

## *The Nitrate Wealth of Tarapacá (1908)*<sup>1</sup>

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When one hitches one's wagon to a star there is always some uncertainty as to ultimate destination of the equipage. At first glance little apparent connection might appear between astronomy and the greatest - I had almost said the only - nitrate industry of the world, whose centre of activities is a South American desert.

But after all, the relationship is obvious. In the famous Chilean pampa the air is the driest imaginable, and the plain averages three thousand feet above sea-level, parts of it much more. It never rains, there is, in consequence, no vegetation, the coast cliffs on the west catch and dissipate the *camanchaca*, or sea fog, and the snow-covered Cordilleras, eastward, detain approaching clouds from the interior. Thus the desert of Tarapacá is characterized by a wonderfully clear and steady atmosphere, providing an ideal vantage ground for the study of astronomy. Here the powers of a large telescope are not forced to magnify countless tremors of the air as well as celestial images, a condition too frequent at observatories nearer sea-level, in more luxuriant climates.

The same qualities which serve astronomy seem to have been operant for centuries in producing or preserving those well-nigh inexhaustible beds of nitrate of soda, which are fertilizing the world, enriching corporations, and incidentally pouring wealth into the Chilean government coffers.

An opposition of Mars called us to the pampa; the commercializing of nature's supplies for practical benefit had already called thither Englishmen and Germans in numbers, to establish modern activities, introducing to a region, unequalled in desolation and lack of resources, all the luxuries and most of the necessities of everyday life. Without this unwitting preparation of the desert, it would have been impossible to conduct, even temporarily, successful observation of the heavens.

Science has never satisfactorily settled the origin of these great supplies of natural fertilizer, found only on the South American west coast, between south latitude 20° and 27°. During the course of his famous voyage in the *Beagle*, Charles Darwin stopped at Iquique, July 30th 1835, and making a trip to the elevated pampa, became much interested in these mysterious deposits. From a specialist's survey of the region he concluded that the mass was deposited by the subsidence of a great body of water, and 'there can be but little doubt that this sheet of water, at least originally, connected with the sea.'

'The superficial saliferous beds of Iquique' he adds, 'though they stand about 3,000 feet above the level of the sea, have been left by the evaporation of the sea-water.'

This upheaval of mountains from ocean, making the magnificent ramparts of a continent, has recorded its story in ways other than alone by marine shells on lofty peaks; chemists, geologists, naturalists generally, are reading its numerous chapters, and the plot is unfolding, but many dramatic scenes, incidents, characters, are yet to be brought forth from these mighty pages. And one revelation will be the inception of the nitrate tale.

Many origins for these deposits have been put forth by writers. What Darwin has suggested of the general upheaval of a continent seems to have become popularized in detail on the nitrate fields themselves into a theory of antediluvian beaches, whose masses of seaweed in decomposing released their nitrogen as nitrate, the small amount of iodine as iodate. But this is severely objected to by many specialists. It is said in refutation that the bromine of seaweed is not found in the crude nitrate soils called *caliche*; and no natural process is known for complete separation of the bromides from a mixture of iodates, chlorides and nitrates.

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<sup>1</sup> Unpublished paper written in 1907-08. The original manuscript is in the Mabel Loomis Todd Papers (MS 496C), Manuscripts and Archives, Yale University Library.

Dr. William Newton, formerly chemist of Laguna Nitrate Company and of the Lagunas Syndicate, put out a pamphlet some years ago, in which he gave his reasons for thinking nitrate derived from land rather than a deposit from subsidence of sea-water.

In small quantities nitrate is of course found in all fertile soil. Vegetation would not be possible without it; there it originates from the oxidation brought about by the action of microscopic organisms, or 'nitrifying germs.' Experiments by Professor Warrington show favorable conditions for their life and work in a porous soil containing plenty of vegetable or animal organic matter, with sulfate of lime and an alkaline base - as carbonates of potash, soda and lime. With these present the amount produced would vary with temperature, conversion being more rapid in heat, and less in cold weather. Greedily absorbed by plants almost as fast as made, accumulation of nitrate under normal conditions is practically impossible.

The enormous plain of Tamarugal, a portion of the famous Atacama desert, has a porous, alluvial soil containing organic matter, chiefly of ancient vegetable origin. Darwin, indeed, found 'in many parts of this now desert plain, rushes and large prostrate trees in a hardened state, apparently mimosas,' buried from three to six feet deep. The soil also contains sulfate of lime, and is basic in its nature, the water percolating through it containing in some localities carbonate of soda.

Nearly vertical sunbeams from a cloudless sky for much of the year bring favorable temperature conditions, and with no vegetation to absorb it, reserves of nitrate accumulate. The Cordilleras on one side and coast range on the other, a plain between sloping gradually to the west, with all escape of its waters prevented except through the soil, illustrate one phase of this theory. As they evaporate during this long passage, the salts they have dissolved would be given up at the foot of the eastern or landward slope of the coast range. And just here, in some regions, the nitrate is actually found, slightly up the first slope, apparently to confirm this carefully constructed story. Similarly, nitrate or salt dissolved in a saucer and allowed to evaporate, to become a saturated solution, will creep up the sides even over the edge, as the crystals deposit. Through the porous earthy strata called *costra* and *congado*, the rich *caliche* has crept, to spread itself in a thin layer near the surface.

Sufficiently plausible, this, - and fitting well to certain regions, yet almost entirely inapplicable to other localities.

Early guano deposits, despite their lack of phosphate accumulation, have been suggested - and dismissed. Vaguely attributed by a few to early volcanic action, little credence is placed in that surmise. An electric theory has been put forward. But as a scientific man connected with one of the companies recently said to me, 'No completely satisfactory cause for these enormous deposits has ever been assigned. Not one "holds water".'

And, indeed, the numerous attempts to account for them are of interest only to students.

*Caliche*, to many men and nations, means a great deal more than an abstract technical theory; and the methods of its extraction, preparation and export have a significance commercially far beyond speculation as to early geologic activities.

The discovery of nitrate in the desert, about eighty years ago, has gradually put a new face upon matters political, geographic and financial. It played an important part in the final peace between Chile and Peru after the war 1879-1883; it has influenced boundaries, and changed maps.

In early days, near the beginning of the nineteenth century, Peruvians in Tarapacá (it was not a part of Chile then) might acquire a certain right of property in the desert, not more than a small holding of two *estacas* (about 200 yards square). Any individual could 'denounce' land anywhere, so obtaining it from the Government if not otherwise claimed by someone else. If added together, any family might, as a whole, become possessed of a good property. Were more desired, it could readily be obtained by exchange or purchase.

The processes of reducing *caliche* to marketable nitrate were exceedingly primitive, of course conducted wholly by hand, and on a very small scale. The *caliche* was boiled in large copper vessels, the finished product being sold chiefly in Bolivia.

Until about 1870 this method continued, when new ways were introduced, as demands began to come from other countries, and foreigners arriving in numbers gradually increasing, obtained holdings for themselves. Of all nations, Germany, Holland and France first appreciated the immense value of the new material.

In Chile and Peru at this time all inland communication was conducted wholly on horseback, supplies being brought on mules to the desolate country, so rich in fertilizer that nothing will grow on it. Absolute sterility reigns. Strange anomaly! A little nitrate is concentrated life. Too much is blank death.

It was not until 1860 that concessions for railways were granted by Peru. On November first of that year two Peruvian gentlemen obtained them, and soon began to attack the problems involved. In 1882 the Nitrate Railways formed, and registered as an English company. Afterward two roads, from Pisagua and Iquique united as one.

But Iquique, at first simply a fishing village, absolutely lacking resources, and artificially expanded to a city without reason except as an outlet for this one export, offered difficulties in landing. Its harbor is not wholly protected, the surf is always high, even on quiet days, and for shipping purposes 'balsas'<sup>2</sup> were used, a sort of catamaran of wood, covered with skins of seals. By sewing several skins together, it was possible to make cylinders, sharp at the ends, ten feet long by about twelve inches in diameter. Two of these abreast, and two feet apart, were connected by a sort of platform, and filled with air from the lungs of the *cachuchero*.

On these buoyant craft, the bags of nitrate, ready for export, were piled. But while difficult to sink, in the tumultuous passage out to waiting vessels beyond the surf, these picturesque balsas must have offered small impediment to the breaking of an occasional sea quite over their cargo. Later, the use of ample and substantial lighters was introduced, but as these could not be beached, the small craft were still intermediary. Lighters now come up to well-built moles at both Iquique and Pisagua.

After Chile's war with Peru, and her acquisition of the province of Tarapacá (a question far too complicated even to be touched on here), there was a sudden influx, almost a rush, of foreigners for the 'nitrate certificates,' and permission to manufacture. Steadily increasing since that day, the almost phenomenal expansion of this industry may be shown by the fact that in 1830 something like 18,700 Spanish quintals were exported (about 22 quintals equal 1 ton); and in 1906 almost 38,000,000.

Entering the port of Iquique today, one sees a forest of masts and funnels, fluttering flags of many nations, and beyond, a low, level city stretching two or three miles along the shore, backed by towering, sandy cliffs, two thousand feet high, which rise abruptly, and generally against a sky intensified in its brilliant blue by contrast with their tawny tint. Frequently in winter, from June to September, their steep slopes are enveloped in the soft folds of *camanchaca*; but sunshine ordinarily prevails, and umbrellas are as unknown as sunstroke.

A charming *plaza* with palms assiduously watered, and a memorial clock-tower to Commander Arturo Prat, hero of the *Esmeralda*<sup>3</sup> (21 May, 1870), with other pleasant parks, a good theatre or two, a fine English club among several of other nationalities, a delightful resort at Cavancha, three miles along the shore, where society constantly resorts for delicious breakfasts, with an accompaniment of rippling green water, white surf and a good orchestra; a sporting club with facilities for polo, tennis, skittles, and an excellent race track; a cricket ground, football field, churches, schools and large business interests - this is modern Iquique, on its desert shore. Thinking nothing of sending a hundred miles for flowers to adorn its dinner tables, and often much farther for fruits and vegetables, most supplies come safely tinned from England; and the city pursues its bright, active, cheerful life in the face of constant if generally harmless earthquakes, and threats of tidal waves.

On more than one occasion this has been a consummated peril, particularly on August 13th, 1868, when the low and narrow plain was swept by the sea to a depth of ten feet, wiping out most of the city. On the Morro at its southern end are the only edifices left of the old city. Again, May 9th, 1877, another *salida de mar* wrought farther devastation and death.

It is a pity not to repeat the picturesque story, told for the benefit of confiding travelers, that a train has always ever since stood in readiness, with thrifty anticipation of another like disaster, at the Iquique station, its steam up night and day,

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<sup>2</sup> The spelling of *balsas* has been corrected from the original text which reads *bolsas*.

<sup>3</sup> The spelling of *Esmeralda* has been corrected from the original text which reads *Esmerelda*.

summer and winter, to carry the inhabitants at the first alarm upward to safe elevations on the cliff-side. This also would be but poetic license.

Back from the sea, on the great plain beyond the cliffs, lie dozens of *oficinas*, centres for the nitrate industry in the midst not only of rich deposits, but of scenery unrivaled for the splendor of its desolate grandeur. Tints and shadings opalescent in mystic radiance brood over the enormous, undulating plain, the ranges of rugged brown rock and sand, and the snow-covered Cordillera, rising eighteen, twenty thousand feet into the sunlit air.

From the roomy, well-built station, the railway line starts up the side of cliffs otherwise almost inaccessible. A gradual ascent along their steep face toward the north, conducts to a sharp V which carries the train still upwards but south. Incomparable views are disclosed - of a bay full of changing tints - blue and purple and emerald green; of silver beaches curving away to sunny distance in the face of pounding pacific surf; of stupendous cliffs, and of countless sea birds wheeling in huge circles far below.

A short distance from Iquique is the reputed largest sand hill in the world, nearly a thousand feet high, soft, irresistible, mighty - said to be still moving bodily, a few inches each year toward city and railway, and putting quite to shame the most famous of sand dunes. An uncanny similarity in shape is very marked, to that of the only living creature indigenous to the desert - the swift lizard (*lagarto*).

Very soon the train emerges from this wilderness of pure sand, cliffs are scaled, and a strange dreamlike ride begins across the pampa.

One might well imagine himself taking a trip on the dead moon.

Singular mineral colors tint the nearer mountains, paths and tracks lead off without apparent reason or destination, hills and vales and towering summits shut out the sea, and the brooding heat of intense sunshine settles on the silent scene. But not one green or growing thing humanizes the colossal view, not even a cactus suggests that vitality is inherent in the brown soil. All previous notions of beauty, of meadow and stream and unfolding forest, must retreat before this majesty of sterility.

All day the journey continues, past miles of rugged salt in chaotic masses mixed with desert soil, now and again sand, and finally as the nitrate region is approaching, *oficinas* with clustering smoke stacks, machinery, villages of workmen, managers' bungalows, acres of rugged and broken *caliche* fields, carts and racing mules, and all the incessant activity of this great industry which stops neither for light nor darkness, for Sunday nor Saint's day, but only once a year to overhaul, repair and keep efficient the harnessed forces.

At Central station comes a parting of the ways. One train starts for the North pampa, with many clustered *oficinas*; another for the south, to La Noria, Pan de Azucar, Buenaventura, Lagunas, and Alianza, - this last, as its name indicates, a combination of several interests, and largest *oficina* of all. Crowds of native Indians, Bolivians, Peruvians, and types of many crossings, gather at Central, as at all the other little stations, picturesque in wide, untrimmed 'Panama' hats, and embroidered shawls. Ladling out *cazuela* (stew) or *chicha* (a sort of cider), selling fruit from wide, flat baskets on the ground, trailing their long and far from cleanly skirts in the dust, are women of all ages and conditions, weather-beaten or rosy according to their years, and men in *ponchos* and spurs; with always a miscellaneous assortment of dark-eyed chubby children.

A tiny station set in the midst of wide, brown desolation, we alighted late in the afternoon - a superb rush of amazingly inspiring air giving first welcome. A small branch track, on which stood waiting a quaint little open car drawn by a sturdy white mule, leads to *oficina* Alianza, half a mile or more away.

Surrounded by rolling leagues of plain, ranges of brown mountains bound it, the enormous slopes of snow-covered Cordillera heights dominate it, and the great white truncated cone of the volcano Miño, soaring over 20,000 feet above sea-level, is its mighty landmark.

The Nitrate Companies are exceedingly generous in the fitting up of residencies for manager and officers, and life and habits correspond. At Alianza the dwelling house is a huge bungalow, more than 150 feet wide, with ample verandas on both sides. From two front entrances one may pass into two large *patios*, or central, floored courtyards, lightly roofed with bamboo, the rooms of the Manager and his family opening from one, those of his six or eight assistants, usually young, unmarried Englishmen, from the other. And luxurious enough are all these varied apartments, fitted even with running water, electric light and bells, and a telephone, all in the heart of a merciless desert waste.

As a rule, the Chilean or half-Chilean assistants, of whom there were four or five, speak English, but they prefer Spanish; and in one or two cases it was odd to find that men with purely Scotch, English or Irish names knew practically no English at all. If born in Chile, even of English fathers, they are citizens of the country and must serve their time in the army.

Beyond the big bungalow, which stands on a slight elevation, and at a comfortable distance, is the *maquina*, where all the processes of converting *caliche* into marketable nitrate of soda are carried on; near it is the *bodega* or storehouse for implements, the carpenters' and blacksmiths' domain, a market, bakery, *pulperia* (dry-goods shop), tailors', and laundry establishments, and all the necessities for a working population of nearly three thousand.

These inhabitants live in two clustering villages, compactly built of corrugated iron, one for the men, and their families, who work in the open (*calicheras*); the other for machinists and other *maquina* laborers. One street in each is reserved for bachelors. The nearby *corral* provides for four hundred mules and a few good horses.

Surrounded surprisingly by familiar luxuries, pampa life is soon found to be unique, sufficient unto itself, curiously rejuvenating. The strangeness of it all at first staggers one's sense of reality, but very soon a singular fascination supervenes, and its spirit becomes all-embracing.

The air stimulates, the sunshine electrifies. Brilliant blue skies by day, a marvelous southern firmament full of strange suns by night, Mars riding high in the heavens, the Southern Cross solemnly aloft, the gentlest of winds apparently the very voice of outer space, softly murmuring - the pampa casts its spell, second only in mystic power to the illimitable Sahara itself. Fences, roads, limitations all absent, conventional boundaries are forgotten in the wild, free gallops over the roadless plain; in the scrambles on sure-footed native horses up sandy ridges to investigate copper, gold and silver mines; in the mountain peaks ascended; the wells and their attendant artificial oases visited.

To guests of the largest *oficina* on the pampa, the nitrate industry and its setting were pervasive. Its brilliant arc lights simulated proximity to some populous city, a low hum from the *maquina* filled the sunny spaces of day and the far silence of brooding star time; its whistles anticipated sunrise, and carried messages at many hours; its busy carts and trains came and went endlessly; its mules galloped about, tassels and *ponchos* flying, its soft white product like heaped-up, unmelting snowdrifts, lay drying in the sun - and yet the nearness of machinery and its constant activity were not repulsive, or even non-picturesque. Very soon they were definitely attractive. From its beginning the work involves processes easily convertible to artistic effects.

To expert eyes, the bare brown soil of the pampa tells various stories. When nitrate is present certain significant signs appear - the head engineer lays out his plan of work, and then gangs of laborers are turned loose, under their chief (*capataz*<sup>4</sup>), to break up the surface with dynamite or gunpowder, pick, crowbar and shovel. While under 'cultivation' of this sort, that region becomes the *calicheras*, gradually retreating farther from house and *maquina* as months and years go on. The stratum of *caliche* is usually comparatively near the surface, ten to twenty feet, occasionally the exceptional depth of forty feet. When this last is found it is not worked from the surface, but by means of tunnels. Hard masses of great extent are blown up, generally by gunpowder (manufactured on the spot) for heavy blasts; occasionally where less resistance may be anticipated, a process is conducted by a *barretero* with dynamite.

When the opening is to be drilled for powder, it is made by a workman called a *particular*, down through the top stratum, or *costra*, containing sometimes 12 to 15% nitrate, past the *caliche* (often as rich as 60%, and as transparent as glass or alum; or again, as poor as 15 or 16%, but even so paying well to work), and on to the substrata of *congelado* and *cova*, earthy matter,

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<sup>4</sup> The spelling of *capataz* has been corrected from the original text which reads *capitaz*.

silicate, sand, etc.

Two other kinds of soil are sometimes encountered, a surface material known as *chuca*, mixed with salt and a trace of nitrate; and lowest of all *banco*, a hard and rocky substance not found when *cova* is present.

Costra

Caliche

Congelo

Cova

## TAZA

The excavation itself, as well as the firing of the blast, is called the *tiro*. Into this shaft, frequently not more than twelve or fifteen inches in diameter, but from six to ten feet (occasionally more) deep, is lowered a small boy called a *destazador*. He makes undercuts called the 'cup' (*taza*) as shown in the diagram, and is then brought up to the surface. The same pieceman (*particular*) at once lays in the explosive, fills the hole with soil and *costra*, compressing it like a gun charge and lights the fuse. A peculiar and far-reaching cry is sent forth to warn from the vicinity the men, who walk leisurely away. Familiarity with possible death every day breeds a certain contempt, and rarely do they take trouble to get beyond the absolute danger point. A sudden muffled sound - and a splendid burst of brown smoke breaks from the earth, rolling in beautiful curls and billows, constantly whiter, often fifty feet high, carrying up rocks varying in size from a tiny pebble to huge masses whose touch would be death.

But even gravity does not hurry in South America, land of *mañana*; and the shower of stones, often falling far aside from the central explosion, comes down in a fashion deliberate if resonant. Gradually settling and rolling along the rough ground in soft masses, the smoke makes a heavy veil, through which the laborers calmly return, unhurried, to break up still more the heavy pieces to which the charge has reduced them. All over the *calicheras* is the sound of one blast after another, clang of pick and shovel, here and there sudden pillars of smoke, - simultaneous activities under the brilliant sky and burning sunshine.

Crowbars not in use are stuck up perpendicularly in the ground. I studied the habit for a day or two before I discovered reasons. The first is to make a sort of primitive sun-dial, warning of the hour to start back for breakfast, as noon approaches. But an almost equally useful purpose is served in keeping them cool. If left lying flat on the sand they would become too hot to use, even in the winter months of July and August.

A first horseback ride out to the *calicheras*, from one to five miles off, is not to be forgotten or ever duplicated. The carts, each drawn by three mules, are grouped about the piles of *caliche*. Men in white hats are filling them with the broken stone, under the eyes of a *capataz*, without whom less than a legitimate load might be surreptitiously dispatched from the field, pay being counted by cartloads. White *caliche*, rather than brown, is desirable, affording less opportunity for hasty filling with material other than the genuine. Men on high, picturesque saddles are galloping about, with silver and carved leather stirrups, an abundance of silver chains, huge and cruel spurs, while gay *ponchos* are flying, hat-brims flapping, and the dignified, handsome *corrector* on his fine horse, is omnipresent.

A *cuarteador* with long lasso is alert to gallop to the assistance of any fallen shaft-mule, the prostrate animal generally lying quietly until this official help arrives.

To especially productive regions of the *calicheras* temporary narrow-gauge railways are laid. Carts full of the broken material back up to trains of open cars, dumping in their precious freight, the little engine gives its tiny, shrill shriek, and away over

the bare and roughened plain, runs the long train (sometimes of twenty-four cars) to the *maquina*.

Dumped once more, the masses of *caliche* are crushed into small fragments about the size of road metal, by a *chancho* (literally a pig), and from its jaws are thrown into a canal or trough, caught into a moving chain of buckets (*capacho*) carried up swiftly about sixty feet, where the cars of this miniature railway, horizontal at last, empty their freight down again into storage-tanks - from there still down into huge boiling tanks.

It should be said that just these details of this process belong especially to Alianza. Ordinarily, getting the crushed *caliche* to the boiling tanks is accomplished by its fall into cars which empty directly, either on a level, or if from above having been taken up an hydraulic hoist, or inclined plain, worked by a wire rope and steam winch.

But at last the process has really began - one of supersaturation and crystallization - the separation of nitrate of soda from the worthless material with which, for geologic ages, it has been associated and concealed. Twenty-four of these rectangular receptacles, six in a series, receive the crushed *caliche*, and give it a vigorous boiling for three hours. The entire process occupies about twenty-four hours, although the *caliche* is under steam for only fifteen.

*Caldo*, or water containing dissolved nitrate, occupies an hour and a half in running out, while meantime the liquors are moving from one tank to another, and heavy material remaining is thoroughly washed. Even this water (*relave*), still containing a goodly proportion of nitrate, is saved and sent around again through the system.

Two hours are needed for completely emptying a tank. Once in twenty-four hours each tank is cleared of the refuse (*ripió*) or worthless material left at the bottom, men standing, for hours, half naked in steaming nether regions, and shoveling with a splendid play of vigorous muscles under shining skin. Eight men (*desripiadores*<sup>5</sup>) 'work' the six tanks of a series, and receive high wages. Even the final refuse itself is still rich, generally retaining not less than seven or more per cent of nitrate. The Alianza dump (already fully 8,000,000 tons of refuse from the twelve years of its existence), will undoubtedly be worked over by future generations at a profit, as new and improved methods are introduced.

Prominent objects in the pampa, the various *oficina* dumps add to nature's hills new and conspicuous ranges. Flat on top, these *ripios* have now and again been used for pleasure purposes, a polo ground being evolved, at one *oficina*.

An engine at the base of this artificial hill supplies power for cars of waste material on four tracks, to ascend. At the top, the omnipresent and ever-useful mule appears once more at the fore, the car is detached from its wire, and pulled to the edge of the dump, the mule dexterously changing to the rear and reversing suddenly the direction of his energy, to pull back mightily as the steep slope of the brink is approached. Then the car is opened and tipped, until refuse and water together flow over, to add their quota to the accumulating mountain.

While the refuse is thus disposed, the *caldo* is flowing on its comfortable way to cooling or crystallizing tanks. The method of getting this valuable solution (literally, *caldo* is broth) over to the tanks, is by the Dunlop process of siphoning. Originally used in the St. Rollocks works in Glasgow by Sir Charles Tennant nearly a century ago, it was first applied in Chile by J. Humberstone, Esquire, in 1876, and has proved entirely effective.

At Alianza there are 260 of these tanks (*bateas*) in twenty rows of thirteen each. The size is uniform, each one eighteen feet square<sup>6</sup>, and three feet deep at one end, three feet six inches at the other, containing about 1,050 cubic feet. Here the saturated solution remains exposed to sun and air for eight days.

Finally having given up its crystals the liquid is drawn off, and as *agua vieja* or 'mother liquor' speeds away in a mimic river to other tanks below, whence it will be again sent around through the system, to be still farther relieved of what riches it may yet retain. And they are considerable.

A cubic foot of *caldo* contains thirty or forty pounds of crystallizable nitrate, which, separated from the liquid, leaves nearly

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<sup>5</sup> The word *desripiadores* has been corrected from the original text which reads *ripiadores*.

<sup>6</sup> Eighteen feet should be the length of the tank, not the surface.

as much more. And so no drop of water, used or unused, is allowed to go to waste. About 100,000 gallons are brought each day to the *Alianza maquina*, 80,000 fresh, 20,000 of salt water. The latter can be used for washing the *caliche* after boiling, but not, of course, in the boilers themselves.

This total amount is reduced only by natural evaporation, and by what is unavoidably thrown out with the *ripio*. Each individual drop goes many times around the circle, an endless chain of usefulness, performing the same duty over and over again.<sup>i</sup>

Into the tanks of snow-white crystals, partly dried by their eight days' exposure to sun and air, climb boys and men armed with shovels and speedily these receptacles are empty, while laden nitrate cars run off on narrow tracks, elevated on trestles above the *cancha* or final drying floor, down to which the glistening loads are dropped, there to lie for nearly six weeks in the sun like a counterfeit presentment of snow-drifts.

When heat and dry air have done their work, groups of boys and youths appear with bags, of a sort of burlap from India - each is filled, holding about two quintals, or two hundred pounds, and quickly sewed up. The 'head boy', in some cases only twelve years old, stands at one side in much state and dignity with his little record book and pencil, keeping tally upon the number of bags sewed by his band. The average time seemed to be about five or six seconds for sewing, tying each end of the seam, and getting to another.

Long trains of flat cars leave the *oficina* each day, laden with the wealth-bringing brown bags which thus proceed to Iquique and thence to the world at large. Some slight additional weight is lost by farther drying on the voyage to Europe or the United States.

Buyer and seller, both, test every bag as it arrives at the port. By the use of a *sonda*, or long metal tube inserted in the bag, enough may be brought out for analysis. Two qualities are made, an ordinary commercial product which contains 95% pure nitrate of soda, and a refined variety of 96%. The better quality should never have so much as 1% of salt. Strictly speaking there is no compulsion, but there are fines in each case if the standard is lowered.<sup>ii</sup>

Saltpetre, and of course gunpowder, as well as iodine in small quantities, are manufactured; and while not precisely a trust, the separate nitrate producers have a combination among themselves, whereby a certain quota is assigned to each *oficina*. The total at the commencement of the combination year, April 1st 1906, was 77,000,000 quintals (22 to the ton), some of the *oficinas*, however, not being then ready to work. During the summer of 1907, 77% of this quota was allowed to be manufactured.

New producers are constantly joining the combination; and for the combination year of 1907 the exports were fixed at 45,000,000 quintals; but owing to a scarcity of labor, and to many new *oficinas* not being ready to work as soon as they expected, the exports did not exceed 40,000,000.

The Chilean government levies a tax of two shillings four pence on every quintal shipped, which would mean £4,666,666.13s.4d. on the quantity mentioned, and is the principal single source of income.

Of course the amount of capital employed in this industry is very large, amounting to many millions of pounds sterling.

But labor troubles have not overlooked the pampa. It was said last summer on authority that ten thousand men were needed from Pisagua to Taltal. Of these perhaps but two thousand would be for the actual work; but their presence would make the companies independent of workmen who will not work, and of such strikes and riots as occurred in the middle of December last year throughout the Tarapacá region. All the *oficinas* were temporarily stopped all over the pampa, and about 300 men were killed in Iquique. The rest soon went quickly back to work. These troublous times are said to be rarely wrought from within, being almost invariably stirred up by professional agitators, perhaps from Spain, and other distant places. Strikes, laziness and indifference in the workmen are more than can always be successfully met. And with such large interests at stake, irresponsible interruptions are more than commonly disastrous.

Of the manifold uses of nitrate in agriculture it is not necessary to speak. Its marvelous effect, when rightly used, is well



known to specialists, although it is less employed in the United States than in Germany, France and England. This country has been peculiarly slow in adopting its benefits.

A rather conservative estimate of the length of time this great natural store house will last, shows that the nitrate fields are by no means inexhaustible. About a century of working at present rates will probably finish the crude mass of the supply. Then perhaps, better methods of extracting will give renewed value to the poorer earths and the *ripio* hills.

And after that, what?

By that time it may be presumed that irrigation will have been brought to the proportions of a fine art, or an exact science - that streams from the Andes judiciously guided and harnessed will cause the whole desert to blossom like the rose, and the dangers and desolations of Atacama will have passed into remote history; while the arable land of Chile, in the beautiful climate of the great plain, will be increased many hundred square miles by its productiveness.

But now it is still the desert, grimly full of wealth, spreading its brown desolation to the knees of the Andes, unresponsive yet compelling, whispering of the eternity to which for many centuries it has consigned those who once blindly trusted its resources.

Notes [These two end notes are footnotes in the original text].

i

A more technical description of the process has been given me by an officer of the Company. The boiling tanks are rectangular, usually of about 30' x 8' x 9' deep, in which are found heating coils of 6 to 9 pipes, generally in one or two serpentes.

The set, or unit is composed of 6 tanks, arranged as follows:

1      2      3      4      5      6

Each tank is connected with the next one by a syphon pipe (s), which rises near the bottom, say, of No.1, and discharges into No.2, at a height of about 6'; from No.2 the syphon discharges into No.3, and so on, and from No.6 a long external pipe (s') takes the syphoned liquor back to No.1. The heater coils discharge into a return pipe, which takes the condensed steam back to the boilers.

Let us suppose that tank No.4 has given up its strong saturated solution of Nitrate, which has run down to the crystallizing tanks. Fresh *caliche* has already been filled into No.5, which is next in the series, and the plug is taken out of the syphon from No.4 to No.5, so that the hot liquid which remains in No.4, being of too low a specific gravity to be sent to the crystallizing pans, passes into contact with the fresh *caliche* in No.5, steam being turned on in No.5 at the same time. The syphon from No.3 (which tank has also steam), into No. 4 is open at the same time, and "mother liquor" from the crystallizing pans is filled into No.3; the syphon from tank No.2 (in which steam has been turned off) into No.3 is also open, and *relave* (water with which the refuse has been washed) is filled into No.2 to drive the liquors, each one heavier in its turn,

from No.2 to No.3  
from No.3 to No.4  
from No.4 to No.5

Once the tank No.5 is filled with the liquid which has passed from and through No.4 into it, the syphons are plugged, and the operation (called locally *traspaso*), is stopped. Boiling then goes on in No.5, No.4 and No.3 until the liquid in No.5 has attained a density of, say, 108 Twaddell, on which it is syphoned off (by a separate syphon with a spout filling into a canal outside of the boiling tank) to the crystallizing pans, and the internal syphons from No.4 to 5, from 3 to 4 and from 2 to 3 are again unplugged, while *relave* is poured into No.2 to drive the liquids in No.2, 3 and 4 into No.5, from which the heavy liquor (*caldo*) is running away. The *caldo* of course, gradually becomes lighter in density; and when it reaches, say, 102 Twaddell, no more is sent to the crystallizing pans, the liquors of 102 and less being passed into No.6, which by this time has been loaded with fresh *caliche*. At this point No.2 is cut off from the series, and the syphons opened are those from 3 to 4, 4 to 5 and 5 to 6, while *relave* is filled into No.3 and mother liquor (*agua vieja*) is poured into No.4. After this, the liquid remaining in No.2 is drained off as *relave*, and fresh water is run in to give the refuse remaining a good soaking, and this water is drained off as second *relave*. Finally the refuse is shoveled out through doors in the bottom of the tanks into cars, which are hauled out to the dump, and No.2 is then ready to be filled with fresh *caliche* and to receive its *traspaso* from No.1, which, during the time that No.2 has been soaking and emptying, has been filled with *caliche* and has yielded up

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its *caldo*. As said before, No.1 is connected by a long external pipe with No.6, to enable the process to be continuous.

The *caldo* in the crystallizing pans is allowed to remain 8 or more days, during which time the nitrate drops out by cooling and remains in the bottom of the pan, while the 'mother liquor' (which contains over 500 grams per liter of nitrate) is run off and used over again, as we have already explained.

ii

Analysis of Refined Commercial Nitrate of Soda

Nitrate of Soda	96.52%
Chloride of Soda	0.79
Sulphates	0.41
Insolubles	0.105
Moisture	2.175
	<hr/>
	100.00

Analysis of Ordinary Commercial Nitrate of Soda

Nitrate of Soda	95.05%
Chloride of Soda	1.585
Sulphates	0.51
Insolubles	0.305
Moisture	2.55
	<hr/>
	100.00