...CYANIDE PROCESS...

By Gerald Voss Hopkins, M. E.

Mr. Gerald Hopkins, M. E., the metallurgist in charge af the cyaniding plant at Silica, owned by the British Columbia Bullion Extraction company, delivered a most interesting and valuable address before the School of Mines on Tuesday evening. The full text of the address is as follows:

In testing gold ores with a view to their practical treatment by any particular process the main object is to arrive at a decision: Firstly, as to whether that particular process is the most suitable and economical one for their treatment, and if so, secondly, as to the best way to apply the process to secure the greatest profit from their treatment by it.

In the following notes I have endeavored to give an outline of a course of testing in connection with the cyanide process, applicable to the general run of ores, etc., but without attempting to meet the requirements of really exceptional cases, also a few remarks on the treatment of ores from a works standpoint.

Whatever the material to be tested happens to be, before proceeding to the actual testing, it is of course essential to find out by assay whether it contains sufficient gold or silver to pay the cost of treatment at all. No hard and fast line can be drawn in regard to minimum gold contents which will pay for treatment, this depends so much on the character of the material to be treated, and here I may mention that there are cases where ores containing little more than $2 in gold are treated by the cyanide process direct and yield a fair margin of profits.

If assays have shown the material to contain a reasonable amount of gold, the next step is to carry out a few preliminary tests, of which a determination of the quantity of acidity, if any, and the consumption of cyanide during short contact of the material with weak cyanide solution. With or without previous alkaline treatment according to results of acidity tests, are the most important—for the former 200 grammes of ore is made into pulp with a little water and the pulp tested, say with blue litmus paper; if this is reddened, soluble acidity is present and a weak standard soda solution is run in until neutral point is arrived at. After this, however, though the blue litmus is no longer reddened, red litmus may not be turned blue, by a slight further addition of soda solution, and in this case, soda is again run in until the pulp does turn red litmus blue, even after standing some time. This second quantity of soda is a measure that goes by the name of "latent acidity," and is due to the presence of various constituents which, though not acid to litmus themselves, have the power of combining with and neutralizing alkali.

If the material is found to be free from acidity, or only slightly so, 200 grammes are placed in a bottle with a similar quantity of weak cyanide solution and shaken for half an hour or so, and the cyanide remaining undecomposed determined; if this is not excessive the ore is generally passed as fit for cyanide treatment without any previous treatment.

If, on the other hand, acidity was found and the consumption of K. Cy. exceeded 0.15 per cent on the weight of the ore taken, (viz. 3 lb K. Cy. per ton of ore) it is necessary to subject the material to preliminary treatment in order to remove as much as possible of the cyanicides present.

From these preliminary trials, one can generally decide whether the material is fit for direct treatment or whether it requires preliminary treatment to remove as much as possible the cyanicides present.

Firstly—Class of ores, etc., suitable for direct treatment, from which the gold is readily extracted by cyanide solutions with moderate cyanide consumption in a reasonable time, and which are not exceptionally clayey:

Secondly—Class of ores, etc., which are not suitable to direct treatment, but which require preliminary treatment—from which the cyanide process, if applied direct, under normal conditions, does not effect satisfactory extraction of the gold, or in the treatment of which the consumption of cyanide is abnormal, or which are exceptionally clayey, etc., etc.

Having broadly classified the ores, etc., the following is an outline of the methods usually adopted for their examination: The material belonging to the first class is crushed to several degrees of fineness—a part through a 30-mesh sieve—a part through a 40 and a part through a 60. A series of percolation tests are then carried out on these various portions, using cyanide solutions of selected strength. The usual strength for this class of material is from 0.1 to 0.5 per cent and the quantity employed varies from 1-3 to one part for each part of the material to be treated.

The course of the experiments is followed by assaying an average sample of the material as charged into the percolator, and from time to time assaying and testing the solutions. The percolation may be by upward and downward flow or entirely by downward flow. For small trials, however, especially on dry materials, it is best that the first passage of the material should be upward and thereafter downward—say once each 24 hours for the remainder of the trial, as by this method channeling is best avoided and a uniform flow of solution between the particles more or less insured.

The normal time of treatment is three to four days, but if the extraction is not fairly complete in that time it is prolonged until such is the case.

Sometimes a better extraction is obtained by a double treatment, i. e., after the treatment has proceeded for a certain length of time, the residues are washed, discharged, recharged to the procolator and treated a second time with fresh solution.

The apparatus required for making these tests is of the simplest description. A large lamp glass, closed with a perforated rubber cork, fitted with a piece of glass tube, which is further lengthened by two or three inches of black rubber tube, which in turn is entirely or partially closed by means of a screw clip.

The lamp glass is provided with a false bottom of asbestos, or a thick disk of sponge of good quality, covered with coarse muslin serves very well; or a sound barrel cut in half would do, one of which as the percolator is fitted with a false spar bottom covered with a filter cloth; and the other as the receiver, may be smaller without a false bottom. The percolator is fitted with a hole in the bottom under the false bottom, this is fitted with a rubber bung carrying a piece of glass or iron tube, to which is attached rubber tubing provided with a screw clip. For upward percolation the tubes of the two vats are connected by a piece of glass tubing and the method of using the apparatus is obvious.

Sometimes a better extraction is obtained by a double treatment, i. e., after the treatment has proceeded for a certain length of time, the residues are washed, discharged, recharged to the percolator, and treated a second time with fresh solution.

If the material under examination consists of tailings, etc., it is advisable to try in the first instance to obtain satisfactory extraction from it in the condition received, so as to avoid regrinding; if this is impacticable the material should be graded and the various gradings assayed to locate the gold, as frequently the gold is found to be locked up in the coarser particles of the residue; on these being finely ground, a further trial often proves satisfactory.

If the material is rich—such as concentrates—the treatment, if by percolation, is often prolonged to a month or so. It is sometimes the practice to treat such material by the quicker agitation method, but if percolation, even if prolonged, gives a good extraction, it is usually found more economical.

Experiments carried on as above will give sufficient data for a decision as to the best general conditions under which the process should be applied for their treatment in practice.

Second—Class of ores not suitible to direct cyanide treatment, but requiring preliminary treatment require a more searching investigation. It is impossible to enumerate the possible characteristics of the materials which tend to cause direct treatment of them by cyanide unsatisfactory. The following are, however, those most commonly met with:

A. A considerable portion of the gold exists irregularly distributed throughout the materials as comparatively large particles, or in case of tailings, large particles of amalgam are left in them.

B. Some base constituents of the material exist in a form which is readily attacked by cyanide, causing abnormal consumption and simultaneously with this, soluble sulphides are formed, which seriously retard the solution of the gold and silver.

C. A considerable part of the gold exists in combination with antimony, tellurium, bismuth, etc.

D. The material is clayey or slimy, so as to prevent or seriously retard the filteration of the solution through it.

Class A.—Ores, etc., of this character are first treated with mercury, to remove the coarse and amalgamable gold by any of the well-known methods, or subjected to concentration. This is often adopted in treating tailings, and in this case tables are used. The residues are then treated either by percolation or agitation method of applying cyanide, and if the only difficulty to direct treatment comes under this heading, the effect of double treatment is usually satisfactory.

In addition to the above treatment the combined treatments can be carried out simultaneously with mercury or amalgamated copper plates and cyanide.

In case of float gold it is sometimes found preferaole to treat first by cyanide and the residue by amalgamation methods.

Class B.—Apart from the abnormal consumption of cyanide caused by the materials being acid, a condition arising from the weathering of contained pyrites, and which in such case is generally prevented by preliminary alkaline treatment, the usual trouble is the presence of certain compounds of copper, iron, etc., and the physical condition in which they exist.

Abnormal consumption of cyanide is usually coupled with poor extraction and the formation of soluble sulphides.

The method of determining the cause of the cyanide consumption as usually employed is to examine the solutions: (1) for cyanogen compound; (2) carbonates, oxalates and sulphides; (3) the bases in solution; (4) sulphides in solution; (5) alkalinity.

The general methods of procedure with ores containing cyanides is to subject the material to a water washing which will remove the soluble metallic salts, followed by a washing of dilute caustic soda to eliminate basic salts of iron. If this is not efficacious free washing, stimulating Spitzkastin treatment, floating off the bulk of the oxides and hydrates which are present; by this method the light pyritic slimes are also removed which will often considerably reduce the cyanide consumption. This is not entirely due to soluble salts so eliminated, but in part to the removal of the actual slime particles, which owing to their high state of division, are more chemically active as destroyers than the mass of comparatively slowly acting and compact ores, and in the last case acid treatment may be required. This is quite effective and practical where copper exists as carbonate.

In certain cases, without the cyanide consumption being really abnormal, sulphide has been formed in solution to a sufficient extent to seriously retard or prevent the extraction of gold or silver; in such cases the addition of certain insoluble compounds of lead such as oxides, carbonates, and ferru, cyanide, etc., which decompose soluble sulphide is often found very beneficial. Such addition is also found to increase the extraction of suver when existing as sulphide.

Class C.—Material of this character is often met with. Occasionally ores consisting entirely of sribnite are found containing gold, and although the cyanide process, applied under normal conditions would fail, yet if the ore is exceptionally finely ground and then agitated for more or less prolonged period, with solutions somewhat stronger than usual, the gold is removed and the consumption normal.

In ores containing only small quantities of antimony telluium in which only a portion of the gold is locked up, a preliminary roasting at a moderate heat is otten effective in rendering the gold completely soluble.

Arsenic, although in many of its properties similar to antimony, does not have the property of combining with gold. Cyanide, is generally efficient in extracting gold from arsenical pyrites as from iron pyrites.

Copper when present in ores generally attack the cyanide forming cuprosocyanide of potassium. Cu. 2, Cy. 2, 2 Kcy. Sometimes ores containing a high percentage of copper in form of sulphides physically in a hard condition has little action on cyanide and but traces are dissolved.

Zinc in ores occasionally is dissolved by cyanide forming double cyanides of zinc and potassium. Zn. Cy. 2, 2 Kcy. nowever, many of the compounds of zinc existing naturally in minerals resists the action of cyanide.

Class D.—Materials of a clayey character present often simply a mechanical and not a chemical difficulty. In certain cases Dehydrating heating brings the material into a condition allowing ot its treatment by ordinary percolation methods within reasonable time.

The method now most generally adopted consists broadly of agitation of the slimes for a short time with cyanide solution and then allowing the solid particles to settle through a comparatively large volume of very weak solution, decanting the supernatant gold solution and if necessary washing the pulp in a similar way by settling and decantation.

Having now determined the best method for the treatment of the auriferous material under examination, it is necessary to consider the type of plant in which it is to be carried out.

A plant usually consists of percolators, reservoirs and extractors, sometimes agitators are added. In considering the general design of a plant it will be necessary to provide sufficient percolators to carry out operations in accordance with the method laid down as result of previous investigations. Thus, if necessary to percolate and wash for two days and a half, and half a day is occupied in filling and emptying the percolators, it is obvious that one vat can only have a fresh charge once in three days, therefore a 50-ton per day plant will require three percolators of 50-ton capacity and an additional one for contingencies.

Agitators: These, if used, are worked on day and night shifts and are thus capable of treating three charges per diem of 1.3 ton agitator charges, thus a 50-ton per day agitator plant running on material requiring six hours agitation would comprise seven agitators of about three-ton capacity, treating three charges per day and three 50-ton percolators.

Reservoirs: These should be of sufficient capacity to contain at one time all the solutions, strong and weak, in circulation in the works. As a general rule reservoir accommodation is provided equal to one-third of the cubical contents of the tanks.

Extractors: These are long boxes or troughs containing the prepared zinc and so arranged that the gold cyanide solution is forced by baffle boards to pass through a considerable amount of zinc before it leaves the extractor.

They are generally constructed with 10 zinc compartments, each of such dimensions that the amount of solution to be treated may flow up through the zinc easily and steadily.

In practice, each compartment is designed to hold about one cubic inch of zinc for every ton per month treated. Thus a 50-ton plant treating say 1500 tons per month would have extractors with compartments of such size as to contain about 1500 cubic inches of prepared zinc.

Pumps: This is required to raise solutions from the sumps to the upper reservoir or to percolators, a six-inch centrifugal works well on such a plant.

Settling Tanks: These tanks are used to collect the slimes during the clean-up.

Lathe: This is generally an ordinary six-inch wood turner's lathe on which the zinc shavings are turned by hand.

Pipe Lines for Solution Residues, Launder, etc., to make up the plant.

Summary of treatment consists in—

1. Passing an alkaline solution or caustic wash through the ore to point of saturation. The strength of this first alkaline solution may be 0.15 per cent cyanide and it may contain up to 8 ounces caustic soda per ton of solution.

2. The Strong Cyanide Solution: This solution varies from 0.3 to 0.5 per cent in cyanide to suit the richness and nature of ore or tailings under treatment, and the proportion of this solution should not be less than one-third weight of charge in vats.

3. Weak Solution: After the strong solution has been run on we may assume most of the gold is in solution. The object of the third operation is to wash out the dissolved gold, therefore the weak solution containing 0.15 per cent Kcn run on till erate solution of the gold by having potential cyanogen always ready at hand to effect the formation of the aurous cyanide necessary for the soluble double salt of gold and potassium. The maximum strength of bromo cyanogen leaching liquor must not be passed if the strength of 5 per cent Kcy plus 0.25 BrCy be exceeded there is a tendency to decomposition of the joint solvent.

Recovery of Gold from Cyanide Solutions.

Zinc precipitates the dissolved gold, as the cyanide has more affinity for it than for the gold.

Two K An Cy2 plus Zn equals 2 An plus K2 Zn Cy4.

As already mentioned, it is used in form of shavings in extracting boxes or troughs; it is also used in form of fumes; these fumes are generally treated by sal ammoniac or other solvent to render them active. The precipitation takes place in an emulsion tank fitted with a coned bottom, which is half filled with these fumes; the gold solution enters at the lower apex of the tank, and so rises through the zinc fumes. Gold is also recovered by electrolysis in the Siemens Halske process. Thin sheets of lead are used as kathode and an iron anode. The gold is only recoverable after a further operation of smelting and cupellation. Sherard Cowper-Coles substituted an aluminum kathode for a lead one. This enables the gold to be obtained as a pure gold.

The Pelatan Clerici process hardly comes under this heading as it combines the two processes at the same time, namely, the solvent action of the cyanide is going on simultaneously with the precipitation of the gold by electrolysis. The kathode here used is an amalgamated copper plate covered with mercury, and the anode are revolving iron plates.

the total quantity of solution and washes represents 75 to 80 per cent of weight of ore.

Precipitation: The cyanide solutions containing gold then flow through one or more precipitation boxes.

Clean-Up: Before collecting the gold slimes, fresh water is allowed to flow through the extractors, until it is no longer decidedly alkaline. The zinc shavings are now rubbed to disentangle the gold slimes. The pulp is then withdrawn, the gold slimes flow into the launder and down to a 40-mesh sieve. To the sieve is attached a twill bag like a pillow case. The gold slimes pass through the sieve; the zinc remains behind. As soon as the extractors have been cleaned or the filter bag is full it is hauled up, squeezed to press out any liquid, and contents dumped out on a heated iron plate on which they are dried. The fineness of the sieve used makes a great difference in the purity of the bullion, a coarser sieve gives a baser bullion.

Fusion of Slimes: This is generally done in plumbago cruicibles Nos. 35 and 50 in a wind furnace, the fluxes usually employed are half their weight in borax and about one-tenth of sodium carbonate.

Having given a summary of the cyanide process, pure and simple, I will just add a few remarks on some modifications of this process.

Messrs. Sulman, Leed, in the bromo cyanide process, recognizing Elsner formula:

Four Hcy plus An2 plus H20 plus 0 equals 2 (K An Cy2) plus 2 K H O. And believing the slowness in cyanide action is due to the difficulty of being dissolved oxygen atom by atom to bear upon the molecular point of attach, they proceed to replace the oxygen by a halogen in practice, they use the halocyanogen BrCy and claim to enormously accel-

GREAT METHODIST CONVENTION.

Epworth Leagues and Sunday Schools to Meet in May.

The ninth annual convention of all Methodists leagues and schools in British Columbia will be held at New Westminster, beginning Thursday, the 18th of May, and close on the Sunday following. Each Epworth League is entitled to send one delegate for each 20 members or fraction of 20 enrolled and each Methodist Sunday school one for every 50 or fraction of 50 of all officers, teachers and scholars enrolled. A number of valuable papers will be read, one of which on league work will be from Rossland. The district representative from Kootenay is Rev. G. H. Morden, who while pastor of the Methodist church here, is stated on the circular to be of Nelson.

Will Return Soon.

From a letter received by James M. Martin, M. P. P., it is is considered probable that John Kirkup, the gold commissioner, will soon return home. The letter is from the minister of mines, and states that in view of Mr. Kirkup's speedy return, it is not deemed necessary to make any temporary appointment to the position.

THE RIFLES HAVE ARRIVED

Soon the Members of the Rossland Company Will be Drilling.

Uniforms Are Now Finished, and Will Follow the Rifles Very Shortly.

The rifles for the Rossland company of the Kootenay rifles have arrived in the city and are now in the office of Captain P. McL. Forin. They are of the latest improved Lee Enfield type, and are provided with two sights, one of which is adapted for ranges from 200 to 1,700 yards, and the other from 1,700 to 2,800 yards. The magazine will hold eight or ten cartridges, and the arrangements for recharging the magazine are of the simplest kind. In the stock there is a chamber containing a can of oil, a cleaner and some other useful articles. Where the left hand grasps the barrel there is a strip of wood that prevents the heat of the barrel from causing any inconvenience to the riflemen. The rifle is lighter than the Snider rifle, and the stock is a little shorter, bringing the sight a little closer to the eye. Those who have tried them say they shoot very easily and there is but little kick or recoil in them.

The bayonet is a new and somewhat shorter one than the old ones, but is a very formidable weapon. It is attached to the rifle very easily, needing only to be slipped on, when it attaches itself with a spring automatically, and can just as easily be removed. The weapon on a whole is a vast improvement on those that have been heretofore used by the militia force of Canada.

The uniforms for the company have been ordered, and it is understood, though not positively known, that they were already on the way. Just as soon as they arrive here they and the rifles will be served out and the first drill will be held. This will be in the skating rink, as in the articles of incorporation of the Skating Rink company, that is provided for. It is now only a question of a few weeks, and before the dust flies, the Rossland rifles will be parading the streets, headed by their band.

Speaking of the band, it may be necessary for the citizens to provide the military uniforms for the band by subscription as the militia department only provides for one band in a battalion, but the people of Rosland will not be likely to object to furnish them, but will probably take a pride in having the members as handsomely uniformed as any in the Dominion.

SPREADING ITSELF.

Financial Arrangement for the "Soo" Line—The Corbin Charter.

New York, April 8.—The Canadian Pacific is spreading itself. Yesterday's announcement that it would cut transcontinental time 10 hours, was followed today by the annuoncement of a big financial arrangement which will enable the Soo line to devote its net earnings to the payment of its interest charges, and at the same time to repay in annual installments the interest which has been advanced by the Canadian Pacific. Its improved earnings justify the belief of the Canadian Pacific directors that it will not only be able to do this, but to make a return on its capital stock, of which the Canadian Pacific holds more than one-half. The total advances to the Soo by the Canadian Pacific up to date amounts to $1,521,664, while the expenditure for equipment, terminal facilities and general improvements during the years in which these advances were made foot up $1,748,041.

The Canadian Pacific has authorized the following expenditures: Improvements of permanent way, $1,150,979; for additional station yard and terminal facilities at Montreal, Vancouver and other points, $788,187; for the completion of air brake and automatic coupler equipment, $305,010; for branch lines to mines in connection with Crow's Nest Pass line, $300,000; rolling stock, $1,000,000, as the traffic of the company may require.

It all goes to show how well the Canadian Pacific is fortifying itself. Its American competitors will at no point get ahead of it very much. It is as strong in Canada as ever, and there is apparently no chance of a charter being granted for the so-called D. C. Corbin project in British Columbia, in which the Great Northern is supposed to be most interested at this time.

Granite and Syenite.

Granite and syenite look much alike to a casual observer. They cannot be distinguished by the texture. The essential constituents of granite are quartz, orthoclase (potash) feldspar and mica, either black or white. This is simple granite; but in this rock also occurs numerous other minerals, most of which cannot be distinguished without the aid of the miscroscope. Syenite consists of orthoclase feldspar and hornblende—quartz not an essential constituent, but often occurs. Diorite differs from the above in the character of the feldspar. Its essential constituents are hornblende and plagioclase (soda-lime) feldspar. When quartz occurs it is called quartz- diorite, and when mica is present, as well, it is known as quartz-mica-diorite. Magnetite often occurs so abundantly in the fine-grained varieties as to give the rock a black color. Diorites range in color from light gray to green and black. Typical rocks are rare. They usually graduate from one variety to another, and the name is usually applied in consideration of the most prominent constituents. In California the granite of the Sierra Nevada contains the essential constituents of both typical granite and typical diorite—hence the name grano-diorite. Phonolite is usually rather fine-grained, dark and compact, and when struck gives out a ringing sound. It would be impossible to identify the rock without a great deal of knowledge of the rock-forming minerals. In the Black Hills' phonolite the principal constituents are nepheline, sanidine ,aegirine, noselite and sodalite—minerals familiar only to students of petrography. Porphyry is a name employed to designate a rock having distinct crystals occurring in a ground mass of finer grain, as quartz porphyry and granite-porphyry, meaning a granite of even grain, in which occurs large crystals of feldspar. Porphyry does not mean any particular kind of rock, but has reference to the structure only.

A Flexible Currency Based on Gold.

New York, April 8.—A declaration for a flexible currency, based on the gold standard, was adopted today by the executive committee of the Indianapolis monetary conference. The meeting of the committee was held at the chamber of commerce of the state of New York, and was called by the chairman, H. H. Hanna of Indianapolis, for the purpose of getting the advice of the committee upon the recommendation to be presented to the republican caucus committee of the house of representatives, which meets at Atlantic City on April 17th.

A NATURAL RESULT.

Farmer, Wife and Daughter Killed by Dynamite Explosion.

Veedersburg, Ind., April 8.—The wife and daughter of John Carrington, a farmer, living about eight miles west of here, were killed by a dynamite explosion. Carrington had placed about 75 pounds of dynamite under the stove to thaw it. He went out to prepare to use the explosive, when it exploded and blew the house into ruins.

Will Operate the Ennismore.

The Avon Mining & Milling company is equipping a force of four men, who will start tomorrow for Burnt Basin to commence development work on the Ennismore, a claim which is said to be one of the very best in that district.

The Fire Hall's Telephone.

A new telephone has been istalled in the fire hall, on Lincoln street, and Chief Guthrie will see to it that alarms are answered from that as well as the regular alarm. The telephone, which is numbered "100," will, he expects, be a useful auxiliary to the fire alarm system.