they might perhaps (from what has been said) be more properly called, is certainly a most curious feature in the geology of New Caledonia, scarcely less extraordinary than that of the red pigs, for which the island is said to be famed, and possibly the color of the latter may have some connection with the presence of these red deposits on the island. So much of the island appears to be colored red by nature that it seems quite a pity in fact it is not red on the map.

The clays or earths are believed by Levat to be the products of the hydrothermal decomposition of the serpentines, as they contain all the elements of these rocks, in addition to iron, manganese, chromium, and cobalt. He supposes that numerous iron and manganese springs found vent through fissures in the serpentine and have eaten it away, leaving half dissolved masses of so-called sugar rock in the clay that fills the basins, which in many places are capped by a deposit of oolitic iron ore, the product of the overflow of the ferruginous waters. Mr. Garland's observations that the ore is found in massive pieces in botryoidal, mammillated, and occasionally in stalactitic forms, and in brecciated masses, supports this view. It has been pointed out also as a remarkable fact that these deposits are mostly found at high altitudes (the mountains of the interior rising to a height of 5,576 feet, and averaging 1,640 feet), and in the lower-lying serpentine areas they are non-existent, but I think it is capable of explanation, if we suppose that the serpentines are the altered products of volcanic action which overflowed in the interior of the island, as it is just there that the conditions would be found most favorable for the deposition of the minerals we have under review, under such circumstances. Veins of chrome iron ore also occur in the hard unaltered serpentines of New Caledonia,* while cobalt ore is likewise found in the red earths, the origin of which latter deposits is considered by Levat to be essentially hydrothermal. The chromium, on the contrary, he thinks, pre-existed in the serpentine, and was derived from it, while the nickel solutions only appeared after the deposition of the clay.

These solutions, circulating not only on the contact, but in the cracks and joints of the adjacent serpentine, would explain the deposition of the hydrated silicate of magnesium and nickel, in "Stockwerk form," which is the most usual mode of occurrence. The nickel ore is, however, also largely found, according to Levat, in a brecciated form on the roof or walls of the basins of red earth, being sometimes symmetrically deposited, when the axis of the basin is vertical (in which case the ore is of equal thickness on the walls); at other times the axis of the basin is inclined, and the serpentine which forms the roof is fissured, the cracks so found being often several meters wide, filled with rich ore, the nickeliferous solutions, being unable to penetrate the clay, finding a natural passage along the walls of the cavities. Where the circulating waters moved for a long time between the walls and the clay, fine strata are found upon the latter (*Annales des Mines, second livraison*). Levat further states that the nickel deposits lie in a series of zones, running northeast and southwest, starting from the east coast, penetrating into the interior, and continuing, as Mr. Garland points out, to the west coast; outside of them there are only local encroachments, which lack uniformity.

Though in 1887, at the time Levat examined them, the deepest workings were only down 275 feet below the outcrop, he concluded that in depth they would lose their thickness, basing his opinion on the probability that the red earths with which they appear connected would not hold down to any great depth. Levat summarizes the general characteristics as follows: 1. The ore is essentially dependent on the serpentine of the east and southeast parts of the island. 2. Ores of cobalt, associated with manganese, are found in beds on the rim of the basins of the earth found traversing the serpentine in a number of places. These cobalt ores do not contain over two or three per cent. of Co, but they are very extensive, being mined simply by scraping up the material. 3. The deposits of chromium are of two kinds, either in veins in the serpentine or in stratified beds in the basins of earth. 4. The nickel deposits are of later formation than either of the two preceding ones, and are situated exclusively at or in the neighborhood of the contact of these clays or earths with the serpentine, and never in the body of the former. They are united in a certain number of northeast and southwest lines, the width of which does not exceed, as before said, 600 meters.

The crystalline dialage, being less attacked than the other constituents of the serpentine by the mineral solutions which have eaten it away, forms a skeleton, which is sought for by the miners as an indication of ore.

True lodes appear to be absent, but some of the fissures filled with ore can be traced for considerable distances along their strike, possess regular walls and dip, have a width of 18 inches to 5 feet, and have been followed down, in one instance, to a depth of 360 feet below the surface outcrop.

As the formation of the deposits in the basins of red earth is due, Levat thinks, to the shrinkage of those clays, their continuity in depth may probably depend, as he supposes, on the depth of the clays in the basins. It must not be supposed, however, that these deposits are likely to be speedily exhausted, as they have a very wide distribution indeed. They are mined in open quarries, in benches, when found as stock works; at other times, by tunnels and winzes. The work is commenced by removing the red clay, which, if mixed with the ore, entails difficulties, as the grains of iron are with great difficulty separated by washing, and consequently appear in the matte produced. Moreover, the clay, being very aluminous (according to Levat), renders the siliceous ore still more refractory.

The gravity system of transport on a single rope at these mines is certainly extremely primitive, but is no doubt due to the necessity of frequently shifting the position of the terminals. It might, however, be improved upon by hauling up the empty bags and carriers on a carriage attached to the main cable by means of a small hoisting rope, operated by a windlass, instead of carrying them up, as is now done, on men's shoulders. The principle of using gravity inclines with double ropes has been satisfactorily employed underground at the Pierrefitte mines in the Pyrenees,

in large open gunnicks; the only instance I know of where such a system has been operated underground. It was introduced because the flatness of the lode would have involved shoveling, and it possesses obvious advantages over an inclined plane, for a short temporary roadway in lofty workings.

According to Mr. Ph. Argall (quoting, I believe, from official sources), the output of nickel and cobalt ore from New Caledonia, in 1890, was 22,690 tons of (say) 10 per cent. nickel ore and 2,200 tons of 3 to 5 per cent. cobalt ore, while, in 1891, the output of nickel ore had only reached 35,000 tons. Mr. Garland states, on the other hand, that these mines are now producing over 60,000 tons of nickel ore per annum; and to reconcile the two statements, I take it that he alludes to the crude ore. He puts the cost of mining at 6s. to 40s. per ton.

The first mechanical treatment of the ore consists of sorting and washing at the quarries, where a division is made into rich ore, carrying 8 per cent. and over of nickel, and poor ore under that amount. The ore is then carried to the plain below to be washed, so as to remove the red clay. The nickel has the same specific gravity as the serpentine, but less than the iron. The ore rejected at the quarry, although it contains 3 or 4 per cent. of nickel, is of no value. Garnier's first idea was to treat the ore in a blast furnace, to obtain crude nickel and refine it; but this latter process presented such difficulties that it was abandoned. Fusion for matte was then tried but was also given up, owing to the high price of fuel and the inefficiency of the convict labor. The cost of producing metallic nickel, dealing with such ores, appears to be—mining and transport, 10 cents; conversion into oxide, 3 cents; reduction into metal, 8 cents; allowance for loss of working, 1 cent; total, 22 cents.

(To be continued.)

THREE YEARS IN A COUNTRY GAS WORKS.*

By S. M. HIGHLANDS, of Clinton, Iowa.

I DO NOT think it is possible for me to add anything new to the gas industry, but I have long entertained the idea that the business was hedged around with too much mystery, and that the very conservatism that has been allowed to grow around it was one of the greatest drawbacks with which it had to contend. In the smaller cities the gas superintendent is alone, and in many places very lonely; and he is very apt to think his business a mysterious one; that he is the only man in the community who can master its intricate details; that all he has to do is just to wait until people come to their senses about the electric light craze, and everything will be serene.

It occurred to me some years ago that this was all a mistake; that educating the general public against their convictions is a slow and unprofitable proceeding; and that gas is only a commodity that people can either use or dispense with without very much inconvenience. And further, that the same methods that are most successful in other lines of business could be used to push the sales of gas, and with equal success. I fully believe that the unparalleled growth of the electric business was because of the efforts to make it popular, without regard to any immediate profits.

Infused with these ideas, I assumed the management of the Clinton (Ia.) gas works on April 1, 1891. The works were the usual 6 inch coal gas works and were built in 1871. In 1875 they sold 5,500,000 feet of gas. In 1884 it had increased to 6,122,000 feet. In 1886 the Thomson-Houston Company built an electric light plant and the sales of gas dropped to 5,892,000 feet, and in 1890 it had risen again to 6,491,000 feet, with the price of gas ranging from \$2 to \$2.50 per 1,000.

On April 1, 1891, the price was reduced to \$1.75 for illuminating and \$1.25 for fuel; and a contract was made for a set of water gas apparatus. At the outset of the new management, the old adage, "The money was made or lost in the retort house," was totally disregarded. The only aim was to make the kind of gas the public would use the most of, without much thought as to whether the gas was 16 or 24 candles, or whether it took 4 or 5½ gallons of oil, or 35 or 50 pounds of coal to the 1,000 feet. We believed then, as we believe now, that the principal duties of a gas manager were to sell gas, and that the making of it was a minor incident connected with the business; that the margin between the cost in the holder and the usual selling price was so great (greater by far than in any other large, legitimate business) that a manager could easily afford to have the cost increased by 10 to 15 per cent., if by so doing he could devote more of his time to selling it and thereby increase his sales. I will venture the assertion that there is not one manager here who believes he is selling one-half the gas the community would take and pay for, if he could only make it to their interest to do so.

In carrying out this idea, we advertised that for a year we would run free service pipes; sell gas stoves at cost; pipe buildings free; and in a great many places we furnished gas fixtures free. At this time the company had only 235 meters set and not a gas stove in use. By May 1, orders began pouring in on us until we had from 15 to 25 gasfitters at work, and during the summer sold 185 stoves and set 392 meters for illuminating purposes. This work cost the company about \$4,000, and you can judge for yourselves whether it is worth this sum to add 577 new customers to a plant that only had 235 to begin with. By September 1, we felt strong enough to tackle the electric light company, and thought a fight with them would advertise us, if nothing else. We sent a canvasser to all their customers and offered to furnish them with gas for a year for half the price they were paying for electric light, generally allowing the customer to say how many gas jets he would need to properly light his place. They had 53 customers, and we took 45 of them on this proposition and had them tied up for one year. This action on our part forced them to sell out to us at once at our price, and we failed to have any fun out of the scheme at all. We metered the 45 contract customers just as carefully as we did the regular ones and took the statements monthly. It might be as well to state here that these contracts raised a new question in our minds

that we will take up some time and settle to our own satisfaction at least.

Please remember that all this occurred in a small town, where the manager could be personally acquainted with each of his customers and know what they were doing; and this article is supposed to be of no benefit to the larger cities. Those 45 contract customers were put on without any idea of making very much money out of them, but rather to force a fight on the electric company. We knew when we took them that some of them would get pretty cheap gas, and we were not disappointed. During the year for which they run, they used 2,894,000 feet, for which they paid \$2,171.06, or 75 cents per 1,000. In December they used 600,000 feet; and in July, 122,200; one of the largest customers fairly heating his building with it, and paying only 40 cents per 1,000, while some of them were paying as high as \$1.50 per 1,000.

We bought the electric light plant in December, 1891, and immediately reduced the price of electric lights 25 per cent., making the rate for a light of 2,000 candle power \$6 per month, for 9 o'clock lights, and \$8 for 10 o'clock lights, the gas contract customers having the option of surrendering their gas contracts and taking the electric light at the new price; but none of them availed themselves of the privilege. At the end of the year none of the contracts were renewed. About one-half of them are now using gas and the rest have returned to the electric light.

We found a great many customers who thought they could afford to use a gas stove, but were afraid to try gas for illuminating purposes; and for such customers we always put a gas burner over or near the stove and connect it with the stove meter. The result was that in a short time the man of the house would come to the office and say that he was tired of sitting in the kitchen to read, and wanted one light in his sitting room; and this was followed by several more in other parts of the house at the illuminating rate.

Our office is kept open from 7 A. M. to 9 P. M., and all complaints are taken care of within an hour of their being made. A meter prover is kept in the office; and when a customer thinks his meter is wrong we ask him to wait and see it brought in and tested. We are always willing to settle with him on the basis shown by the prover. I have yet to find the customer who was not perfectly satisfied after seeing this test made, and agreed with us that if there was anything wrong with his bill, the fault was at his house and not in our office.

Another imperative rule is that while we now have a monopoly of the lighting business, our customers should not find out that we know it; they should always be treated as courteously as they are in any other mercantile house; a trivial complaint should be treated with as much consideration as the most serious one. Another rule that will have more weight with them than all others is, whatever we do must be well done. Nothing temporary allowed, and never a makeshift.

In rebuilding the gas works, money was not spared to make it a good one. In rebuilding the electric light plant, the very best Corliss engines and high grade boilers were used. The results are that "no gas" complaints are rarely, if ever, heard, and we have not had a claim for rebate on account of "electric light out" for over two years. Our electric service has been so good that the city has just closed a contract with us for all their street lights for a period of 12 years, and the electric street railroad has contracted with us for its power for 7 years.

There have been no changes in prices on the gas for 3 years; and for the past 2 years we have been charging a fair price for all service work, also for all electric wiring and renewals. In the meantime, the growth of the gas business has been much more rapid than that of the electric business.

As I stated before, the company sold 6,491,000 ft. of gas to 235 customers in the year 1890. In 1891 they sold 11,432,000 ft. to 627 illuminating and 185 fuel customers. At this time—January 1, 1892—we had 50 commercial arc lights and 800 incandescent ones. For the year ending January 1, 1893, we sold 18,000,000 ft. of gas (an increase of 64 per cent.) to 940 customers, and in the year ending January 1, 1894, our sales of gas had increased to over 20,000,000 ft. to 977 customers; while the electric lights had only increased to 65 arcs and 1,200 incandescents, exclusive of the street lighting. With the street lighting and street railroad work, the gross business of the electric light plant is larger than the gas business, but is, of course, a great deal more expensive to us to furnish. On the whole, we are satisfied that proper business methods will push the sale of gas just as readily as that of any other commodity, and that without it the gas business is apt to cut a very small figure in small cities.

As some of you probably know, we also supply gas to Lyons, a city of some 7,000 inhabitants, immediately adjoining Clinton. Lyons has a municipal electric light plant that also supplies domestic lights. This plant has been established some 10 years, while the gas mains were only run 3 years ago. At the time we extended the gas mains there, nearly all the stores and shops were using the electric light. We did not make any effort to displace the electric light, but instead concluded we would see what a fair competition between gas at \$1.75 per thousand and arc lights at \$5.50 each per month would result in. For the first year or so we did not do a great deal of business with the stores. A customer would use the gas through the summer and then put back the electric lights in the winter when the evenings were long. In the summer of 1893 we sent 50 Welsbach burners up there to see what they would do. We equipped one large jewelry store with them at our expense and then waited for results. And they have been surprising, indeed; for to-day there is not one store in the city using electric lights, the Welsbach burners having entirely displaced them; but at the same time it has cut down our sales of gas, and I do not know but that we had better let a few of the electric lights come back, if we can only get rid of the Welsbach burners. The burners are all that is claimed for them, and give our customers unqualified satisfaction; but the confounded things won't let any gas through them. The same jewelry store that was formerly using two arc lights only used 3,000 ft. of gas in December. After our experiment with them at Lyons, we would prefer furnishing electric lights rather than Welsbach burners in Clinton.

* At the Gasconne mine the serpentines are particularly rich in chrome, occurring in veins in the undecomposed rock, but breaking off suddenly at the contact of the serpentine and clay.

* A paper read before the Western Gas Association, Cleveland.—*American Gas Light Journal*.