a belt about 100 mi. wide on the east side of the railroad that traverses the *altiplanicie* along its eastern edge. Deposits of all the metals are nearly coextensive with the main eastern range of the Andes, but those of commercial importance seem to be grouped about certain more or less well-defined centers. Gold mining is confined almost entirely to the department of La Paz. The Chuquialguillo placer near La Paz, for a time an important producer, is idle, and the gold output has been derived chiefly from the Olla de Oro and Incaoro mines (both owned by American capital), which lie to the east and north of La Paz respectively. Almost the entire silver production comes from the districts of Huanchaca, Oruro and Potosi; but the province of Sud Chichas, in the southern part of the department of Potosi, will soon be an important producer. At Chocaya and other neighboring places, tin ores carrying good silver values are being mined and the silver is to be recovered by lixiviation.

Nine-tenths of the Bolivian copper production comes from the Corocoro district, which lies outside of the main mineralized belt of the eastern Andes, on the *altiplanicie* itself, within a belt of copper deposits that extends more or less continuously the entire length of the high plateau. The remainder of the output comes as a byproduct from



THE PRINCIPAL MINING REGIONS OF BOLIVIA

the ores of the Compañia Huanchaca de Bolivia at Pulacayo, from those of the Aramayo Francke Mines, Ltd., to the south of Pulacayo, and from Oruro and Potosi.

The lead ores are derived almost entirely from southern Bolivia in the region about La Quiaca. They are packed in on llamas and mules to the latter place and exported via Argentina. In 1913 over three-fourths of the lead ores went out by this route. The zinc ores come entirely from the Pulacayo mines. As stated, the actual occurrence of lead and zinc ores is far more widespread than is indicated by these few producing points.

The tin deposits are the most widely distributed of the Bolivian mineral deposits and are being worked throughout the extent of the Cordillera Real, or eastern range. Nevertheless ten important centers of production account for nine-tenths of the total production, and these from north to south are Araca, Oruro, Machacamarca, Huanuni, Llallagua, Uncia, Potosi, Sala Sala, Chocaya and Chorolque. Simon I. Patiño's mines at Uncia and Huanuni produce nearly two-fifths of the total. The Uncia and Llallagua mines, which work different parts of the same group of veins on the same mountain, together produce over two-fifths of the total; while the Uncia mines alone produce about 30% of the total Bolivian tin output. Three-fourths of the production comes from the department of Potosi.

The bismuth ores are associated with the tin ores, but are not so widely distributed. Important amounts of bismuthinite are found in certain of the Uncia veins, but the chief producing mines are those of the Aramayo Francke Co., Ltd., at Tasna and Chorolque, and the Carmen mine at Huayni Potosi (north of La Paz), worked by the Huet brothers. The latter mine is particularly noteworthy on account of the abundant occurrence of native bismuth. Otherwise the prevailing bismuth mineral is the sulphide of bismuth, bismuthinite.

The antimony ores are also found in the same general region as the tin ores, but as a rule not in the same veins. The veins are usually narrow, but the filling consists almost entirely of stibnite with very little gangue; so that it is comparatively easy to sort out a high-grade material. In the "boom" of the past year the principal centers of production were the Chuquiutu district, near Uncia, the country about Porco and that around and to the south of Atocha.

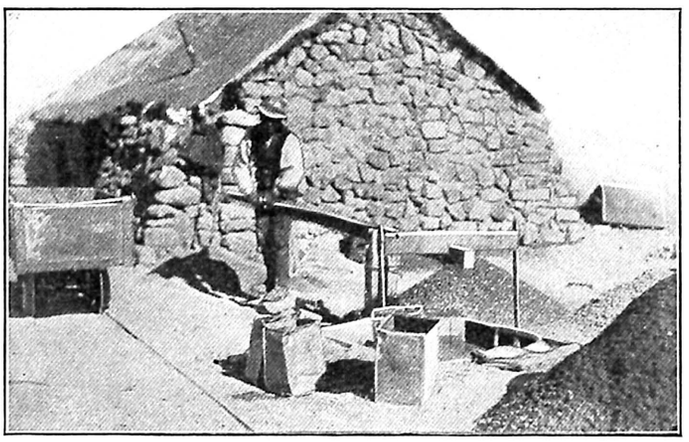
Tungsten ores are likewise widely distributed through the tin region and have been produced at many points. At present the chief producing regions are the Quimza Cruz district, northwest of Cochabamba, and the region between Uyuni and Chorolque in which Sala Sala is the most important center.

This review of the distribution of the mineral deposits of Bolivia shows that from the standpoint of present productivity the department of Potosi is the most important and that it produces over half of each of the metals considered with the exception of gold and copper, for which that position is held by the department of La Paz.

Mining Conditions in Bolivia

The greatest difficulties encountered in mining in Bolivia are high transportation costs, lack of fuel and scarcity of labor; in which respects it does not differ from other West Coast countries of South America.

While transportation problems are not easy in Bolivia, they are by no means so difficult as in Peru, and the mining industry is far better served by railroads in the former country than in the latter. Bolivia is fortunate in having its mineralized country paralleled by the great high plateau along and across which the construction of railroads is comparatively easy. The completion of the Antofagasta & Bolivia R.R. to Oruro over 25 years ago and the extension of the Southern Railway of Peru via Lake Titicaca to La Paz 15 years ago made it unecessary to pack everything to and from the coast on animals. It seems remarkable that the former road was not extended to Viacha to connect with the latter until as late as 1908. This extension gave La Paz, the virtual capital[2] of the country, two outlets to the sea by modern transportation. The completion of the Arica-La Paz line in May, 1913, gave a third and more direct outlet. There is now consequently a line running the entire length of the *altiplanicie* along its eastern edge, from which branch lines are being built into the mineral belt to the east of it. At Oruro is the partly completed line to Cochabamba that has already opened up the Berengela district and made more accessible to rail transportation a number of other tin-producing districts of that region. From Machacamarca, the next station south of Oruro, Simon I. Patiño is constructing a private railroad to his mines at Huanuni and



MARITATA, OR HAND JIG, USED AT BOLIVIAN MINE

Uncia. It is now in operation beyond Huanuni and when completed will also put the Llallagua mines on the railroad. The branch line from Rio Mulato to Potosi has now been in operation four years, and its course lies only three miles north of the old mining town of Porco, in which district it has made possible a revival of mining. The line has a length of 108 mi. and is the second highest railroad in the world, reaching an elevation of 15,814 ft., or only 51 ft. lower than the highest point on the Morococha branch of the Central Railroad of Peru. At Uyuni the Compañia Huanchaca de Bolivia has a line 25 mi. long to its mines at Pulacayo, and a line is under construction to La Quiaca on the Argentine border to connect with the Argentine railroads. It is now in operation as far as Atocha, a distance of 51 mi. out of a total of nearly 200 mi. This line runs through a mineralized area that was of considerable importance formerly, and the introduction of modern transportation facilities will no doubt again make it an important contributor to the mineral production of the country. The completion of this line will also provide a second transcontinental railroad in South America, that will have an advantage over the present line (between Buenos Aires and Valparaiso) of being able to operate throughout the year. The previously mentioned Arica-La Paz line has solved the transporta-

[2]The City of Sucre is the nominal capital, but the congress meets at La Paz and the president resides there.—Editor.

tion problem for the Corocoro district. There are now 1,000 mi. of railroad in operation in Bolivia. There are still many ore deposits lying dormant in the country, owing to lack of transportation facilities, but compared with conditions that existed only a few years ago and that still exist in other South American countries, mine operators in Bolivia have much for which to be thankful.

With increased transportation facilities the fuel situation is not nearly so acute as it was. Accustomed as we are to an abundance of coal and wood, it is difficult to realize what a problem this has been. The most important native fuel is the *taquia,* the droppings of the llamas. Incredible quantities are used both as domestic fuel and to run mining machinery and smelters. One of the companies at Corocoro alone consumes annually 10,000 tons of *taquia,* having a value of $4 per ton. Locally *yareta* is found in sufficient quantity to be of importance as a fuel. It is a plant that grows in large clusters of woody, resinous fibers adhering to the rocks at high altitudes and has the appearance of large clumps of moss. In addition, at a few points there are sufficiently large accumulations of peat to make it an available fuel. Fuels other than these must be imported, and if their price is not to be prohibitive at the points of consumption, relatively cheap transportation must be provided. The rapid extension of the railroads of Bolivia in recent years has made it possible to use increasing quantities of imported fuel, and especially oil. Diesel engines are being introduced very extensively, as they furnish the easiest solution of the power problem at present.

The labor question in Bolivia is a difficult one. The high plateau lies at an elevation of over 12,000 ft., and the mines are in the hills and mountains that rise above it up to elevations of as much as 18,000 ft. Most of the mines lie between 14,000 and 16,000 ft. At such elevations it is impossible to use imported labor, as it cannot endure the strain of continuous manual exertion, and it is necessary to depend on the native Indian stock. The supply of this is limited, and consequently in the regions where there has been the greatest development of mining operations difficulty is experienced in obtaining sufficient labor. The Indians are a primitive people, and their methods of work are equally primitive, with the result that their efficiency is not high. The obvious and probably the only method to meet the growing demand for labor attendant on the increasing development of the country is to increase the efficiency of the labor available. A more enlightened and altruistic attitude on the part of the Spanish inhabitants of the country might also be effective in considerably augmenting their numbers. Efforts along the lines of social, moral and sanitary uplift, instead of the purely materialistic policy of exploitation of these people, might yield such results and prove more profitable in the long run. The present status of the Andean Indians was described in some detail in a previous article[3] and need not be discussed again.

Travel and Living Conditions

Travel in Bolivia cannot in any sense be called a pleasure from the standpoint of comfort and conveniences in comparison with our own standards. On the other hand, conditions are far from unendurable, and anyone who has a real purpose in traveling in Bolivia need not hesitate to do so. The *nocturnos,* or through trains, have modern sleeping cars and a really good dining-car service furnishing for 3 bolivianos (about $1 gold) table d'hote meals) that are better than the meals one can get at any hotel in the country. The most uncomfortable feature of the trains is that they are not heated. During the day, when the sun is shining, the cars are quite comfortable, but early in the morning and in the evening it is very cold in the coaches, and on the *nocturnos* the water often freezes to such an extent that one cannot wash in the morning. The railroad fares range from about 2½ to 5c. per mi., and 50 kg. of baggage is carried free. On the principal lines there are about three trains a week and on the branch lines usually not more than one. As soon as one is called upon to leave the lines of railroad transportation, though he can in a few instances depend upon stage lines, for the most part he must travel on muleback. Owing to the lack of forage and grain, mules are expensive and often it is impossible to secure animals at all.

There is no first-class hotel in the entire country. Even in La Paz, the *de facto* capital and principal city, the best hotel makes no effort to furnish a hot bath after 6 p.m., and what is called hot water before that hour is merely water that does not feel cold to the touch. A source of considerable discomfort is the lack of heating apparatus, so that only rooms on the sunny side of the house are warm during the day and no room is comfortable to sit in at night. We were repeatedly driven to bed immediately after supper in order to get warm. Fresh milk and fresh butter are almost unknown. In the northern part of the country, at La Paz and Oruro, one can get Peruvian butter shipped in from Arequipa; elsewhere canned Danish butter is used. The meats are not particularly good and are nearly always spoiled for some *yanquis* by the liberal flavoring with *aji,* a variety of pepper. One can nearly always get good bread, so that even under the worst conditions he can satisfy his hunger. In La Paz one pays about $2.50 per day for room and meals, and in the rest of the country from $1.50 to $2.

Taking into consideration the resources of the land, its stage of development and the amount of travel, one must in all fairness say that railroad and hotel accommodations are all that one can reasonably demand. Except for the lack of heat, the houses of the better classes are comfortable and their food supply varied and good, so that if called upon to remain at a given place any length of time, one can make oneself comfortable.

[3] "Eng. and Min. Journ.," Vol. 101, May 13, 1916, p. 849.