

definitely die out. Men cannot nowadays keep slaves to work their gold mines as of old; but, always provided that they work upon the basis of proper geological surveys, the mining, mechanical, the electrical engineers, and the metallurgical chemists, with all the far-reaching fingers of their various sciences, can gather out the countless small particles of gold from the rock matrices, and pile them into the bank storehouses. Industry must be set off against industry; our future gold, got by well-directed industry, will represent the result of honest men's toil. Gold so obtained will reach a steady value; it will neither become greatly "appreciated" nor "depreciated," as the supply will constantly keep pace with the requirements of commerce; it will help to keep the countless mills of many different industries in continuous motion, without intermittent periods of fluctuating trade, and thus bring benefits to many people in all parts of the earth.

Mine Sampling.

The readers of the prospectuses of mining companies, of which there are at present no lack, are familiar with the phrase that "samples taken from the mine have been assayed by Messrs. So-and-So, and have yielded" so many ounces or pennyweights to the ton, as the case may be. Now, the name of the assayer is a guarantee that the samples submitted to him contained no more and no less than the amount certified. It is, however, in no sense a guarantee that the samples so tested represent the actual average value of the lode. This latter depends for its accuracy not only upon the sampler, the conditions under which the samples were taken, but also upon the quantity of the sample, and whether it was taken from a heap of ore already mined and accessible outside the mine, or from the lode itself as standing and exposed in the workings. Now the sampling of a heap of ore is of itself a difficult process, but with care and the exercise of patient skill, judgment and supervision on behalf of the sampler, and the absence of interested parties, a tolerably correct idea of its average mineral contents can be arrived at, and is, indeed, a common occurrence amongst mineral merchants, who keep men and appliances especially for this work. In the mining and smelting districts of America mills are erected solely for this purpose, and the whole process is automatic and mechanical. The ore is crushed in bulk—that is, in quantities of from 50 tons upwards—and as in the process of sampling its quantity is reduced, great care is taken to prevent any tampering with its quality, until, at last, a finely-crushed sample of a few pounds in weight is obtained, which accurately represents, by its mineral contents, that of the total amount operated upon. In short, it is a recognized rule that, unless the ore is thus treated in a sampling mill erected for the purpose at great expense, a correct idea of its value cannot possibly be obtained. In spite of all this, we are brought face to face with presumably competent men, who, in the course of an hour's ramble through a mine, knock off a stone here and there, and so pretend that they have procured an average sample of a mass of ore, amounting to many thousands of tons. The idea that such an haphazard way of doing business can afford any reliable data is, to us, so preposterous that we have long ago ceased to place any confidence whatever in the results so obtained. They are, in short, as likely to show on the one hand that the mine is too poor to work, as they are, on the other, to prove that it is a perfect Eldorado. Only by a most improbable concurrence of circumstances can they possibly give an accurate estimate of the value of the lode. Apart from the treatment of a bulk sample of several tons in a sampling mill, there is only one reliable method of ascertaining the commercial value of the ore—and that is, by milling a large quantity of it. If there is no mill on the spot, it is far wiser, and in the end cheaper, to go to the expense of conveying the ore to a neighboring mill than to risk the expenditure of public money on results obtained by crude, imperfect, and unreliable methods. In the case of a mine with a mill already at work, the duty is simplified; as, if it is not advisable to accept the results obtained by past operations, it is a comparatively easy matter to clean out the mill, and put through a hundred tons or so obtained from various parts of the workings. In the case of gold ores where Government returns of the bullion obtained in the past are usually available, it is not impossible to confirm the number of tons said to have been crushed in order to obtain that amount by measurements of the stopes, levels, and shafts from which the ore was abstracted, and so obtain the average yield per ton upon which it would be fair to base an estimate for the future. If these returns are available, and can be utilized for the purpose, it would be manifestly absurd to neglect or ignore them; and yet we have known of an expert under such conditions ignoring the past, and the milling returns actually obtained for several consecutive years up to the very date of his examination, and basing his opinion, to a large extent, upon a sample of a hundredweight or so of the ore obtained during a hurried examination, with the curious result that while his sample showed that there was no gold in the ore being treated, the actual milling returns for the same time yielded considerably over half-an-ounce to the ton.

In every well-managed mine the process of sampling is practically a continuous one, for in order to arrive at the difference between the amount of gold actually contained in the ore and that extracted from it by the milling operations, in order to ascertain the amount of loss, a careful and systematic sampling of the crushed ore, and also of the tailings, is a part of the routine of the day's work. This process is very clearly described in a paper read on April 21st last by Mr. A. C. Claudet, before the Institute of Mining Engineers. When dealing with the sampling of the ores and tailings at the Mesquital del Oro Gold Mine (State of Zacatecas, Mexico), he said that "as a general rule it is found that the gold extracted, added to that left in the tailings, approximates pretty closely to the assay of the ore before entering the batteries;" in fact, as we understand, there is rarely a difference of 5 p. c. between the two. This proves that the method of sampling is nearly perfect, even though it is not an automatic one, but is effected by taking a couple of shovelfuls of the crushed ore every two hours, just previous to its entering the feed hoppers. An iron bin is fixed between each head of five stamps and the sample is put into this, making four shovelfuls for each 10 head of stamps per two hours. At the end of each shift of 12 hours the bin is emptied, its contents well mixed and quartered down, the final sample from each 10 heads weighing about 20 lb. The whole of the battery samples are mixed together in the assay office, crushed down to the size of peas, well mixed and again quartered down until reduced to an amount of about 2 lb, which is the representative battery sample for the shift. A portion of this is assayed, and a portion kept to be mixed with all the other samples taken during a month's run so as to form the sample of the mineral crushed in the month. In like manner, a cupful of tailings from each battery is taken every two hours, and when dried forms the tailings sample, from which, again, a portion is taken to make the monthly sample. It is very evident that, if it requires a careful and long continued process like the above to arrive at the average value of the ore, it is practically impossible for the cleverest expert to obtain even approximate results by any less carefully conducted operation; while to expect to do so by merely dipping a shovel into an ore-bin is a farce, and is as likely to yield as valuable an idea of the contents thereof as the dipping of one's hand into a lucky-bag at a bazaar. Enough has been said to prove that, wherever possible, bulk samples only should be dealt with, and can alone give fairly accurate results. It will, however, sometimes happen, that there are no means of handling the quantity necessary,

and for many reasons it may be necessary to arrive at approximate results by simpler means, such as by sampling an ore heap and assaying the sample. The process seems simple, but it necessitates the cutting of a trench straight through the ore heap, the reducing by hand to the size of macadam, or under, and the quartering of the large sample so obtained. The reduced sample must now be crushed down still finer well mixed and quartered down again until the amount is reduced to 20 lb or so of ore. This may be still further reduced, but great precautions must be taken to prevent its being tampered with, as the insertion of a few grains of gold by any of the well-known dodges would vitiate the results.

The sampling of a mine itself is a long process, and will entail the cutting across of the face of the lode at regular and frequent intervals, the careful collection of the whole of the mineral so obtained, and the reduction of its bulk afterwards by the same system of crushing and quartering-down as before. If the ore occurs in rich shoots, then the samples from them should be kept separate from those of the poor ones, so that the extent and value of each may be known. Some experts say in their reports that "after picking out all pieces of visible gold the sample assayed," &c., but if the sample has been fairly taken it seems just as absurd to us to pick out the gold because it is visible, as it would be to take out the sterile pieces of quartz. In both cases the result would be unreliable as indications of the value of the ore. The sampling of a mine is by no means to be lightly undertaken; it is a most serious matter, and will require patient care and occupy many days; but seeing that the expenditure of large sums of money depends upon the results, we would enforce an opinion that the work should be entrusted only to well qualified men, and that they should be prepared to go minutely into the whole question, and spend whatever time on the spot which may be necessary to obtain reliable results.—*Mining Journal* (London).

The Spontaneous Combustion of Coal Cargoes.

The following excerpts are from a paper read before the Institution of German Engineers, by Mr. Hermann Pape, C.E. :—

The first part of the paper deals with the theory of the spontaneous combustion of coal in vessels, and in the second part the author propounds a method for the prevention of the danger. He arrives at the conclusion that the first and most important condition for an efficient protection of the coal cargo in ships is to prevent as far as possible the absorption of oxygen. This can be done either by shutting off the atmospheric air from the ship's hold, or by changing the surface of the coal so that during the voyage little or no oxygen is absorbed. Mr. Pape, after showing that it is practically impossible to prevent the absorption of oxygen by providing a neutral atmosphere in the vessel, proceeds to describe a new invention, which he claims to be suitable for removing in a most simple and safe manner all the difficulties which have as yet stood in the way of the effective protection of coal ships. This is the invention of Mr. Behnke, manager of a large chemical works in Germany. The process, upon which Mr. Behnke's proposals are based, is shown by the following experiment: If a glass vessel is partly filled with carbonic acid, and vapour of ammonia is brought into the vessel, the shell of the vessel or the surface of anything brought into the vessel is immediately coated with a thin white film. A closer investigation shows that this film consists of carbamate of ammonium ($\text{NH}_2\text{CO}_2\text{NH}_4$). If then some moisture is made to act upon the white film, the latter does not change its appearance, but its chemical constitution is altered. It is transformed into carbonate of ammonium $[(\text{CO}_2)_2(\text{NH}_4)_2\text{H}_2\text{O}]$ or sal volatile. If afterwards fresh carbonic acid is allowed to act upon the transformed film—for instance, by making up enough carbonic acid to maintain the same percentage in the interior of the testing vessel—the white coating is still further changed, finally bicarbonate of ammonium $(\text{CO}_3(\text{NH}_4)_2\text{H})$ being formed by the additional carbonic acid. If now the vessel, the shell of which is covered with the thin coating of salt of ammonium, is heated, there will appear an evaporation of this salt at a temperature of about 158 degs. Fahr., the vapour of the salt escaping quickly out of the vessel into the air and causing an odor of ammonia. By the foregoing experiment, the principal idea of Mr. Behnke's invention is shown. His process consists in providing in the ship's hold an atmosphere containing carbonic acid, and then forming the salt just described by the introduction of vapour of ammonia. This salt precipitates upon the coal at first in the form of carbamate of ammonium in very thin layers; later on it takes up moisture from the atmosphere between the coal and is thereby transformed into carbonate of ammonium, while finally, by excess of carbonic acid in the atmosphere of the ship, this salt is transformed into bicarbonate of ammonium. In this form the thin coating remains until the voyage is finished, and the presence of this coating is said to entirely prevent the absorption of oxygen. If, says Mr. Pape, the putting into practice of the Behnke principle is entertained, the question will at once arise as to the best way in which an atmosphere containing sufficient carbonic acid can be produced in the ship. This is proposed to be done by introducing gases obtained by the combustion of coke. By burning good coke the fire gases will contain 14 to 16 per cent. of carbonic acid, 0.5 to 4 per cent. of oxygen, 0.5 to 2 per cent. of carbon oxide, and 79.5 to 81 per cent. of nitrogen, and the combustion of 240 lb. of coke will furnish sufficient gases for filling up the whole air space in a cargo of 1,000 tons of coal. To ensure having an atmosphere charged with enough carbonic acid, it would seem desirable to introduce double the theoretical quantity of coke gases; hence every 1,000 tons of coal would require 480 lb. of coke. The ammonia necessary to form the salt already mentioned is introduced into the ship in the shape of liquid ammonia by means of the pipes used for the coke gases. The ammonia evaporates immediately after being released from the high pressure existing in the cylinder and spreads quickly through the coal. The quantity of ammonia required for the process will be, as is proved by trials made on a large scale, about 80 lb. for every 1,000 tons of coal. As to the combustion of coke, this can either be done in an auxiliary boiler or in a furnace built for the purpose. The introduction of the gases is effected by a fan. It is suggested either that ships should have on board a special coke furnace with fan, or that the application should be made while the vessel is still in the harbour by a tug boat provided with the necessary plant.

Machinery Foundations.

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The importance of a sound and unyielding foundation for machinery or other erections has long been realized, and at an early stage in the work of opening and fitting a new colliery, the engineer has to turn his attention to this subject. The first engine that is to be used in sinking a shaft requires to have a foundation previously provided for it. Boilers and chimneys; the permanent winding, pumping, and haulage engines; head-gear and screening plant all require foundations. In the present

* Paper before the British Society of Mining Students.