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Sodium and Sodium Salts

Samuel Henry Salisbury Jr.

SODIUM AND SODIUM SALTS

By Samuel H. Salisbury, Jr.

In the sodium industry nothing new has been developed. The Virginia Electrolytic Co. and the Niagara Electrochemical Co. are the only manufacturers. The latter company uses the Castner process, caustic being the electrolyte and hydrogen a waste product. The annual production of sodium is estimated at 2000 tons. Some details as to recent practice are given in Mineral Industry, **9** and **22.** A number of factories have been started in foreign countries. One is reported at the Sognefiord, north of Bergen, Norway. The manufacture of metallic sodium, sodium peroxide, and other compounds is to be undertaken under the title of Frederiksstad Elektrochemiske Fabriker, Frederiksstad, Norway. No imports of sodium into the United States are reported.

Sodium Cyanide

Before sodium cyanide—the commercial product which is now used in gold and silver mining the world over—was placed on the free list, 90 to 95 per cent. of the consumption in America was supplied by domestic production.

Following the removal of the tariff, the reverse became the case—90 to 95 per cent. has been imported, principally from Germany.

The largest plant, although partially dismantled and operated at about one-tenth of its capacity, is still in existence. Before the tariff was removed, the United States produced 16,000,000 to 18,000,000 lb. a year, of which the large plant located at Perth Amboy, N. J., yielded 14,000,000 lb. The owners will probably find it advisable under present conditions to resume operations, provided they can be assured of some protection in the future against foreign importations.[1]

Nitrate of Soda

All known deposits of niter which occur in various desert regions through the world are insignificant compared with the well-known deposits in the deserts of Atacama and Tarpaca, in the north of Chile. These deposits command a great deal of interest, not only on account of

[1] *Eng. Min. Jour.*, Oct. 1, 1914.

their commercial importance, but also for the many attempts which have been made to explain why the quantity of nitrates in this particular region should be so large, compared with any other known deposit.

The first shipment of nitrates to Europe from Chile was made in 1825. Since then the annual exportation has continuously increased until in 1912 the total quantity exported amounted to 2,485,860 tons, of which 1,925,590 tons went to Europe, 469,100 tons to the United States, and 91,170 tons to other lands.

The arid region in which the nitrates are found extends for about 430 miles between 13° and 25° south latitude and lies between the Andes in the east and the Coast Range on the west. This area lying between the two mountain ranges does not form a continuous valley, but is broken up by transverse ranges into a series of elevated basins or plateaus. These plateaus are generally flat or undulating and have an elevation from less than 2500 ft. to more than 5000 ft. They have a general slope from the foot of the Andes toward the Coast Range, and as a result the lowest part of this plateau region, or pampa as it is called in Chile, lies along its western border where it joins the foothills of the Coast Range. It is along this zone that the nitrate deposits occur. The surface of the surrounding region is dry and sandy and vegetation is totally absent. The nitrate beds as they occur in different parts of this region vary in thickness up to about 6 ft. They are usually found at or near the surface, but may in some cases be covered with an overburden to a depth as great as 30 ft. The nitrate deposits are never found pure, but are always mixed with sodium chloride and other salts, and are impregnated with insoluble earthy material. Crude nitrate may sometimes run as high as 60 to 70 per cent. of sodium nitrate, but a deposit running 50 per cent. is considered high-grade material. Material containing less than 16 per cent. is too low grade to be mined at a profit at present.

The source of these deposits is a subject which has given rise to a great deal of discussion. Many theories have been advanced to account for the origin of the nitrates, but all appear to fall short of adequately accounting for all the conditions under which the nitrates are found in Chile. It is generally considered that an organic source is the most probable, but there have not been lacking explanations for the formation of these nitrates which have been based on inorganic agencies.[1]

Of late years a factor which the nitrate trade has to consider is the competition of substitutes such as sulphate of ammonia and synthetic products. As regards the first named, apart from the introduction of possible new processes, there does not seem much prospect of an expanding output, and the carbonizing business is one in which it is very difficult

[1] Wm. H. Ross, *Chem. Eng.*, **20**, No. 4.

to decide what the exact cost of a particular product is, since it may pay to incur loss in one department to maintain profitable output in another. Of the synthetic nitrate business, especially in Norway, great expectations have been expressed. At present, however, we have to deal mainly with estimates. The export last year was 70,171 tons, as compared with 2,655,000 tons from Chile. Should the industry prove as great as the promoters hope, we may expect the Norwegian government to be no less anxious to participate in the exploitation of its natural resources than is the Chilean government in the nitrate fields. The tax in Chile is, roughly, 2s. 4d. per quintal, and possibly arrangements might be made to lower this in cases where the more economical extraction promised us is practised. It is interesting to note that in Norway the government is already proposing to manufacture and export nitrate, and desires to pass an act regulating concessions for limestone deposits. The Nitrogen Products & Carbide Co. is also stated to be negotiating with the government for the sale of their options on the Toke Falls, thinking, probably, that as lessees from the government there would be less likelihood of a conflict of interests arising.[1]

The factories for the production of azotized cyanamide and synthetic saltpeter are numerous, and are increasing in number, not only in Norway, but in Austria, Italy, Spain, United States and other countries enjoying abundant water-power. It is perhaps debatable whether these artificial manures are of equal value as fertilizers to natural products, notwithstanding that some of the former include a somewhat larger proportion of nitrogen. The competition between synthetic and natural manures promises to become so keen that the Chilean government is considering measures to protect their saltpeter trade. During the last 5 years the price of nitrate, though still permitting a prosperous business, has suffered a notable reduction.

Messrs. Thomson Aikman, Jr.'s half-yearly report[2] on the nitrate industry, dated London, June 30, states that the total advised production for the nitrate year just ended has been about 62,200,000 quintals, against 59,400,000 quintals for the previous year, when the available production, after deducting oficina consumption and "merma," proved to be only 58,200,000 quintals. That there will prove to be a similar difference between the "advised" and "available" production for the past year is considered unlikely, as on stocktaking at January 31 last, it was found that there was up to that date practically no shortage, showing that producers had apparently, without advising the market, been sending forward their monthly returns on the "net" instead of as previ-

[1] *Min. Jour.*, July 4, 1914.
[2] *Min. Jour.*, July 4, 1914.

ously on the "gross" basis. Shipments during the past year have been about 58,100,000 quintals, against 58,450,000 quintals, and the world's consumption, including losses and loss in weight, about 59,200,000 quintals, against 55,800,000 quintals for the year ending June 30, 1913. During the 12 months three new oficinas started working and four old oficinas, which were stopped, had their maquinas rebuilt. The total production of these amounted to about 1,400,000 quintals, but as their capacity is about 250,000 quintals monthly, an increase during the coming year of about 1,500,000 quintals may be looked for from them. The agreement come to by oficinas representing an annual production of 41,000,000 quintals, to restrict their production for 6 months by 2,050,000 quintals, or 340,000 quintals monthly, terminated at January 31, since which date these oficinas have shown a monthly increase of about 400,000 quintals, and, should there be no restriction or other cause to interfere with production during the coming year, a consequent increase from these of about 2,500,000 quintals appears possible. The oficinas not in the restriction scheme have fully maintained, and in some cases slightly exceeded, the increased rate of production which they attained while the others were restricting, and, as no new oficinas are likely to come in till near the end of the next twelve months, the total increase in production during that period would seem likely to exceed the past year by about 4,000,000 quintals. The total supply of nitrate in sight at date, including stocks in Chile (assuming there has been no shortage in production), and visible supply for Europe, America, and other countries, amounts to about 1,269,000 tons, against 1,139,000 tons at June 30, 1913, being an increase of 130,000 tons or about 2,900,000 quintals. In order, therefore to reduce the supply in sight at June 30, 1915, to the same figure as at June 30, 1913, a consumption for the world of 68–60,000,000 quintals would appear necessary during the coming year, unless the present heavy rate of production is reduced by concerted action on the part of producers, or by natural causes. From above figures it would appear that, after allowing for a normal increase in consumption during the coming year, a restriction of production by 4–5,000,000 quintals from July 1, 1914, to June 30, 1915, is required.

Several meetings, both in London and in Chile, have recently taken place with the object of effecting an agreement to reduce production during the coming 6 months, the individual quotas to be based on the production during January and June, and it is quite possible, with this knowledge in sight, that individual producers have been straining their utmost to attain big figures for January and June, with a view to getting a good quota, and should no agreement be reached some reduction

might nevertheless take place. A large number of producers are also in favor of centralizing sales in the hope of thereby increasing the consumption, and a sub-committee appointed to study the matter has submitted a scheme for this. As, however, the commissions and other costs involved are very materially higher than the present margin of profit on which the trade is worked, it is difficult to see where the benefit to producers would come in, unless the selling price to the consumer is to be considerably higher than at present. A representative meeting of producers to discuss the whole position is being held in London to-day. The cost of production has in most cases shown a slight decrease from the high figures to which it rose last year, and strenuous efforts are at present being made to further reduce same by a new process of manufacture, the inventors of which claim that a reduction of 6d. to 1s. per quintal should be easily attained.

The world's consumption for the year shows an increase of 155,000 tons, or 6.25 per cent. Europe and Egypt have shown an increase of about 180,000 tons, or 10 per cent.; America a decrease of 29,000 tons, or 5 per cent.; and other countries an increase of 4000 tons, or 5 per cent. The decrease in America is to be accounted for by the fact that heavy inland stocks of probably nearly 50,000 tons were carried over last year, and have all been consumed this year, so that the real consumption this year has actually been greater than last year. The low level of price now ruling is stimulating purchases for next spring, more especially in Europe, and it is believed by many of the large distributing dealers that at the present level of price nitrate is capable of materially expanding its consumption, irrespective of the prices of the less popular competitive nitrogenous fertilizers.

Messrs. W. Montgomery & Co.'s report[1] dated London, June 30, states: In our report of December 31 last, we pointed to the probability of a very large consumption in Europe during the past 6 months, granted that weather conditions were favorable. With the exception of the month of March, the weather, for the most part, was probably all that could be desired, and an increased consumption of 166,000 tons must, from a producer's point of view, be considered highly satisfactory. The actual figures are 1,497,000 tons, against 1,331,000 during same period last year (an increase of 12.5 per cent.) Production during the same period (estimating that of June at 5,600,000 quintals), has amounted to 62,169,708 quintals (2,816,000 tons), against 59,450,540 quintals (2,692,000 tons) for the preceding 12 months. Adding stocks, the visible supply for Europe to-day amounts to 400,000 tons, against 420,000, a decrease of 20,000 tons. Great as has been the increase of consumption in recent years, we venture to think that in this direction

there is still an extensive future for the article in Europe, where it had its first introduction, some 60 or 70 years ago, as well as in the states and other countries, which have more recently come to appreciate its fertilizing value. As the years succeed each other so does the population of the world increase, and as a consequence more foodstuffs are required; hence it is that more extensive and intensive cultivation of the land is necessary. We have a strong belief in the ever-increasing demand for fertilizers of all useful kinds; nevertheless, we fail to see that any good end can be served by producers of nitrate of soda forcing the pace unduly as was the case during the past season, and as is still the case, judging by the production figures advised each month. It may be argued that absorption of the nitrate provided proves that it was all required, but this is true in a sense only.

Finding last summer that prices were dwindling away to an unsatisfactory level, owing to apparent over-production, producers made vigorous efforts to bring about a restriction, and were finally able, about the end of August, to announce the completion of a scheme in which 60 per cent. of the producing power agreed to restrict their output for the 6 months ending January 31 by something just over 2,000,000 quintals, or about 90,000 tons. The effect of this declaration (and previous expectations) was to advance the f.o.b. price in Chile about 6d. per quintal, or 11s. per ton—and the figures of 7s. 9d. to 8s. per quintal were maintained throughout the restriction period, therefore producers have no cause for complaint. Unfortunately the scheme was faulty, inasmuch as without the remaining 40 per cent. the 90,000 tons restriction proved to be more nominal than real. The 40 per cent. outsiders made more, and the 60 per cent. in agreement were found, upon the expiration of the term, to have adopted a new method of returning their monthly production. Hitherto the production had been returned on the gross amount from which certain deductions had to be made, but on this occasion it was found that these deductions had already been allowed for in the returns; hence it was that the stock in Chile was found to be at the end of the restriction period 25–30,000 tons more than was looked for. These causes, combined with a heavy fall in freights—steamer freights especially—brought a greater supply of nitrate to market for the actual consuming season than had ever been anticipated. Thus was the market weighted from the commencement of the season with a supply actual and prospective, and although the consumption has proved itself beyond expectations, considering the abnormally wet March through which we passed, the supply was at all times in too great abundance to permit of any buoyancy in prices. Such being the case, the incessant rain which prevailed throughout the month of March acted upon the

nerves of holders, who hastened to relieve themselves of their holdings at prices a long way below the equivalent of those paid to producers for f.o.b. nitrate in Chile.

What the trade is suffering from is over-production. If producers, for instance, show that they are producing a quantity of nitrate for the season which is 5–6,000,000 quintals, or about 250,000–300,000 tons, more than the consumers' hitherto known capacity of absorption, they must expect to find buyers very chary of entering into forward engagements on the "bull" side; not only so, but they need hardly be surprised if some of those engaged in the trade take the view that the chances are in favor of a very bad market and operate the other way; hence unsteadiness all along the line. Of course, if some central body, which may yet be created, took the risk upon themselves, it might be found that, with the development of the season, the whole quantity would be required, but if not—what then? Meantime, production goes on apace, and only a drastic and immediate curtailment will stay the inevitable sagging of prices. Even the largest and cheapest producers will, ere long, realize that if dividends are to be made it will be perilous to leave the market longer to struggle with what is to-day an apparently prospective excessive supply. Negotiations of some sort are, we understand, going on between the Nitrate Committee here and the Iquique Committee, but as there are two schemes in the field—namely, "restriction" and "centralization," much valuable time (and a considerable amount of money to the producers themselves) is being lost while they decide which of the two will be the more effective in bringing about a normal and healthy market. Whatever virtue there may be found in "centralization" when its details are unfolded, it is almost certain that "restriction" will have to be employed as a stop-gap in the meantime if prices are not to be allowed to descend to a figure which will cause many oficinas to close down, and thus put a check upon production, and perhaps for a short time enable the survivors to obtain what they are probably aiming at to-day—viz., a price of about 8s. per quintal f.o.b. Chile.

The nitrate industry, has suffered very severely from the war. Already in a situation of some difficulty, owing to production in excess of consumption, and struggling to arrive at an agreement among consumers for an effective limitation, it was struck by the blast of war and great disorganization ensued. So far as can be judged, no concerted movement has yet proved practicable to deal with the situation, involving as it does the world's chief market. Germany, Austria, and Belgium are, of course, closed to all imports, and in the United States the difficulties in the cotton industry are likely to lead to a considerable reduction in

requirements there also. In addition, we have the fact of the disorganization of the beet sugar industry, not to say the uncertainty of how long the interference with extensive areas of the world's agriculture will continue.

The ordinary figures of production, shipment, stocks, etc., are necessarily of a fragmentary character for the period since the outbreak of the war. Mr. Thomas Aikman, Jr., estimates the production in Chile for the second half of the year at 965,000 tons, making with the 1,455,000 tons in the first 6 months a total of 2,420,000 tons for the year, against 2,730,000 tons in 1913. Shipments are put at 1,754,000 tons, against 2,696,000 tons. Of the total shipped, over 100,000 tons is believed to be in German shipping interned in neutral ports. As will be seen, there has been a large accumulation of stocks in Chile amounting to 1,118,000 tons, compared with about 490,000 tons for the 2 years previous. There has been great dislocation of the officinas working previous to the war, which, according to the latest reports, numbered forty-three, and the expectation is that some of these will close as soon as their existing contracts run out. Messrs. Montgomery & Co. point out that even at present the production is in excess of requirements, and that the present price of about 6s. per quintal is not one which economically justifies production. Here, however, as in other mining fields, the desire to maintain labor, which once scattered is not easily recalled, is probably operating to modify purely economic considerations.[1]

The following table shows the shipments and consumption of nitrate of soda for the last 13 years.

NITRATE OF SODA STATISTICS (*a*)
(In tons of 2240 lb.)

Year.	Shipments from South America.	Consumed in Europe.	Consumed in United States.	Consumed in World.	Stocks in Europe.	Visible Supply at Close of Year.
1900	1,429,000	1,126,000	175,000	1,324,000	221,000	794,000
1901	1,238,000	1,154,000	192,000	1,364,000	243,000	617,000
1902	1,360,000	1,028,000	214,000	1,259,000	263,000	660,000
1903	1,435,000	1,127,000	265,000	1,412,000	155,000	654,000
1904	1,476,000	1,131,000	275,000	1,447,000	162,000	672,000
1905	1,623,000	1,190,000	308,000	1,547,000	183,000	674,000
1906	1,700,000	1,243,000	355,000	1,636,000	190,000	733,000
1907	1,626,000	1,252,000	350,000	1,658,000	202,000	695,000
1908	2,017,000	1,378,000	309,000	1,732,000	402,000	928,000
1909	2,100,000	1,465,000	407,000	1,938,000	337,000	999,000
1910	2,300,000	1,651,000	501,000	2,241,000	310,000	969,000
1911	2,412,000	1,696,000	550,000	2,355,000	479,000	1,058,000
1912	2,478,000	1,908,000	481,000	2,508,000	310,000	1,004,000
1913	2,655,000	1,775,300	.....	2,520,000	.....	1,146,000

(*a*) Statistics of W. Montgomery & Co., London.

Practically no niter is produced in the United States, although a few

[1] *Min. Jour.*, Jan. 9, 1915.

deposits are known. All the nitrate consumed in this country is imported from Chile, the amounts being shown in the following table:

IMPORTS OF SODIUM NITRATE INTO THE UNITED STATES (*a*)
(In tons of 2240 lb.)

Year.	Quantity.	Value.	Value per Ton.	Year.	Quantity.	Value.	Value per Ton.
1903.....	272,947	$8,700,806	$31.88	1909.....	422,593	$13,281,629	$31.43
1904.....	228,012	9,333,613	40.93	1910.....	529,172	16,601,328	31.37
1905.....	321,231	11,206,548	34.89	1911.....	544,878	16,814,256	30.86
1906.....	372,222	14,115,206	37.92	1912.....	486,352	16,668,404	34.25
1907.....	364,610	14,844,675	40.71	1913.....	625,862	21,630,811	34.56
1908.....	310,713	11,385,393	36.64	1914.....	543,715	15,228,671	28.00

(*a*) As reported by the Bureau of Statistics, Department of Commerce. The figures of value appear to be doubtful, especially with respect to the earlier years.

Niter in the United States

In this country few nitrate deposits are to be found apart from those of cave origin. The most extensive so far known occur in San Bernardino and Inyo Counties, California, along the shore lines or bed beaches of what was supposed to be a former sea, but which is now geologically known as Death Valley. The region popularly known as Death Valley is that portion of the valley proper which is below sea level. The territory covered by nitrate beds has been estimated to cover an area of about 35,000 acres. Through erosive agencies the clay beds in which the nitrates were deposited have been worn into buttes and ridges of characteristic shape and color. The hills so formed vary from only 50 ft. to over 300 ft. high. Samples taken from the niter-bearing strata in the hills, and exposed by erosion, vary all the way from a trace to more than 50 per cent. of nitrates. It is generally agreed that these deposits have not been formed *in situ*, but have resulted from the concentration of nitrates formed from the decomposition and nitrification of animal and plant life which must have existed in the region at the time that the valley was filled with water. Owing to the limited distribution of these nitrates they are not considered of much commercial importance, and the same may be said of all other deposits so far discovered in this country.[1]

Florida.—It is reported that a company has been organized and the representatives of the concern are now in Florida and prepared to open up to commerce the natural nitrate deposits in the gulf section of the state, and that a railroad is to be built connecting the deposits back in the forest with railroads leading both to deep water and to northern railroad connections.

It is also stated that Hillsborough County is known to have large areas

[1] *Chem. Eng.*, Oct., 1914.

where once the egret and other birds denizened in multitudes, and it is likely that deposits will be found there.[1]

Idaho.—Niter has recently been discovered near Homedale, Idaho. The field lies in and about the valley of Sucker Creek, in Malheur County, southeastern Oregon, near the state line and about 16 miles southwest of Homedale. Two general classes of deposits have been recognized: (1) crevice and cave deposits in the lavas bordering Sucker Creek, and (2) more or less bedded deposits in low rounded hills composed of sedimentary materials.

The first class includes the nitrate deposits. They occur in crevices usually only a fraction of an inch wide, distributed in more or less indeterminate zones a few feet in width, where the fractures and shelly lava form the protected cliff faces of small recesses or caves, and at the base of cliffs, along the soil line, at the same localities. The more abundant deposits of the first class thus far discovered are those at the soil line. The main deposit available seems to be that in the crevices in the rock, but it is doubtful if the nitrates have any great extent or volume within the rock mass. The percentage of nitrate present in the rocks is very small in comparison with the body of rock that would have to be handled if any attempt were made to recover the nitrates for commercial purposes. The amount is probably not more than 1 or 2 per cent.

Analysis in the laboratories of the U. S. Geological Survey shows that the crevice and cave deposits consist largely of nitrates of sodium and potassium, with some other nitrates and accompanying sulphates of sodium, magnesium, and aluminium.

It is comparatively easy to separate by hand the better nitrate material from the sulphates which occur in the same crevice and in adjacent crevices. One hand-picked specimen of this selected material yielded 90.6 per cent. of total nitrates. Another sample more nearly representative of the average material yielded 64.7 per cent. of nitrates, chiefly sodium nitrate. This figure is higher than the percentages usually found in the better grades of saltpeter mined in Chile.

In picking down the rock for commercial treatment, however, separation of the better material from the sulphates would not be practicable, and the nitrate deposits, though of good quality, appear therefore to offer little hope of successful development. Deposits of this character are widespread throughout the arid and semi-arid regions of the West, extending from Oregon to Texas.[2]

Some niter of more or less value has been discovered in Montana and was noted in MINERAL INDUSTRY, **22.**

Small nitrate deposits are also to be found in various other parts of

[1] *Amer. Fert.*, Jan. 23, 1915.
[2] *Amer. Fert.* March 20, 1915.

the world, as in the Sahara, in Russian Turkestan, and in Egypt, where nitrate earths occur which contain about 15 per cent. of calcium and sodium nitrates. The earth has long been used locally as a fertilizer and its use is supposed to be increasing. The source of the nitrates in this region is not known.

IMPORTS OF SODIUM SALTS (*a*)
(In tons of 2000 lb.)

	1910.		1911.		1912.		1913.		1914.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Arseniate	242.3	$14,368	84.2	$5,199	178.3	$11,195	634.0	$55,941	114.1	8,267
Ash	2,495.0	55,262	1,939.1	43,365	1452.7	33,459	1550.4	35,461	1,114.5	28,102
Bicarbonate	73.2	4,472	42.6	2,634	55.0	3,193	40.3	2,238	44.4	2,324
Bichromate and chromate	1,332.1	101,687	.....	.....	1	.....	.....	.....	3	5.5	542
Caustic	519.4	33,882	1,492.1	73,968	465.3	28,937	335.7	25,364	332.7	23,914
Carbonate (crystal)	69.9	2,569	152.6	4,235	177.3	5,616	84.6	2,928	103.7	309
Chlorate	.....	.....	.....	2	.....	22	.....	10	0.2	84
Chloride (salt)	138,376.2	374,420	141,227.8	390,043	145,041	379,539	125,428	356,911	16,987.5	456,426
Hyposulphite	22.3	626	14.7	612	4.3	277	3.6	228	463.1	128,828
Nitrate	542,334.0	16,548,036	546,394.6	17,101,155	481,786	15,427,904	656,672	20,713,375	620,533.2	17,926,165
Nitrite	566.3	52,237	238.8	21,205	487.3	47,399	634.8	57,595	922.2	76,813
Phosphate	31.0	1,045	22.0	750	.....	.....	.....	14	682.4	24,975
Prussiate	649.9	76,648	598.0	66,971	823.2	90,654	943.7	118,475	1,147.9	171,831
Sal soda	241.1	4,630	107.2	1,512	126.8	2,020	64.0	1,010	81.8	1,274
Salt cake	3,928.0	40,640	11,398.1	121,218	659	8,394	189.1	4,771	31.4	618
Silicate	599.5	12,994	617.3	11,713	466.6	8,870	516.1	9,400	523.3	10,881
Sulphide	298.3	9,086	228.0	4,751	361.5	10,456	475.8	12,360	1,265.0	36,383
Sulphite	125.5	4,082	493.7	14,810	177.1	4,860	13.6	400	191.3	5,627
Sulphate	.....	.....	.....	.....	.....	.....	336.3	5,685	455.1	7,475

(*a*) For fiscal years ending June 30.

SODA

Africa.—The directors of the Magadi Soda Co., Ltd., have issued a circular to the shareholders stating that from advices received from East Africa the interruption of the construction work is likely to be of considerably longer duration than was originally anticipated. The branch line to the Magadi Lake is entirely under military control, and civilian traffic of any description is only allowed at intervals when considered safe by the military authorities. The final completion and ballasting of the railway by the contractors as well as the erection of the works at the lake, which is largely dependent on the use of the line, are practically at a standstill. The erection of the subsidiary works, both at Kilindini and elsewhere, which will work entirely on raw material supplied from the lake, has either been stopped altogether for the present or considerably curtailed in order to husband the company's financial resources. All works of this description which will be required on the commencement of trading are sufficiently advanced to ensure that they can be completed and put into working order within the time still required to complete the works at the lake after the re-

sumption of normal operations. In the meantime the company will be incurring expenditure not anticipated in the original prospectus, and the estimates, owing to this delay, are likely to be considerably exceeded. Practically the entire staff in British East Africa has been enrolled in the defence forces, and in agreement with the general manager on the spot the board is making such provision as is considered reasonable for them.[1]

California.—Large amounts of various sodium salts, particularly the borate, carbonate, and bicarbonate, occur at Searles Lake.

Among the minor saline minerals here, salt is the most abundant. Above ground, salt occurs in three or four types of deposits. The scaly deposit is the result of evaporation. A thin crystalline coating collects on the surface of pools of water. This coating, being broken up by winds, sinks to the bottom of the pool, further crystallization cementing the scales together. There also exist an efflorescent crust, largely of salt, a foot in depth and covering a considerable area. This habit is not generally known to salt, and it is possible that it may occur through replacement of sodium carbonate or sulphate.

Below the surface crystalline masses of salt are found in nearly all parts of the lake. At points these crystalline beds are found to be 20 ft. or more in thickness.

Hanksite, thenardite, ulexite (cottonball), and glauberite occur here in greater or less quantities.

One of the vagaries of nature here is the occurrence of the trona "fish-bone" crystals. These crystals were first discovered by F. C. Ware in 1910, in a delta of sandy mud which cuts the soda reef. They have very much the appearance of flat tapering splinters of wood and occur like roots, projecting into the ground vertically as deep as 6 or 7 in. The tops of these "fish bones" rise just to the surface of the mud and only the exposed top has definite crystalline planes.

They were at first thought to be gaylussite, their appearance and growth being similar to the "nails" of the Venezuelan alkali makers. Their analysis, however, shows Na_2CO_3 45.89 per cent., $NaHCO_3$ 31.90, H_2O 17.67, insoluble 32.7 per cent. It is possible, of course, that they are pseudomorphs after gaylussite. Indeed, this interchange of personalities has also been observed in gypsite, which has been found almost entirely replacing the sodium sulphate in the cruciform thenardite crystals.

The knowledge of the value of these deposits lay dormant for many years, and it was not until 1905, when C. E. Dolbear commenced investigating the extent of the deposits and their commercial possibility, that this dormant condition was dispelled. In 1908 he organized the

[1] *So. Afr. Min. Jour.*, Nov. 28, 1914.

California Trona Co. for the purpose of operating, first, the surface deposits. This company acquired the old borax works, and in the fall of 1908 commenced the construction of a plant with the capacity of 100 tons per day of soda ash.

According to C. E. Dolbear, the percentage of potassium chloride in the brines is quite uniformly 4.49; that of the solids, 3.46. His estimate of the total potassium chloride content in salts and brines is approximately 30,000,000 tons. Calculations of other salts of major importance are sodium biborate (anhydrous), 17,100,000 tons; sodium carbonate, 115,130,000 tons; sodium bicarbonate, 42,700,000 tons.[1]

Salt

Salt occurs in two distinct ways—as rock salt in beds or associated with bedded or sedimentary rocks, and in solution, as in sea water or in brines or bitterns. A very large part of the salt production is derived by converting the natural rock salt into brine, which is then pumped to the surface and evaporated.

The two main methods of obtaining salt are the mining of rock salt and the evaporation of salt-bearing solutions. Rock salt is produced chiefly by deep shaft mining in the eastern, central, and southern parts of the United States. Active mines are located in Livingston County, N. Y.; near Detroit, Mich.; in Ellsworth and Rice Counties, Kans.; and in Iberia Parish, southern Louisiana. A small production comes from surface deposits in the dry climates of Utah and California. In 1913 the marketed production of rock salt in the United States was 1,062,291 short tons, valued at $1,968,567.

The processes employed at the present time in the manufacture of salt by evaporation are solar evaporation, direct heat evaporation, steam evaporation, and vacuum pan evaporation. Salt is made by one or more of these processes in the great majority of the salt-producing states. California is unique among these states in that the great bulk of the salt produced in that state comes from sea water, being obtained by solar evaporation on San Francisco Bay, near Long Beach and near San Diego.

Michigan ranked first among the salt-producing states in 1913 in both quantity and value of production, followed by New York, Ohio, and Kansas in the order named.

The production of salt in the United States is shown in the following table:

[1] S. H. Dolbear, *Min. Eng. World*, Oct. 31, 1914.
[2] U. S. Geol. Surv.

PRODUCTION OF SALT IN THE UNITED STATES (*a*)
(In barrels of 280 lb.)

Year.	California.	Kansas.	Louisiana.	Michigan. (*c*)	Nevada.	New York. (*c*)	Ohio, W. Virginia, and Pa. (*b*)	Texas.	Utah.	Other States.	Total, Barrels.
1904	821,557	2,161,819	1,095,850	5,425,904	(*d*)	8,600,656	3,030,829	.....	253,829	639,558	22,030,002
1905	664,099	2,098,585	1,055,186	9,492,173	(*d*)	8,359,121	2,728,709	(*d*)	177,342	1,390,907	25,966,122
1906	806,788	2,198,837	1,179,528	9,936,802	11,249	8,978,630	3,436,840	(*d*)	262,212	1,361,494	28,172,380
1907	626,693	2,667,459	1,157,621	10,786,630	6,459	9,657,543	4,007,390	(*d*)	345,557	464,143	29,719,495
1908	899,028	2,588,814	947,129	10,194,279	9,714	9,005,311	3,572,635	(*d*)	242,678	1,291,042	28,750,630
1909	886,564	2,769,849	(*d*)	9,966,744	16,107	9,880,618	3,835,267	(*d*)	246,935	2,505,562	30,107,646
1910	937,514	2,811,448	1,372,248	9,452,022	17,535	10,270,272	3,829,475	382,164	249,850	983,128	30,305,656
1911	1,086,163	2,159,859	(*d*)	10,320,074	12,856	10,082,656	4,485,886	385,200	272,420	2,391,710	31,196,824
1912	1,090,000	2,573,626	(*d*)	10,946,739	12,536	10,502,214	5,408,300	373,064	283,293	2,135,036	33,324,808
1913	1,082,993	2,698,079	(*d*)	11,528,800	8,971	10,819,521	5,424,056	355,529	330,443	2,189,913	34,438,305
1914	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	34,804,683

(*a*) Statistics of the U. S. Geological Survey except for New York since 1905, which are from reports of the State Geologist. (*b*) The production of Pennsylvania since 1905 is included in "Other States. (*c*) Includes brine used in manufacture of alkali. (*d*) Included in "Other States."

CONSUMPTION OF SALT IN THE UNITED STATES
(In tons of 2000 lb.)

Year.	Production.		Imports.		Exports.		Consumption.	
	Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.
1900.....	2,921,708	$6,944,603	199,909	$634,307	7,511	$65,410	3,114,106	$7,513,500
1901.....	2,879,332	6,617,449	201,733	676,324	9,433	86,414	3,071,632	7,207,359
1902.....	3,338,892	5,668,636	184,764	647,554	5,094	55,432	3,518,562	6,260,758
1903.....	2,655,532	5,286,988	165,981	495,948	12,750	95,570	2,808,763	5,687,366
1904.....	3,084,200	6,021,222	166,140	467,754	13,964	113,625	3,236,376	6,375,351
1905.....	3,635,257	6,095,922	161,159	492,189	34,238	239,223	3,762,178	6,348,888
1906.....	3,944,133	6,658,350	170,505	502,583	33,988	274,627	4,080,650	6,886,306
1907.....	4,160,729	7,439,551	153,435	452,227	30,802	232,895	4,283,362	7,658,883
1908.....	4,024,345	7,486,894	156,609	440,484	26,627	202,338	4,154,327	7,725,040
1909.....	4,215,070	8,343,831	158,487	447,983	40,158	269,273	4,333,397	8,522,541
1910.....	4,242,792	7,900,344	142,549	388,015	49,013	320,926	4,336,328	7,967,433
1911.....	4,365,756	8,345,692	137,759	378,083	48,873	335,285	4,454,642	8,397,490
1912.....	4,665,473	9,402,772	136,391	361,664	62,410	418,525	4,739,454	9,345,911
1913.....	4,821,368	10,123,129	150,601	416,375	70,289	515,194	4,901,680	10,024,310
1914.....	4,872,656	10,271,358	132,970	385,752	82,195	586,055	4,923,431	10,071,055

The domestic production of salt for 1914 will probably be about the same as in 1913. For accounts of the occurrence and production of salt in the several leading salt-producing states, see MINERAL INDUSTRY, Vol. **22.** These states are California, Michigan, and New York, and they produce the bulk of the domestic salt; Louisiana is also an important producer of salt in the form of rock salt, in which it ranks second among the states. The salt mines underly so-called islands, which are really mounds rising above the marsh lands along the Gulf shore of Iberia Parish. The Petite Anse mines on Avery Island were operated during the Civil War, having been developed in a small way in 1862. These mines were flooded twice and a new shaft was sunk in 1890. Mining on Weeks Island began in 1902. The extent of the Weeks Island deposit, which is operated by the Myles Salt Co., of New Orleans, has been demonstrated by borings to cover at least one-half of the island which contains 2000 acres of highlands.

The deposit, which is in a solid mass, goes down to an unpenetrated depth of at least 4000 ft., a near-by boring having been driven down 3800 ft. The output of the present plant on the island averages about 10,000 tons per month and is constantly increasing. About 12,000,000 tons of salt have been taken out of the mine since mining operations began and it is estimated that there are still 5 billion tons left on the level upon which they are working at the present time. This level is at a depth of about 600 ft. The salt produced is so pure that it needs no treatment other than grinding, analyses having shown it to run 99.84 per cent. sodium chloride.

Pennsylvania (By Richard R. Hice).—While Pennsylvania was at one time a large salt producer, the production has been gradually decreasing until for several years there have been but two producers remaining. Both of these plants were located on the North side, Pittsburg, the brine used coming from wells at the plants. The source of the brine was probably the Berea grit.

Both the plants in Allegheny ceased operations some time in the year 1913, and so far as known there was no production of salt in 1914.

Foreign Countries

Africa.—There is a possibility of a salt industry being developed in Senegal, and the subject is now being studied on the spot. The results have so far proved satisfactory, and it is reported that a salt market of some size will be established in the Saloum. The persons interested have already obtained some land concessions upon which they are shortly going to begin work.[1]

Bahamas.—A Chicago corporation contemplates leasing a tract of at least 1000 acres on Inagua, one of the Bahama Islands, widening and deepening a canal to admit barges of 300 or more tons, and establishing a big salt-making plant. Auto-trucks would be loaded at the salt pans and convey the salt to lighters. The trucks would carry 8 tons of salt. At present private firms pay 2 cts., United States currency, for hauling their salt to warehouses, while other expenses bring the total cost up to 5 cts. for placing the salt on steamers. The price paid for the salt is only 6 cts., which is too close a margin. The American corporation could reduce the expenses greatly. A steamship line has offered to carry the salt to New York at a nominal rate. Thence it would be conveyed in meat cars returning to Chicago, usually empty. A dozen industries allied with this corporation would require salt.[2]

Canada.—Extensive beds of salt or salt-producing springs are found in nearly every province of the Dominion of Canada.

The largest, and at present the only, producing district, is situated in

[1] *Chem. Tr. Jour.* and *Chem. Eng.*, Dec. 12, 1914.
[2] Consul W. F. Doty, Nassau, *Daily Cons. Tr. Rept.*, Oct. 12, 1914.

the southwestern peninsula of the province of Ontario, bordering on Lake Huron, the St. Clair River, Lake St. Clair, and the Detroit River. The salt here exists as beds in the Salina formation of the Silurian system, which formation in the productive area is covered by upward of 1000 ft. of other strata, chiefly Devonian.

In this district the principal plants are located at Windsor, Sarnia, Sandwich, Goderich, Clinton, and Kincardine. A prominent feature of the salt produced from the brine in Canada is its remarkable purity and also its freedom from other salts detrimental to its use in the production of caustic soda and bleaching powder. There is a good opportunity for the soda industry in the Dominion, and it is assuming larger proportions each year. At Sandwich a plant has been recently erected for the manufacture of caustic soda and bleaching powder from the brine.

The production in Canada is obtained wholly from the evaporation of salt brines, either natural, or else formed by the pumping of water down drill holes to the salt beds and the re-pumping of the water when it has become a saturated solution.

Western Ontario possesses a large area of salt-bearing territory, roughly estimated at 2500 sq. miles. The immense tonnage available in this area is indicated by the fact that a borehole near Goderich, in Huron County, sunk to a depth of 1500 ft., traversed six beds of salt, ranging in thickness from 6 to 35 ft. At Windsor, in 1600 ft. of saline strata, four beds were encountered, one of which measured 250 ft. in thickness. The formation is Onondaga, of Silurian age. The mineral is extracted by forcing water down the boreholes and evaporating and purifying the effluent brine.

Twelve firms are engaged in the extraction and manufacture of saline products, the total output of salt in 1912 being 95,053 tons. Two firms are now producing soda and other alkaline products.

No account of the economic geology of the Dominion would be complete without a reference to the salt that abounds in the Devonian strata along the west side of Lake Winnipegosis. Salt springs are found in every direction through the district, and a small creek entering the lake north of Bell River is estimated to carry down 37 tons of salt per 24 hr.

It is not yet known whether the mineral exists in the form of brine or rock-salt beds, but the vastness of the source, indicated by the numerous salt springs, favors the latter theory. The high proportion of potassium chloride (up to 209 grains per gal.) in the brine points out the possibility of the occurrence of potash minerals in this region, and especially in connection with the heavy beds of gypsum which accompany the saline strata. The whole district is well worth careful examination and some drilling. Transportation facilities are very good.

Greece.—News has arrived at Salonica from Kilkitch confirming the importance of the mines of rock salt which have recently been discovered. The Department of Public Works has sent to Kilkitch an engineering expert to study the beds on the spot.

India.[1]—The salt business in India showed increases, both in quantity and value by 32,000 tons and £18,000 to 607,000 tons, valued at £584,000, and was mostly imported into Bengal and Burma. The chief countries from which salt is imported are the United Kingdom, Germany, Spain, Aden, Asiatic Turkey, and Egypt. The importation from Spain and Asiatic Turkey increased largely during 1913–1914 with a setback in the case of imports from the United Kingdom, Egypt and Aden, while those from Germany remained steady. English salt has declined from 198,000 tons in 1911–1912 to 152,000 tons in 1912–1913, the latter figure being reduced in 1913–1914 to approximately 137,000 tons, although the consumption of salt during 1913–1914 was 1,769,300 tons, or about the same figure as in 1912–1913.[1]

Philippines.—The manufacture of salt from sea water in the Philippine Islands is accomplished by the very crudest methods. The greater part of the salt made is produced by sun evaporation; a small proportion is made by artificial heat. The Chinese have introduced slightly improved methods. About 40,000,000 lb. of crude salt is produced annually. In the Mountain Province a small amount of poor grade salt is produced by evaporating the water from carbonated springs, but the supply falls far short of the demand, and the quality is of the poorest. About 20,000,000 lb. of salt is annually imported. Most of this comes from China. This is chiefly crude. About 1,000,000 lb. comes from the United States each year. This consists of the better grades of table salt. The United Kingdom sells the islands about 350,000 lb. yearly; Japan about 300,000 lb.; while Australasia and the other countries supply the rest—about 60,000 lb.[2]

Russia.—The Russian reserves of salt, whether in rock or brine, are in places abundant. Those principally worked are in the zone stretching from the district north of the Azof Sea to the district on the northwest of the Caspian Sea; the former including the important Bachmut and Slavyansk reserves, and the latter the rock-salt deposits of Illyetz Zaschtchitchi. But the salt production in Russia is not a rapidly progressing industry. Such increase as does take place is surprising in its insignificance. It is largely a syndicated business, which probably accounts for the decline that has taken place in the production of salt in the less important districts.[3]

[1] *Chem. Tr. Jour.* and *Chem. Eng.*, Jan. 30, 1915.
[2] J. F. Boomer, *Daily Cons. Tr. Rept.*, July 3, 1914.
[3] *Chem. Tr. Jour.* and *Chem. Eng.*, Jan. 30, 1915.

According to the Russian Mining Department there has been a serious decline in the production of salt in Russia over the past few years. Figures furnished in support of the statement show that this has occurred. In 1904 the production amounted to 112,500,000 poods; in 1908, 119,066,000 poods; in 1909, 136,955,000 poods; but in 1913 only 119,611,000 poods. It is pointed out that the decline observed during the past few years, reaching down to the figure named for 1913, is not in keeping either with the growing population of the country or its active economic development. Efforts have been made to get contractors to accept concessions for the production of salt under certain conditions, conformity with which would insure a larger output. The department, however, has been forced to the conclusion that other measures must be taken, to come into force in about 3 years' time, when the regulations under which salt deposits are now exploited will have elapsed.[1]

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[1] *Chem. Tr. Jour.*; *Chem. Eng.*, Feb. 20, 1915.