casieu Parish, Louisiana, at a depth of one thousand feet below the surface. But all attempts to get at the deposit and bring the sulphur to the surface had failed completely, on account of the layers of quick sand above the deposit. Mr. Frasch evolved the idea of melting the sulphur in place, by means of superheated water forced down a boring, and forcing the melted sulphur to the surface, through an inner tube. During the period beginning October 23, 1890, to February 6, 1905, Frasch has applied for ten patents for his inventions of apparatus and processes for accomplishing this result.

His efforts have been entirely successful. The Union Sulphur Co. was organized, he secured control of the sulphur deposit, set up the batteries of boilers, bored the wells, built the railroad to carry the sulphur to the seaboard, and the docks at Sabine Pass, for the ships which deliver the sulphur to the seaboard.

There are seven batteries of boilers, each of which runs a well. A single well delivers about four hundred and fifty tons of sulphur per day. In a two-months test, six wells delivered one hundred and twenty-two thousand tons of sulphur, proving the capacity of the mines to exceed the entire consumption of the world.

The sulphur is pumped into bins about fifty feet high constructed of planks, where it congeals and forms a block of from seventy-five thousand to one hundred and fifty thousand tons, over ninety-nine per cent. pure sulphur. The planks are subsequently removed, the huge block is broken up by blasting, and the sulphur is loaded directly into the cars by a scooping derrick which picks up two tons at a time.

The effect of this work on the imports of sulphur into the United States is very far-reaching, as will be seen in the following figures, showing imports and exports of sulphur into and from the United States.

	Imports. Tons.	Exports. Tons.
1903	188,888	none
1907	20,399	35,000

At present the Louisiana Deposit supplies this country with sulphur, and might supply large quantities to European countries. Fortunately the Company is owned by a few broad-minded and large-hearted men, who could not be induced to bring starvation and ruin upon the two hundred and fifty thousand people dependent upon the mining of sulphur in Sicily.

Ninety per cent. of the stock of the Union Sulphur Co. is owned by Herman Frasch, the estates of H. McK. Twombly, Abram H. Hewitt and Edward Cooper and Mr. L. H. Severance.

I have presented to you very briefly the great achievements of Mr. Frasch in the field of Applied Chemistry, but quite fully enough to satisfy you that your Committee is fully justified in placing Mr. Frasch by the side of Sir William Perkin, as one of our greatest Industrial Chemists and Chemical Engineers.

To Mr. Frasch:

It gives me great pleasure, as the representative of the Society of Chemical Industry, and the affiliated Chemical and Electro-Chemical Societies, to place in your hands this beautiful token of the appreciation and affection of your Fellow Chemists.

ADDRESS OF ACCEPTANCE.

By Herman Frasch.

Mr. Chairman, Ladies and Gentlemen:

When I received the notification that I had been awarded the Perkin medal, I was most happily surprised. I recognize and appreciate fully the honor and distinction which the medal conveys, and I wish to express my sincere thanks and appreciation to the members of the Awarding Committee and to the Societies which they represent.

OIL.

Very little is known of the impurities contained in petroleum. They influence the price, however, to a remarkable degree. The best illustration of this is the case of Ohio oil. This contains about 0.75 per cent. of sulphur, and before my desulphurizing process was known sold at 14 cents per barrel, while Pennsylvania oil, with a sulphur content of only 0.03 per cent., sold at $2.25 at the same time. Sulphur affects the value of petroleum in a greater degree than phosphorus does that of iron ore.

One of the oils which contains an objectionable amount of sulphur is that found near Pretolia, Ontario. It is the only crude that has been found in the Dominion of Canada. When this oil was first discovered in 1868, it was refined in the usual way—treated with sulphuric acid and soda, and then put on the market. The result was disastrous. The odor emanating from the oil was very offensive and penetrating, so much so that the cargoes of ships carrying flour and bacon, anchored near a vessel loaded with Canadian oil, were spoiled, as the flour and bacon absorbed this odor. Law-suits based upon these facts were decided against the shippers of Canadian oil, and all export ceased. In order to protect the home industry, the Canadian Government imposed a duty of 9 cents per gallon on Pennsylvania oil, but in spite of this almost prohibitive duty, half the oil consumed in Canada was imported from Pennsylvania.

The offensive odor of this oil, moreover, was not its only objection. It had also the property of depositing soot upon the lamp chimney, so that a large percentage of the light emitted by the flame was lost.

The Canadian Government, as well as the Canadian producers and refiners, made every effort to discover a method by which the objectionable properties of this crude oil could be eliminated, but practically nothing has been accomplished in twenty years, except perhaps in the matter of covering up the odor, when in 1885 I bought a refinery in Canada and made a thorough investigation of the character of this crude and decided to discover a remedy, if possible.

This dreadful odor, which the Canadians called "skunk," arose from a peculiar hydrocarbon-sulphur compound, and the clouding of the lamp chimney was due to its sulphur content. The sulphur in the oil burned into sulphuric acid, which condensed against the lamp chimney, and any unconsumed carbon of organic particles in the air would adhere thereto and form this objectionable soot. To remove the sulphur from the oil completely meant the elimination of the smoke as well as odor, and when this was effected the oil furnished an illuminant equal in quality to the best Pennsylvania.

To free petroleum of elementary sulphur or hydrogen sulphide presents comparatively little difficulty, but the sulphur compound which is the cause of this offensive odor is very stable and cannot be broken up into hydrogen sulphide or any other sulphur compound which can be eliminated. It was because of the presence of this peculiar compound that Canadian oil for so many years resisted all the efforts made to refine it.

This sulphur compound has the peculiarity of dissolving a number of metallic oxides. When the oil is saturated with all the oxide it can carry in solution, the disagreeable odor disappears. It reappears, however, if an attempt is made to free the solution of its metal. I found that this solution of metal in petroleum has an intense affinity for sulphur, and also that when a portion of the sulphur has been precipitated with the metal as a sulphide, additional quantities of metal oxide can go into solution. If more oxide than that necessary to precipitate all the sulphur is added to the petroleum while it is being distilled, a complete desulphurization of the petroleum is effected.

When this petroleum solution is made with water-white petroleum distillate, which has been freed of elementary sulphur and hydrogen sulphide, the solutions assume colors characteristic of each metal. The lead solution is a canary-yellow; mercury, orange; copper, blood-red; silver, brown.

I selected copper as the metal most suitable—first because it dissolves in the petroleum, and in the second place because of the readiness with which the sulphide of copper can be reconverted into oxide.

When the laboratory work had been completed, I applied for letters patent and erected a 1,200 barrel still, carrying on the process on a large scale. The shell of the still was 22 feet in diameter and 16 feet high, and was supplied with a stirring device which kept the copper in suspension while distillation was carried on. After 80 per cent. of the contents of the apparatus was distilled, the remainder, when cool, was pumped through a filter press. The solid portion was ignited and roasted, while the liquid residuum was mixed with a new charge of revivified oxide of copper to be used for the desulphurizing of a further quantity of sulphur-containing distillate. I used a shelf furnace, operated by hand, to roast the resulting sulphide of copper. In this manner I produced a burning oil containing 0.02 per cent. sulphur, which is the percentage contained in Pennsylvania oil of similar specific gravity, while Canadian oil, refined by the ordinary method, has a sulphur content of 0.6 per cent.

It was about this time that oil almost identical with the Canadian was discovered in Ohio, and while the question of refining Canadian oil was interesting, the problem became intensely important when 30,000 barrels per day were being produced in Ohio. The new field proved to be very extensive, and the Standard Oil Company bought property near Lima, Ohio, upon which they erected a large refinery. They disregarded the enormous difference in the sulphur content of Pennsylvania and Ohio oils, decided to refine the latter in the usual way and put it on the market. When the refined product had been distributed among their customers, it all came back as unfit for use. Every effort was made to solve the difficult problem, but in 1887, after two years of experimentation and with all the skill which the Standard Oil Company could call to their assistance, it was decided that no illuminating oil could be made from Ohio crude and that it was fit only for fuel. A pipe line for this purpose was built to Chicago, and long-term contracts made at 14 cents per barrel.

My patents had now been granted and I was selling refined Canadian oil with a guarantee that it would burn equal to the best Pennsylvania. After an investigation which convinced them that I had solved this problem, the Standard Oil Company bought my patents and my refinery, and as soon as possible Lima, Cleveland, Whiting, Philadelphia and Bayonne were refining oil by the new method.

The Ohio field was found to extend into Indiana and the production increased to 90,000 barrels per day. The price of this crude went up to nearly $1.00 per barrel, fluctuating between 60 cents and $1.00 for a great many years. The advantage resulting from the ability to use these oils for illuminants did not stop with the large profits of the Standard Oil Company, but the farmers and oil producers of Ohio and Indiana benefitted by the enormous advance in the value of Ohio crude, which amounted to many millions of dollars per year.

METHODS OF DESULPHURIZATION.

In desulphurizing petroleum, the oxide of copper is mixed with the petroleum distillate in a still supplied with an upright shaft and arms radiating therefrom, to keep the oxide in agitation during the process of distillation, flexible chains attached to the arms being used to prevent the copper from adhering to the bottom of the still. One hundred thousand pounds of oxide of copper are used for the first charge of 2,000 barrels of distillate. After 80 per cent. has been distilled off, a new charge of distillate is added with an additional charge of 30,000 pounds of copper, which is followed by two further runs, so that about 200,000 pounds of copper material are in the still when the fourth run is made. The residuum is pumped through a filter press, and the solid product of the filter press has the oil adhering thereto burned off. The dry mixture of oxide and sulphide of copper is then put into a roasting furnace, where it is desulphurized to 1 per cent. or less.

A variation of my method treats the vapor coming from a still charged with crude petroleum, and consists in passing the vapor through two brushes made of No. 10 steel wire, the brushes being $5^1/_2$ feet in diameter and 16 feet long. They are inserted into a shell which is almost the same diameter as the brush, and the requisite amounts of copper and heavy oil are pumped into two shells, each containing one brush. The vapor passes in series, first around the shell to prevent condensation; then through the shells on to the condenser. The brushes are made to revolve at about six revolutions per minute. These wires immersing continually in this oxide of copper magma, the shells containing the brushes are surrounded by the vapor coming from the still, and as the temperatures of the vapors increase, anything condensed thereon during the prior period is reevaporated by the hotter vapor following.

Both these processes are now in operation at different works.

ROASTING FURNACE.

When the question of supplying the copper necessary for the works at Lima was under discussion, it was found that 160 furnaces, such as I used in Canada, would be required to do the work. In order to avoid the handling and transportation involved in such a gigantic furnace plant, I was obliged to construct a mechanical roasting furnace of a capacity in conformity with the magnitude of the business.

To eliminate the difficulties of the warping of the shaft and the arms which had caused the failure of the McDougal furnace, I constructed a stirring device, the shaft and arms of which were cooled artificially to withstand the high temperature of the roasting furnace. I first forced air as a cooling medium through the stirring device, but found that the oxidation of the sulphide of copper and the carbon from the residuum of the petroleum produced a temperature even higher than that of the ordinary pyrites furnace. It therefore became necessary to substitute hot water for air as a cooling medium, which proved very satisfactory. This made possible an increase in the size of the furnace to 16 feet inside diameter, and to-day these shafts and arms are connected with steam drums and are used like a water tube boiler, so that the surplus heat extracted from the stirring device of the roasting furnace is converted into steam and utilized in the plant. The capacity of a furnace is fifty tons per day, and four to six are used in one refinery. After the copper has been revivified, it is ground and mixed with residual oil from the filter press. In this manner the copper charge is pumped into the still which may be half a mile away. During the twenty years that this process has been in operation many millions of barrels of oil have been desulphurized.

CALIFORNIA OIL.

In 1902 the California field became important, and it was discovered that another oil which smoked chimneys had to be refined. This oil, however, was practically free from sulphur, the smoke being due to a large percentage of the aromatic series of hydrocarbons and to the fact that the percentage of hydrogen to carbon was too small to maintain the flame temperature necessary to consume all the carbon. I ascertained further that sulphuric anhydride converts the aromatic series into sulpho products, insoluble in petroleum, and that by treating the distillates from the crude oil with sulphuric anhydride, the members of the aromatic series in the petroleum can readily be extracted.

The existence of a petroleum containing nearly 50 per cent. of the coal-tar products is intensely interesting, especially in view of the theories advanced upon the origin of petroleum. The percentage of these hydrocarbons in the crude varies from the percentage contained in coal tar, benzol existing in a smaller proportion than toluol, while xylol represents 7 per cent. of the volume of the crude. Naphthalene, entirely free from all traces of carbolic odor, is quite prominent, while anthracene and carbolic acid are entirely absent.

I employed numerous methods for separating the products of California crude by physical means. Distillation, with large back-flow condensers attached, showed very encouraging results, as did also the method of washing the distillates with alcohol, carried on in series, the aromatic series being more soluble in alcohol than the paraffine series. However, the sulphuric anhydride treatment, which I first used in determining the amount of the two series contained in the petroleum, has proved to be very simple and effective on a large scale, and is now used by the Standard Oil Company at their plant in Port Richmond, California. The process of making the sulphuric anhydride employed there is the one purchased from the Verein Chemischer Fabriken of Mannheim. The capacity of the plant has been increased a number of times, until to-day it is by far the largest in the United States, if not in the world.

SULPHUR.

In 1865, while boring for petroleum in Louisiana, a sulphur deposit was discovered beneath a layer of quicksand about 500 feet thick. As a result of this discovery, quarrels and controversies arose as to whether the lease covering the petroleum rights also included the sulphur. It was some time before the matter was decided, and by the time a decision had been reached, both parties had lost a great deal of money, and those who got the sulphur deposit lost still more in trying to exploit it. The deposit seemed to bring misfortune to every one connected with it, and I have heard many stories and met many people who told me of having lost money in the various schemes that marked the progress of the sulphur mine. Progress there seemed to mean failure. An Austrian company, a French company, and numerous American companies—everybody failed and not a ton of sulphur was produced.

When I heard of this extraordinary situation, in 1891, I obtained a core from the sulphur deposit and many pamphlets from the various companies who had tried to operate it, each one telling the prospective purchaser that his fortune was made if he but owned a few shares of the stock of that particular company. I became interested, and having had a great deal of experience in drilling and mining petroleum and salt, I thought the problem might be solved if all the facts concerning the deposit were known. Unfortunately, all the drilling records had been colored by the people who expected to float companies—everything unfavorable was concealed, and only that given which would be likely to induce investment, so that what I had considered a correct report proved later to be entirely wrong.

Being misinformed as to the character of the deposit, I reached the conclusion that the sulphur was distributed in the rock as in Sicily, and when I heard of the limestone roof covering the deposit, I felt that sulphur could be found anywhere within reasonable proximity to the sulphur mine.

To meet the extraordinary conditions existing in this deposit, I decided that the only way to mine this sulphur was to melt it in the ground and pump it to the surface in the form of a liquid. After careful study and consideration, I became convinced that this could be done. In view of the information obtained from the various companies, I believed that there was sulphur over miles of territory, and started to drill on land I had purchased within a mile and a half of Sulphur Mine. I went down over 2,000 feet without finding anything, then I located a second, a third, and a fourth well, but found no sulphur in any instance. This took much time and money, and I finally reached the conclusion that all the sulphur was located on the land owned by the New York company operating it at the time. They had a very ingenious scheme for sinking a shaft with a shield, but after the expenditure of a great deal of money, the shield was lost, and the danger due to the presence of water containing hydrogen sulphide was demonstrated by the death of a number of men. It was decided to abandon this method, especially after a drilling record had been made by a drilling company who reported direct to the owners, when it was discovered that there was no roof over the sulphur, and that sulphur water was permeating the deposit in inexhaustible quantities.

I realized at the outset that a method entirely different from that employed in the mines of Sicily was necessary for success here, as the class of labor required to operate this mine would demand at least $5.00 per day, while the Sicilian miners were being paid 60 cents.

I succeeded in getting possession of the property and at once set to work to drill a well of sufficient diameter to determine finally the character of the existing material. When this had been done, I was obliged to modify completely the process and apparatus I had expected to employ.

At that time the drilling of a well in an alluvial deposit containing quicksand, etc., was a very tedious task, and it took from six to nine months to get through the alluvial material to the rock—work which we do now in three days.

I drilled a well through the alluvial deposit to the rock with a 10″ pipe, then continued through the sulphur deposit, which was about 200 feet thick, with a 9″ drill, and immersed a 6″ pipe from the surface to the bottom in this well. The 6″ pipe had a strainer only 6″ long, at the very bottom, and a seat to receive the 3″ pipe through which we expected to lift the sulphur to the surface. The 6″ pipe, directly above the seat for the 3″ pipe, was also perforated for a distance of three feet.

After the well had been drilled and before the pipes were inserted, it was filled up with sand in order to insure a tight receptacle at the bottom for the liquid sulphur. After the sand had been washed out, the pipes were inserted and equipped, and the well was ready for the melting fluid.

This melting fluid consisted of water superheated to 335° Fahrenheit. The porosity of the rock in which the melting had to be done seemed to furnish an almost insurmountable obstacle to success, as I feared that the wild waters in the rock would break into the melting zone I expected to create and reduce the temperature of the fluid with which I expected to melt below the temperature necessary to fuse the sulphur. I had supplied a large number of boilers to furnish the heat necessary to maintain in the well a temperature higher than that required for the fusion of the sulphur.

The water was superheated in columns in which 100 pounds per square inch pressure was maintained, and the apparatus which I had constructed to accomplish this proved very efficient. We used twenty 150 h. p. boilers for a well, which represents experimentation on a ponderous scale.

When everything was ready to make the first trial, which would demonstrate either success or failure, we raised steam in the boilers, and sent the superheated water into the ground without a hitch. If for one instant the high temperature required should drop below the melting point of sulphur, it would mean failure, consequently intense interest centered in this first attempt.

After permitting the melting fluid to go into the ground for twenty-four hours, I decided that sufficient material must have been melted to produce some sulphur. The pumping engine was started on the sulphur line, and the increasing strain against the engine showed that work was being done. More and more slowly went the engine, more steam was supplied, until the man at the throttle sang out at the top of his voice, "She's pumping." A liquid appeared on the polished rod, and when I wiped it off I found my finger covered with sulphur. Within five minutes the receptacles under pressure were opened, and a beautiful stream of the golden fluid shot into the barrels we had ready to receive the product. After pumping for about fifteen minutes, the forty barrels we had supplied were seen to be inadequate. Quickly we threw up embankments and lined them with boards to receive the sulphur that was gushing forth; and since that day no further attempt has been made to provide a vessel or a mold into which to put the sulphur.

When the sun went down we stopped the pump to hold the liquid sulphur below until we could prepare to receive more in the morning. The material on the ground had to be removed, and willing hands helped to make a clean slate for the next day. When everything had been finished, the sulphur all piled up in one heap, and the men had departed, I enjoyed all by myself this demonstration of success. I mounted the sulphur pile and seated myself on the very top. It pleased me to hear the slight noise caused by the contraction of the warm sulphur, which was like a greeting from below—proof that my object had been accomplished. Many days and many years intervened before financial success was assured, but the first step towards the ultimate goal had been achieved. We had melted the mineral in the ground and brought it to the surface as a liquid. We had demonstrated that it could be done.

This was especially gratifying as the criticisms I had received from technical papers and people who had heard of what I was attempting to do had been very adverse. Every one who expressed an opinion seemed to be convinced that this thing could not be done, one prominent man offering to eat every ounce of sulphur I ever pumped. A fair illustration of public opinion is the remark of the mail boy who drove me to the railroad the morning after our first pumping. He said: "Well, you pumped sulphur sure, but nobody believed it but the old carpenter, and they say he's half crazy."

This severe criticism, while not agreeable, did not carry very much weight with me. I felt that I had given the subject more thought than my critics, and I went about my work as best I could, thoroughly convinced that he who laughs last, laughs best.

At first we pumped with an ordinary deep-well oil pump, changed to meet the corrosive action of the sulphur. We experienced great difficulty with the valves in the pump, the high specific gravity of the sulphur, the great depth from which it had to be raised, and the corrosive action of the mineral itself making the maintenance of valves very difficult. Zinc and aluminum are practically the only two metals unaffected by liquid sulphur, but both these, being soft and easily disintegrated, would not withstand the shock at the change of stroke of the pump. I decided that if the specific gravity of the sulphur could be raised by the admixture of some other body much lighter, a point might be reached where the hydrostatic pressure of the water in the ground would raise the sulphur. Air seemed the most suitable, and we introduced compressed air into the column of liquid sulphur standing in the well, using a volume of two parts of air and one of sulphur. We have raised our sulphur discharge lines 70 feet above the ground, so that we can fill bins to a height of 65 feet without machinery or pump of any kind in the sulphur proper.

The first well lasted long enough to demonstrate the possibility of success, and to indicate in what directions improvements must be made. At that time, my sulphur enterprise was merely a hobby, the bulk of my time devoted to my Standard Oil work.

Many difficulties arose which we had not foreseen. We lost some wells because of the parting of the pipes. As the mineral was melted from the bottom, the earth above would follow as the sulphur rock settled. The grip of the sand and earth against the pipe was so great that instead of sliding, it would pull the pipe in two and the well would be lost. A 12″ pipe outside of the 10″, with stuffing box and telescope joints, obviated this difficulty. All wells, however, are eventually broken and crushed, when the abstraction of sulphur becomes so great that the cavity made cannot withstand the weight of the ground above it.

We succeeded in increasing the life of a well greatly by lining the hole drilled through the rock with a 9″ perforated pipe.

About that time we found that some wells gave out and ceased to pump when there had been no breaking of the pipes. I reached the conclusion that the cold sulphur water permeating the rock had broken into the melting zone, and brought the temperature of the melting water below the melting point of sulphur. I thought this might be remedied by pumping large amounts of a material like sawdust into the mine with the melting fluid, and that if the quantities of sawdust were large enough, the channels through which the wild waters in the rock entered the melting zone could be sealed.

One well, after pumping about 7,000 tons, at the rate of approximately 350 tons per day, ceased to produce. The pipes were all in good order, and we started to pump sawdust into the ground with the melting water. After pumping in about six carloads per day for five days, the well "sealed" with sawdust and promptly produced 39,000 tons more before the caving of the rock broke the pipes.

We perfected this method of artificially "sealing" the rock surrounding a melting zone, so that the amount now obtained from a well has been greatly increased. Whenever a well breaks, we shoot off with dynamite the 10″ pipe in the quicksand above the rock, and permit the sand to follow into the cavity from which the sulphur has been abstracted, filling up the space of the extracted sulphur rock with sand. The surface, consisting of about 200 feet of clay, follows the quicksand, gently but surely, and in order to maintain the pressure which is necessary to prevent the melting water from breaking into steam, the volume of the sulphur abstracted from below must be replaced by earth from above. To do this a dredge with a capacity of 4,000 cubic yards per day became necessary. Numerous reservoirs have been dug on the outskirts of the mine to supply the material required to do this. This filling has been going on constantly, and the ground has sunk to such an extent that where our house once stood is now 80 feet below the original surface.

These improvements were made slowly, as all experiments had to be made on a ponderous scale and the smallest change required a great deal of time. During the long intervals which necessarily elapsed between my visits to the mine, I could give this new enterprise no attention. It took months to drill a a new well when an old one was lost. At one time the work lay idle for a whole year before I could take it up again, and it was not until 1903 that we could see financial success ahead. In that year we produced 35,000 tons, and in 1904 enough to supply the entire consumption of the United States. It was in that year that we sent the first cargo of American sulphur to France.

In order to demonstrate what the mine could do with six wells, we pumped that number simultaneously for two months, producing 122,000 tons of sulphur, which is more than the consumption of the whole world for that period of time.

Prior to the development of the Louisiana sulphur mine, the sulphur production of the United States was less than one-half of one per cent. of its consumption, practically the entire amount required being supplied by Sicily and Japan. The former really had a monopoly of the sulphur business for a great many years. The Sicilian sulphur industry was closely interwoven with the politics of the islands, both internal and external. It was in 1833 that an English fleet appeared in the Bay of Naples to compel the Italians to rescind the sulphur monopoly that had been granted to France.

The ups and downs of the Sicilian sulphur business are extraordinary. The people, a large percentage of whom are employed in the mines, are very poor and used to be in the hands of dealers and usurers, who manipulated the sulphur market to suit themselves, and extremely high prices and extremely low prices followed each other as suited their convenience.

In England a process had been discovered for the recovery of sulphur from the waste products of the Leblanc soda process, quite a large amount of money being invested in the necessary machinery. When another sulphur crisis occurred in Sicily in 1894–5, and sulphur sold below the cost of production of English recovered sulphur, a number of English capitalists decided to finance and market the Sicilian output. They incorporated as "The Anglo-Sicilian Sulphur Company," and succeeded in getting between 75 and 85 per cent. of the Sicilian mine owners under contract for the entire output of their mines, whatever that might be, at a fixed price. This arrangement was made with the consent of the Italian Government for a term of five years, with the privilege of renewal for five years more. The scheme proved an excellent one, both for the Anglo-Sicilian Company and for the Sicilians. The former made a great deal of money, paying about 50 per cent. per annum on their common stock, and reserved large sums for contingencies. The contingencies arose in the form of the Louisiana sulphur production which came like a bolt out of a clear sky. They had received complaints from their agents here that the business in the west had diminished on account of sulphur furnished from a mine that was no mine at all, but where the sulphur came out of the ground ready to ship. The Anglo Company, as well as the Sicilians, declared that this was impossible, and that the whole thing was an "American swindle."

I was very anxious to get all the business possible, as our stock pile was much larger than our bank account, and I was surprised to hear that the Anglo-Sicilian Company had accepted a contract for 20,000 tons to be delivered in America, very much below the price they generally quoted, and not far above their cost. I decided to go to London and have a talk with them in order to find out if it would be necessary for us to put the price below their cost in order to maintain the American business which we needed very badly. I was perfectly frank and explained our position fully. I met with a great lack of enthusiasm for this "American humbug," and was told that they would go their own way, and I could go mine. I did. I had arranged for the sale of our sulphur in the various European countries, and knowing the production cost to my competitors, I succeeded very shortly in demonstrating that Louisiana sulphur was not a swindle. I found out afterwards that the lesson had cost the Anglo-Sicilian Company 285,000 pounds sterling—but then we were friends. Their attitude changed greatly, and they decided to go out of business and let the Sicilians and Americans take care of themselves.

The Anglo-Sicilian Company, especially during the last years of its life, had found it necessary to store a great deal of the sulphur tendered to them on their contracts, as they had lost the American market, which was their best customer, and it looked very much as though this enormous accumulation, approximating 500,000 tons, would have to be thrown on the market to be sold for whatever it would bring. To the poor Sicilian miner, whose lot under the most favorable circumstances is not an enviable one, this would have meant sulphur below cost, with the eventual closing of the Sicilian mines and misery and starvation to a large population.

The men well acquainted with the situation felt, as I did also, that this would result in revolution and bloodshed for Sicily. The laborers could not live on a wage lower than that which they already received. Frequent strikes and disturbances occurred when the misery of the working people was greater than usual.

Understanding the peculiar character of the Sicilians, the Government, when the matter was brought to their attention, decided to form an obligatory trust, so that no sulphur would be sold below cost, and the government was to finance the large stock on hand by issuing bonds and guaranteeing the interest. All the Sicilian sulphur mines were to be included in this obligatory trust, and the government agreed to advance, in cash, four-fifths of the value of the sulphur when it was received from the mine owners, the remainder to be paid to them after payment for the sulphur sold had been received and the expenses of conducting the business deducted.

A law creating this obligatory trust, which is known as the "*Consorzio Obbligatorio per l'Industrie Solfifera Siciliana*," was passed, and it has now been in operation since August 1, 1906. It has gone through the vicissitudes and occupies a unique position among the various trusts, which is of special interest to the United States. Here we have in successful operation a trust created by force, which all those engaged in that particular business are obliged to join. It has a board of thirty directors, an executive committee of ten, four of whom are members of the Government, and a Royal Commissioner, also appointed by the Government, who is practically its President. Prices are fixed and maintained, and sulphur is sold to all comers at the same figure.

This obligatory trust has been a godsend to the people, and so well are the Sicilians satisfied with its operation that they have already petitioned the Government to extend the period of its life beyond that originally decided upon. Moreover, the present Commissioner's able and wise administration has been so successful that the Sicilian stock of sulphur on hand and the obligation of the Consorzio towards the Government and the Bank of Sicily have been diminished to such an extent that the stock will be reduced to normal within two years and the Consorzio will be entirely out of debt. It is a striking illustration of the fact that a trust may be beneficial to all concerned. Great credit is due to the Italian Government for averting the misery which would inevitably have followed another sulphur crisis.

GEOLOGY OF THE SULPHUR AND SULPHUR OIL DEPOSITS OF THE COASTAL PLAIN.[1]

By CAPTAIN A. F. LUCAS.

In accepting the honor to make some remarks on the geology of the Great Calcasieu Sulphur Mines and the sulphur oil fields of the Coastal Plain, I have not done so because I consider myself a specialist, these subjects having been covered by far better pens than mine, but because the small part I played therein qualifies me in a small measure to join you in paying honor to a man who has through his ability, pluck and steadfastness attained international fame in solving a stupendous undertaking where many before him failed.

The geology of the sulphur mines and oil fields of the Coastal Plain is, of course, familiar to most of you, therefore I will only touch the subject by some practical observations, which through the success of Mr. Frasch have become of international importance and which makes me feel glad to be an American citizen.

America stands abroad as a great country and Americans as great men who do great things, men who, undaunted by failures of others, have undertaken and carried to practical solution problems that appeared foolhardy to undertake, and the success of this accomplishment must in all candor be ascribed to genius, especially so when this genius compels other nations to take notice and "willy-nilly" pay him tribute.

The geology of the Coastal Plain—which of course includes the mounds or domes—extends over a vast area, practically beginning at the northwestern coast of Florida for about 50–100 miles in width, and following the littoral zone of the Gulf States of Alabama, Mississippi, Louisiana and Texas down to Mexico and beyond.

This vast area is practically as level as a floor, with a slight dip toward the sea, and in traveling westward one comes upon slight elevations of say from 10-100 feet in height over the surrounding prairie. These elevations, which we will later on feel warranted in calling domes, are of limited area, say from 250–2,000 acres which have by now assumed wonderful economic importance.

It is, therefore, precisely of these elevations that we will speak, for they now form the basis of the whole economic geology of the Coastal Plain in the states of Louisiana, Texas and the Gulf States of Mexico.

To attempt to make soundings in search of minerals of economic value beyond this elevated zone is perfectly useless as the drill will only encounter the clays, sands and gravel of the Pleistocene Columbia series, then the red sands of the Neocene Lafayette series and deeper down the blue clays, "Gumbo" and sporadic laminations of limestone, at which time the driller (if he is lucky to have reached this depth safely) will be glad to pull out and call it done.

It is true, however, that at times these elevations are so slight that the "wild catter" often confuses them with the local phenomena of the ant mounds and feels warranted to drill anyway, and we have instances on record where he eventually hit the apex of a hidden dome as it happened for instance at Batsom Prairie, Texas, whereby he obtained economic results.

Undoubtedly there are more such hidden domes scattered over this vast area, and I make a passing reference to the possibility of their existence in order to point out the hazard of hitting any, as very great.

We will now proceed from New Orleans westward and come upon "Belle Isle," the first of a series known as the five Salt Islands.

They are called in sequence "Belle Isle," "Cote Blanche," "Grand Cote," "Petite Anse" and "Jefferson Island." The last named was the winter home of the late Joe Jefferson, the actor.

These Islands are of limited area, or from 250–1200 acres in extent and rise abruptly out of the surrounding marshes at an elevation of from 60 to 200 feet. They have all been explored and salt found thereon except "Cote Blanche."

On Belle Isle salt was found at 101 feet in depth and the drill continued in salt to the depth of 3,250 feet. Unfortunately, owing to its hardness at the bottom, it has been impossible to obtain drilling to

[1] Address delivered at the Perkin Medal Meeting, Society of Chemical Industry, Chemists' Club, Jan. 19, 1912.