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CIRCULATION.

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CONTENTS.

GENESIS OF BUTTE COPPER ORES

Mr. Reno H. Sales has prepared for the Butte meeting of the American Institute of Mining Engineers a very thorough description of the ore deposits at Butte, Montana. The general geology of the district, structural features, rocks, rock alterations, superficial alterations of the veins, ground-water, mineralogy of the veins, the ores, vein systems and genesis of the ores are discussed. The paper is accompanied by a series of instructive maps, which show the structural relations of the veins and fissures, important areas of rock alteration and distribution of ore shoots.

The origin of the deposits is believed by Mr. Sales to have been in the granite magma.

"The original source of the ores at Butte was the granite magma. Quartz-porphyry dikes formed a local closing phase of the igneous activity connected with the intrusion of the parent rock, and these dikes structurally and areally are in such close association with the ore deposits that they appear to be a direct factor in the localization of the ores. Heated waters and gases escaping from the cooling magma were the carriers of the metals to their place of deposition. The elements thus transported and deposited in the veins were cilicon and oxygen as SiO_2, sulphur, iron, copper, zinc, manganese, arsenic, lead, calcium, tungsten, antimony, silver, gold, tellurium, bismuth and potassium. Small quantities of potassium are believed to be added to the granite in the sericitization process. Other elements, as sodium, calcium, and manganese, were undoubtedly carried by these solutions, but, as shown by analyses, they were extracted from the granite in the alteration process instead of being added as in the case of the first-named elements.

"The chemical composition of these ascending waters varied in significant particulars as the process progressed. The granite wall rock was decomposed, furnishing much sodium, calcium, and possibly magnesium to the solution. Iron was also freed from the iron minerals of the granite to form pyrite with the sulphur of the invading waters. These interchanges affected the solvent capacity and character of the ore-bearing waters by the subtraction of the acid radical sulphur and the addition of alkaline radicals. While hydrogen sulphide and acidic conditions may have prevailed at the initial stages of ascent, the waters would tend to become alkaline through interaction with the wall rock. Along circulation channels, however, this action would gradually become less pronounced after a barrier built of sericitized granite had been formed bordering the fissures, thus protecting the solutions from further reaction with the fresh

granite, and permitting the acidic conditions to ascend to higher horizons. Also, the earliest vein minerals, chiefly quartz and pyrite, would tend to insulate the solution from the granite. And finally, increasing alkalinity of the solutions and lower temperature would lessen action on the granite at points further removed from the central source.

Applying the above reasoning to the facts of ore occurrence, it is found that chalcocite as a primary mineral is the latest important copper sulphide of the ores; it is, moreover, found only in association with the highly altered phases of the granite. From these facts the conclusion may be drawn that under the geologic conditions existing in Butte, the more acidic conditions were necessary for the deposition of this mineral. Similarly, enargite is associated with highly sericitized granite, and is therefore believed to have been deposited only under certain conditions pertaining to the temperature and relative alkalinity of the solution.

"Sphalerite, rhodochrosite, and galena are increasingly abundant toward the intermediate and peripheral zones, suggesting their formation under lower temperature conditions with relative high alkalinity. Quartz and pyrite are everywhere present, and evidently are formed under all conditions. Pyrite is more abundant in the central and intermediate zones than in the peripheral zone. Quartz is more prominent as a gangue mineral in the peripheral zone than elsewhere.

"Structurally there is no good evidence for distinct periods of mineralization in the Butte veins. It is here held that there was but one period of mineralization, varying in intensity, possibly, from time to time, with important changes in chemical character of solutions. But the mineralogical difference in vein material of the central, intermediate, and peripheral zones can be adequately explained, it is believed, by the reasoning herein set forth, which assumes that the copper mineralization indicates high temperature and acidic conditions versus lower temperature and alkaline conditions as the solutions migrated toward the peripheral fractures now represented by the manganese-silver veins.

"Concerning the formation of chalcocite there is much geologic evidence, mainly structural, to support the theory above outlined, which assigns to this mineral a primary origin from deep-seated waters."

The subject of chalcocite formation is of exceptional interest and is given special treatment by Mr. Sales. He does not agree with Mr. Weed, who considers the Butte chalcocite to be secondary.

"W. H. Weed has set forth some facts which, in his opinion, tend to prove the secondary origin of the Butte chalcocite. He observes generally that the old quartz-pyrite veins were originally of very low grade and they became commercially valuable through the later addition of enargite, bornite, chalcocite, and other copper minerals. He believes that this copper mineralization followed various periods of faulting, the enargite and bornite being the first to appear, probably contemporaneous in a general way with the Blue and Steward fault system. Chalcocite, which forms the bonanza ores of the district, is thought by him to have been almost entirely a product of descending sulphide enrichment processes, acting at great depths, however, only where the older quartz-pyrite veins were crackled and broken by faults, thus permitting a ready passage for the downward-seeping waters. He cites many examples of such intersections of faults and older veins in support of this view, and maintains that the old quartz-pyrite veins are workable only where thus fractured.

The writer's own observations do not confirm Weed's conclusions as above outlined. Actual examination of a great many intersections of old quartz-pyrite veins by later faults have shown conclusively that as a general proposition the east-west veins are no richer at or near intersections with Blue vein faults than at other points along the vein except in cases where the fault vein ore shoots cross the older vein. It is extremely difficult to form even an approximate idea as to the extent of primary enrichment in the older veins due to the late faults of the Steward system. Mineralization processes were active in the early veins prior and subsequent to the Blue vein period, so that it is impossible to determine, in the absence of any characteristic minerals, what influence was exerted by the later faults upon the older veins. As might be expected, the fault vein intersections are usually accompanied by a breaking and shattering of both the older vein and the country rock in the immediate vicinity, thus developing favourable factors tending to greatly influence ore deposition at such points. In any case, where a chalcocite enrichment of a vein of the Anaconda system is shown to have resulted from the influence of an intersecting fissure of the Blue or Steward system there remains the strong probability that such enrichment is due to primary waters, if, as believed by the writer, the primary chalcocite was deposited in great quantities, after the appearance of these faults, not only within the faults themselves, but in the fractured older veins."

ASBESTOS MINING

The Black Lake, Thetford and adjoining districts in the Eastern Townships of the Province of Quebec, produce about 90 per cent. of the world's supply of asbestos. The industry is a large one; but of late years the financing in connection with the merging of several of the companies has brought it into well deserved disrepute. Overcapitalization accompanied by over production of the mineral, brought trouble to both those who were responsible for the manipulation and to those who were conducting their business on a sensible basis. The market did not absorb the un-

called for increase in production, and prices fell to unnatural low levels, when buyers discovered that the sellers were over-stocked.

Reorganization and saner methods of conducting the business have happily resulted in bringing the industry recently into a much improved condition. A good and steadily increased demand is being found for asbestos. New uses are being found for the lower grades, which are more difficult to dispose of than the long fibre. To-day the mines are busy and the outlook is bright. It is to be hoped that the lesson has been learned. Naturally the industry should become yearly a larger one. The reserves of mineral are enormous, and the uses are rapidly increasing.

SUDBURY-COBALT-PORCUPINE EXCURSION

Continued from Aug. 15th Issue

The A3 excursion train of the International Geological Congress arrived in Cobalt Sunday evening, July 27th. In the morning a trip was made on foot to visit exposures in the vicinity of Cobalt and Cart lakes. The first stop was made at the Little Silver mine, where one of the first discovered veins has been worked out. The old workings give a very good idea of the structure of the silver deposits, and of the sedimentary rocks, which comprise the Cobalt series. A narrow vertical vein has been removed by mining just enough of the rock to allow the rich ore to be taken out. It was worked before concentrators were available, and only high-grade ore was saved.

The rocks in which the opening was made are, in ascending order, a well laminated mud rock or argillite, a gray quartzite and a massive conglomerate, containing pebbles of numerous types or rock, granites being especially noticeable. The Cobalt series has usually some conglomerate below the argillite, but the exposure in Little Silver cliff does not show the lowest part of the series. A photograph of the exposure was reproduced in the August 1st issue of the Journal. Near the base of the hill there is a fault displacing the vein a few feet to the south.

A short distance from the Little Silver vein, close to the T. and N. O. railway track, exposures were then examined, which show the conglomerate which forms the base of the Cobalt series lying on Keewatin rocks. All such exposures were critically examined by those interested in the origin of the Cobalt conglomerate, and proved productive of much discussion on the probable glacial age in Huronian times.

The Provincial Mine.

The party next visited the Provincial mine, where Dr. Miller told of Ontario's experience in the mining business. At the time when silver was first discovered at Cobalt, a large section, known as the Gillies' limit, lying south of the Nipissing property, was not open to prospectors. The Government had sold to lumbermen the timber on this property, and it was not considered fair to the purchasers to allow prospectors to work there until the timber had been removed. Owing to its location, the northern portion of the timber limit was considered very valuable mining property, and the problem of disposing of it properly became a vexatious problem. The Government decided to prospect on its own account, and in 1906 Dr. Miller, the Provincial Geologist, was given charge of the work. Much of the area was found to be of little value, but finally a very promising vein was discovered. Having assumed the role of prospector, the Government now undertook to do some mining, and the then inspector of mines, Mr. E. T. Corkill, was given charge of the mining operations. Some rich ore was taken out; but the development work showed that the deposit was much leaner at depth, and the mine was never a large producer. The Government then sold the mine and several adjoining lots by tender, and went out of the mining business.

From the Provincial the party proceeded along the shore of Cart lake. On the rock dumps at the south end of the lake, the conglomerate was found to be not strongly cemented and pebbles were easily freed from the matrix. Numbers of them were examined for possible glacial markings, and a general discussion of the causes of striations on pebbles ensued.

Diabase Contracts.

The party next visited an old adit driven in at the base of Diabase mount at the contact of the diabase sill, with the underlying argillite. Dr. A. C. Lane was especially interested in this exposure, and took several specimens of diabase from measured distances to study from the standpoint of his theory of the grain of rocks.

The party then turned north to Peterson lake, where Dr. Miller pointed out exposures of diabase lying on the older rocks near the west shore of the lake. The several exposures give unmistakable evidence of the sill-like character of the diabase mass.

Exposures on the Nipissing Property.

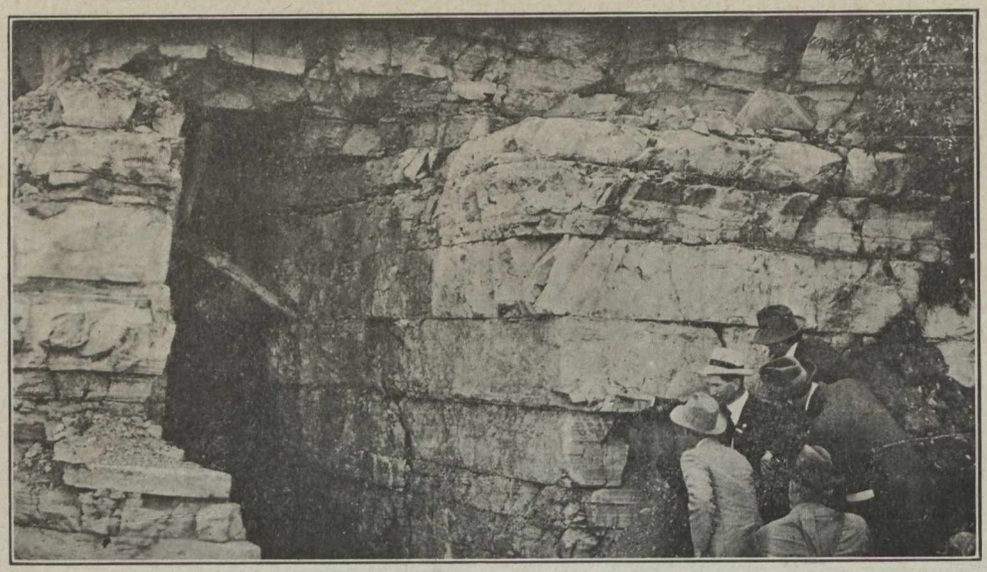
In the Keewatin rocks, Mr. Knight pointed out lawprophyre dikes, which have a decidedly conglomerate appearance, owing to the enclosure of numerous fragments of lighter coloured rocks.

A large portion of the Nipissing property has been washed clean of debris, and presents numerous excellent exposures of Huronian and Keewatin rocks. Near the pumping station on Cobalt lake, some of the party were shown excellent exposures of ripple marked quartzite overlain in places by thinly laminated argillite, and in other places by argillite containing numerous large boulders, some of which lie almost immediately upon the ripple-marked surface. The most evident explanation here is that the conglomerate has been formed under water in which fine silt and sand were accumulating while icebergs dropped numerous boulders.

Visits to Timiskaming, Crown Reserve and Coniagas Mines.

In the afternoon, the party was divided into three groups, and the Timiskaming, Crown Reserve and Coniagas mines were visited. At the Timiskaming a rich shoot of ore has recently been taken from the diabase, which here underlies the Keewatin rocks. The 650-foot level was visited to allow examination of this vein.

At the Crown Reserve mine some typical high-grade veins were seen, and Mr. Cohen gave some account of the development of this wonderful property, which until recently has paid over $1,000,000 yearly in dividends. The mine has produced at the end of last year 15,227,143 ounces of silver, and promises to make a further very large production, though the production from the Carson



AT COBALT, ONT.

Examining the wall rocks of the Little Silver vein Nipissing mine

vein during the past few months has been very dissappointing. It is planned to drain the lake this summer, to allow of recovery of ore under Kerr Lake. The necessary preparations are now being made, and it is expected that in two months after the pumps are started, the water will have been removed.

After coming up from the mines the members were entertained by Mrs. Cohen at Crown Reserve, and Mrs. Rogers at the Coniagas. Tea was served, and a very pleasant half-hour was spent before returning to the train.

In the evening the local branch of the Canadian Mining Institute, tendered the visitors a reception at Massey Hall. Mr. A. A. Cole described some of the characteristic features of the silver veins, illustrating his talk by projected views of some of his excellent underground photographs. Mr. Fraser Reid presented a much appreciated paper on the treatment of the Cobalt silver ores. Chairman Neelands called upon some of the visitors for a few remarks. Mr. Chas. McDermid, Secretary of the Institute of Mining and Metallurgy; and Mr. G. A. J. Cole, Director of the Geological Survey of Ireland, commented on the remarkable richness of the Cobalt mines, and were pleased to have an opportunity of thanking the citizens of Cobalt for the splendid reception accorded the excursionists.

Refreshments were then served, and dancing concluded a very much appreciated evening's entertainment.

On Tuesday morning those who had visited the Timiskaming and Crown Reserve, went underground at the Coniagas mine. Here the best example of the mode of occurrence of the silver ore was seen. The party was conducted through the stopes, and saw the numerous thin but rich vertical veins in the sedimentary rocks. The method of mining these was described in the August 1st issue of the Journal.

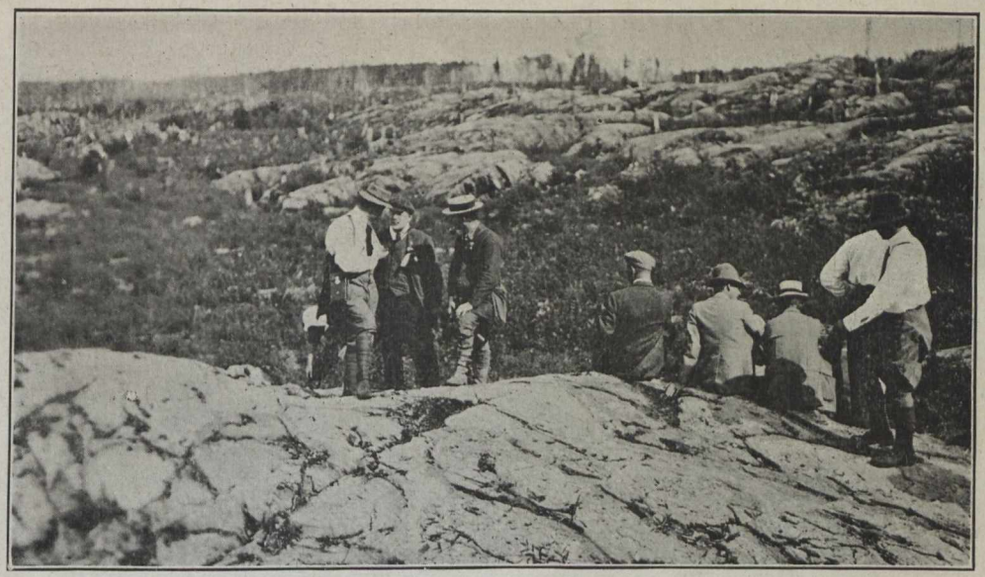
Nipissing High Grade Plant.

While some were underground at the mines others were taken through the remarkable plant in which the high-grade silver ore of the Nipissing mine is so successfully treated by a combined amalgamation-cyanidation process which will be described in a later issue of the Journal.

In the afternoon the train proceeded to Haileybury, and a steamer trip was taken down Lake Timiska-

AT DOME MINE, PORCUPINE; ONT.

Contact of ellipsoidal Keewatin greenstone, at left, with Timiskaming conglomerate, at right.



AT DIXON MINE, PORCUPINE, ONT.

An outcrop of ellipsoidal Keewatin greenstone.

ming. Several exposures near the shore were examined, and the sail on the lake proved very enjoyable.

Visit to Kirkland Lake.

While the greater number were on the lake, fifteen members of the party went on by special train to Swastika to see the recently discovered gold deposits at Kirkland lake, described in the July 15th issue of the Journal. At the station, Mr. Foster had stages awaiting the party. The road has been only recently made and is not yet completed, and the visitors were able to see a Northern Ontario mining camp in the making. The first few miles are fairly good for a new road, but for some reason the work has been discontinued about one mile from the Tough-Oakes mine, and is almost impassable for loaded wagons. The visitors, however, were men used to rough tramping, and were much pleased with their journey out. It offered an excellent opportunity to judge of the character of the country in which the new finds have been made and presented some of the difficulties to be encountered by those who are opening up the district.

The property was reached late in the afternoon, and Messrs. Foster, O'Connell and Hotchkin aided Mr. Burrows, who is making a geological study of the district for the Ontario Bureau of Mines, in pointing out the geological features. The veins and the country rock were closely examined, and many interesting specimens obtained. In the article published in the July 15th issue, the writer called attention to an abundance of black graphitic material in the ore. Mr. Foster stated that analyses show this to be partly, and perhaps wholly, molybdenite. Specimens were obtained, which show the characteristic features of this mineral, and Dr. Walker suggested that some of the black graphitic looking material may be a mixture of molybdenite with crushed rock. Mr. Chas. Spearman stated that tests on some of the material showed

AT DIXON MINE, PORCUPINE, ONT.

Keewatin greenstone showing ellipsoidal structure characteristic of submarine volcanic rocks.

AT HOLLINGER MINE, PORCUPINE, ONT.

The A 3 party visiting the large quartz outcrop where the gold was discovered in 1909.

molybdenite in some cases and graphite in others. Another feature which attracted considerable attention was the character of the tellurides which occur in the ore. Mr. Foster stated that in some material analyzed by Messrs. Campbell and Deyell, of Cobalt, it was found that none of the gold occurs as telluride, but that some native gold is mixed with lead telluride. Some of the party collected specimens which they consider to be tellurides containing gold, and Mr. Spearman stated that he has obtained gold, silver and lead globules on roasting some clean particles of the minerals. He believes that the ore contains a telluride containing all three metals.

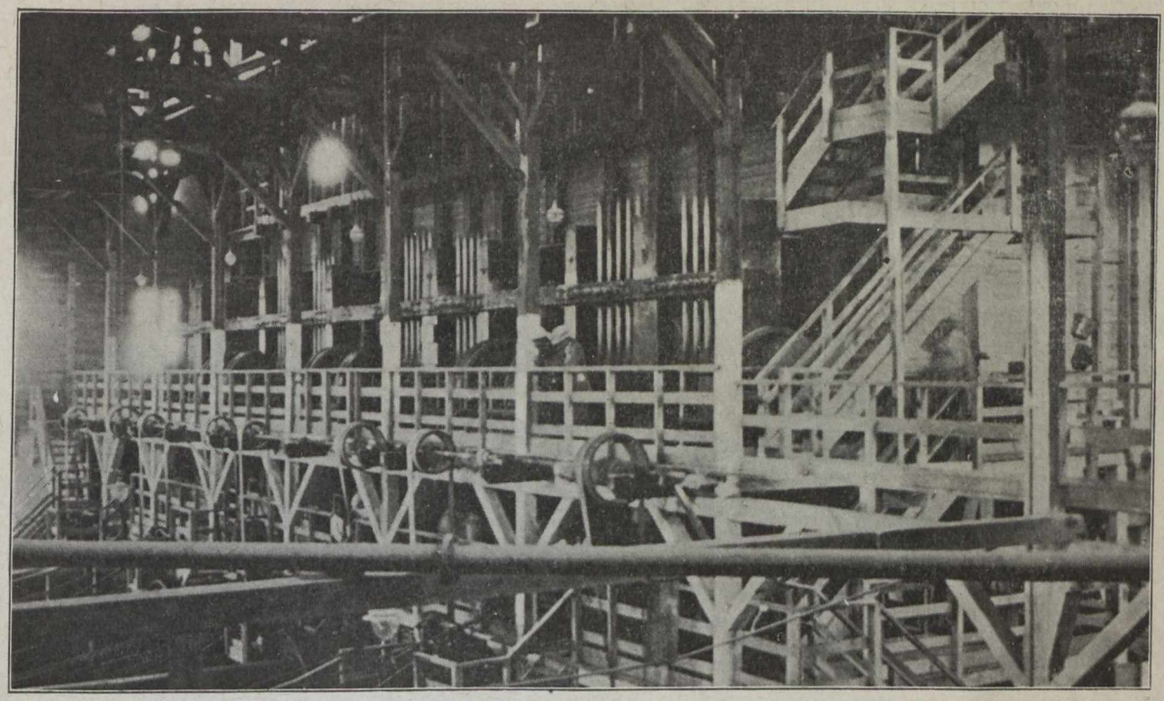
After examining the outcrops on the Tough-Oakes property, a visit was made to the Burnside property, where similar ore was seen. At the Burnside a shaft is being sunk on a recently discovered vein. It is a dark-gray vein a few inches in width, enclosed in gray conglomerate similar to that on the Tough-Oakes property. The vein, so far as opened, is nearly vertical and apparently conforms to the bedding of the conglomerate. It varies much in thickness, and is in places very rich.

About 8 p.m. the much interested visitors were reminded that they had not yet had supper, and were invited to partake of the hospitality of a Northern Ontario mining camp. A splendid meal was furnished by the Tough-Oakes company, and was done full justice to. At its conclusion, Mr. Bedford McNeill in a few words presented the hearty thanks of the party, and Mr. Foster in reply, stated that all Canadian mining men were pleased to have such visitors, and wished them a pleasant and interesting visit to the other mines.

Immediately after supper the party was taken underground to see the No. 2 vein at the 100-foot level. The cutting of a station here has exposed the vein well and gave a good opportunity for examination. In cutting into the hanging wall, another thin vein of good ore has been recently exposed.

Without going to the bottom of the mine, the party returned to surface and started for Swastika. The

Breaking down gold quartz in open pit, Dome Mine, Porcupine, Ont.



The8Stamps, Hollinger Mill, Porcupine, Ont.

first mile's walk in the dark over the unfinished portion of the Government road, gave the foreigners some new sensations and brought to those familiar with the district vivid recollections of the Porcupine trail, as it was in 1910. Without serious mishap, the party reached Swastika before midnight, and about an hour later were picked up by the excursion train and taken on to Porcupine.

Dome Mine.

On Wednesday morning we looked out on the blackened tree trunks and scorched ground north of the Dome mine. The train was later run in close to the mine workings, and the mine officials joined Mr. Burrows in conducting the party over the property. First the rich ore, known as the "golden stairway," was examined. The most spectacular surface showing of gold has been removed, not by members of the party; but similar coarse gold was seen by descending a few feet into a raise which has been brought to surface in the rich ore.

The party then visited the open pits, where there are numerous excellent exposures of gold quartz and wall rocks. The irregular shape of the large quartz masses and intricate structure of the veins was pointed out by Mr. Burrows and the mine officials.

Mr. Burrows then conducted the party to several exposures near the mine, where the contact between the Dome conglomerate and the underlying Keewatin rocks can be seen. As pointed out by the writer in the October 15, 1910, issue of the Journal and in a paper presented at the 1911 meeting of the Canadian Mining Institute, the conglomerate is quite unlike that in which the silver veins at Cobalt occur. It seems to overlie the Keewatin greenstones, and may be either a sedimentary series of late Keewatin time or of early Huronian, or, as suggested by Dr. Coleman, may perhaps be not properly correlated with either Keewatin or Huronian. Mr. Burrows and Dr. Miller correlate it with similar rocks near Cobalt, and call the series of which it forms a part the Timiskaming series. They

Ellipsoidal Keewatin greenstone, Porcupine, Ont.

AT DOME MINE, PORCUPINE, ONT.

Examining "golden stairway" vein

S. Cerulli-Irelli, Italy; F. L. Ransome, Washington; Fred Searls, Nevada; A. G. Burrows, Toronto; H. F. Bain, California; A. C. Lane, Mass.

do not assign it definitely either to Huronian or Keewatin.

The writer in order to locate its position with relation to the Huronian series in Michigan, would correlate the Timiskaming with Lower Huronian, and the Cobalt series with Middle Huronian. There is, however, a possibility that the Timiskaming is considerably older than any of the known Huronian.

The Bureau of Mines geologists have found according to their published reports plenty of evidence that the Timiskaming series is older than the Cobalt series and younger than the Keewatin greenstones; but do not consider that there is sufficient evidence on which to correlate these series with those of the original Huronian area.

After Mr. Burrows had pointed out the exposures showing the relationships of the rocks and the character of each series, the mine officials took some of the party underground, while others inspected the mill and cyanide plant.

Much of the ore thus far milled at the Dome mine has been broken down in open pits, drawn off at the 45-foot level, trammed by mules to an inclined shaft, and thence hoisted to the surface. Here it is crushed and then elevated to the mill bins.

At the 100-foot level the deposit has been extensively blocked out by drifts and cross cuts as at the 45-foot level. It is not intended to hoist the ore from deep levels up the inclined shaft, however. The vertical No. 2 shaft, now about 300 feet deep, will be made the

AT THE EDGE OF OPEN PIT, DOME MINE, PORCUPINE

H. S. A. Sjogren, Sweden; P. P. Piatnizky, Russia; H. F. Bain, California; J. J. Barrell, New Haven.

main hoisting way, and the ore will be trammed on surface from this shaft to the mill.

After a busy morning at the Dome mine, the party boarded the train and was taken to Timmins. Immediately after lunch Mr. Burrows conducted the party to the numerous exposures on the Miller-Middleton, Hollinger and Dixon properties. The characteristic features of the ore deposits were pointed out and typical rock types were examined. Some excellent exposures of Keewatin greenstones showing ellipsoidal structures were shown on the Dixon property.

Having viewed the surface, the underground openings at the Hollinger and McEnaney were then examined. At the Hollinger a great deal of work has been done, and the party was conducted through a

Head frame at Tough-Oakes Mine, Kirkland Lake, Ont.

maze of drifts and cross cuts, in which splendid exposures of the gold quartz and enclosing rock were seen.

The most common wall rock of the ore-bearing veins is a fine grained gray rock, composed largely of sericite, carbonates and quartz. It is largely secondary and is probably an alteration product of quartz porphyry or feldspar porphyry. Considerable interest was evidenced by those who examined this rock, as its original character has been almost entirely obscured by secondary changes. Mr. Knight in his early work in the district, described it as probably an altered quartz porphyry, and the writer in a paper on the nature of the ores and rocks presented at the 1911 meeting of the Canadian Mining Institute, confirmed Mr. Knight's observation.

Having visited the underground workings, the party was then conducted through the Hollinger mill and cyanide plant. The process of treatment was described by the guides. The officials of the company did much to explain all that was seen on the surface, underground and in the mill, and the courtesy was much appreciated. Before leaving the property, the visitors were invited to view the mine maps and a glass model of the workings which is now being constructed.

At Temagami.

During the night the train was moved down to Temagami. The morning was spent in a delightful sail down the lake to Temagami Inn and Bear Island. At Bear Island there is a Hudson's Bay Company post and an Indian village. Much interest was manifested in the Indians, some of whom were found at their tents making moccasins, curing hides, etc. An amusing little bear cub, belonging to Chief White Bear, attracted great attention, and one of the Toronto ladies with no great difficulty induced her husband to purchase it as a mascot for the Congress. During the afternoon, most of the geologists were busy examining outcrops in the vicinity of Temagami; but the natives gathered around a well known explorer, who was amusing himself and spectators on the station platform with his new-found pet. When the train started south, the pet, labelled "a bear called Congress," was in a box addressed to 14 Walmer road.

While the bear was being looked after at the station, Dr. Miller and Mr. Knight were conducting members of the party to exposures of the jaspilite, which forms the ridge paralleling the northeast arm of Lake Temagami and to exposures of the contact of Huronian conglomerate with the underlying Keewatin schists. These exposures, of some of which photographs may be seen in the Journal of Geology, 1910, were examined especially with a view to obtaining evidence of the origin of the conglomerate. Dr. Ransome electrified one group of searchers by finding what appeared to be a glaciated surface under the conglomerate; but which was soon found to be quite similar to a lower surface in the Keewatin rocks, and probably smoothed by a slipping action at the contact. Similar exposures were pointed out further south by Mr. Knight, and much discussion of the principles of sedimentation was brought out by the examinations. Most of the party seemed to be of the opinion that the deposits are glacial. Some, however, including Dr. Miller, hesitated to accept this view until more evidence has been found. At Doherty, Mr. Knight pointed out an excellent exposure of the conglomerate lying on granite and containing large boulders of the latter. Similar exposures occur a few miles west at Herridge lake.

The examination of the basal conglomerate concluded what every member of the party voted a very interesting and instructive excursion. The trip was admirably arranged and carried out and a vote of thanks to leader, guides and secretary, proposed by Mrs. Tyrrell, was heartily seconded. The railway men also received much well deserved praise for the manner in which the train was handled.

From Temagami the party proceeded to Ottawa, where, joined by members of A1 and A2 excursions and several new arrivals, a day was spent as guests of the citizens of Ottawa, the Dominion Government and the Geological Survey. On Saturday the members were entertained at Montreal by the Montreal local committee. The splendid reception accorded to the visitors in these two cities has been recorded elsewhere in this isue.

MILLING PRACTICE IN COBALT CAMP*

By Fraser Reid.

In the first three years of the life of the camp, there was practically no attempt made to recover the values locked up in the low-grade ore. A large percentage of the ore was sacked underground and the balance hoisted to the surface and washed, the high-grade being hand sorted, the low-grade going to the dump. Later sorting houses were operated. Here the ore passed over a grizzly, the resulting fines averaging 125 ounces being shipped direct to the smelter. The oversize passed on to a bumping table where the first-class ore of from 2,000 to 4,000 ounces, and second-class ore averaging around 400 ounces to the ton were sorted out by hand and the discards with a value of from 15 to 30 ounces went to the low-grade dump. It was this rapidly accumulating low-grade product that caused the mine operators considerable concern and in the fall of 1907 the first concentrator in the camp started to operate on this low-grade ore. It was a five-stamp mill, built and operated by the McKinley-Darragh Mining Co., and had a capacity of from 12 to 15 tons per day.

Shortly after this the Coniagas Mill started, with a capacity of 60 tons per day; then followed the Buffalo, Cobalt Central and others, until today we have seventeen mills in operation, with a total daily capacity of 2,000 tons, producing silver at the rate of 14,000,000 ounces per year, or nearly 50 per cent. of the camp's present production.

To-day the camp has 500 stamps in operation with a dropping weight of 625,000 pounds and roll mills to the equivalent of 150 stamps, giving a total dropping weight (if all were stamps) of 800,000 pounds of metal.

The general practice in the camp is to hand-sort the high-grade ore in the mine as closely as possible and send the remainder containing a portion of vein matter to the mill. Here it is crushed in breakers, sized, and given a preliminary treatment on jigs and reciprocating tables and in some cases further hand-sorting is resorted to. This preliminary treatment before fine crushing usually yields from 30 to 50 per cent. of the total values milled and practically means the recovery of vein matter. The wall rock containing finely disseminated minerals and fine leaf silver passes on to the regrinding machines for further reduction and concentration.

About 75 per cent. of the total ore milled is crushed by stamps, the stamps being in favour owing to the hardness and toughness of the ore and the simplicity and reliability of the stamp as a crushing device. The stamps in some cases are followed by tube mills. The remaining 25 per cent. of ore is crushed in rock breakers, further reduced by rolls or their equivalent and finally ground to the desired size by Chilian or Hardinge mills.

In straight concentration mills this re-ground material is classified, the sands treated on Deister, Wilfley or James tables and the slimes on James and Deister slimers or Frue vanners.

In some mills the tailings from the slimes are re-treated on canvas tables, when a further recovery at a profit is possible.

Up to the latter part of 1912 the cyanide process played a minor part in the recovery of silver, but with new additions to the Dominion Reduction mill and the advent of the Nipissing low-grade mill, this process has now become a more important factor in the production of the camp. Owing to their complex nature, the cyaniding of Cobalt ores presents unusual difficulties, and it is in this field that the greatest advances have been made in the development of new processes.

These are of sufficient importance to warrant fuller discussion and will be referred to presently.

Amalgamation is employed in three mills, the Nipissing and Buffalo high-grade mills treating high-grade ore and concentrates, and the Dominion Reduction treating concentrates only.

These mills recover the values in the form of marketable bullion, thus dispensing with smelting.

Amalgamation does not play any part in the recovery of values from the low-grade ores.

In the treatment of low-grade ores in this camp two processes are used, mechanical concentration and cyaniding, some idea of their relative importance may be gained from the following considerations. There are thirteen mills in the camp using straight concentration. Three use cyanide as an adjunct to concentration, namely, the Buffalo mill, cyaniding the slimes only, and the Dominion Reduction and O'Brien, which re-grind the sand tailings from the concentrating process and cyanide the whole.

One mill only, the Nipissing low-grade, uses an all-sliming cyanidation process after stamping.

An analysis of the total silver production of the camp would show approximately the following figures.

Recovered by sorting underground about 50 per cent.

Recovered by preliminary treatment in mills, 20 per cent.

Recovered by mechanical concentration after stamping, 17 per cent.

Recovered by cyaniding, 13 per cent.

The ratio of concentration by mechanical concentration averages 37 tons of ore to 1 of concentrates.

In an all-sliming and cyanidation process below the stamps the ratio of concentration ranges from 500 to 1,000 tons of ore to one ton of bullion according to the richness of the stamp discharge.

The complex nature of Cobalt ore has developed two processes of importance which are a distinct departure from the general hydro metallurgical treatment of gold and silver ores.

Early in the history of the camp, Prof. S. F. Kirkpatrick, of Queen's University, undertook some experiments on the cyanidation of Cobalt ore. He found the ore as treated by him fairly amenable to cyanidation, but found that zinc as a precipitant had a great tendency to foul the solution and produce a bullion below the market standard.

He finally tried aluminum as a precipitant. This had been discovered and patented by Moldenhauer, who claimed that not only was it a satisfactory precipitant for silver, but that it re-generated the cyanide in chemical combination with silver.

Moldenhauer used the aluminum in the form of plates, which soon became coated with aluminum hydroxide and the action was seriously retarded and the process was consequently impracticable.

*Paper read at a reception to visiting geologists at Cobalt, July 28.

Professor Kirkpatrick substantiated all the claims of Moldenhauer and made the process commercially successful by using aluminum in the form of dust. This aluminum percipitation process has been very successful, as it leaves the solution unimpaired and gives a marketable bullion.

It is now in use in the O'Brien mill, the Deloro smelter and, in a slightly modified form, in the Nipissing mill and the Buffalo high-grade mill.

The other process referred to is the de-sulphurizing process, as worked out by Mr. J. J. Denny, resident metallurgist of the Nipissing mine, and is in operation at the Nipissing low-grade mill.

This mill represents the very latest practice in the cyanidation of silver ores, and is a credit to the Cobalt Camp in general and in particular to Mr. R. B. Watson general manager of the Company, to the metallurgical staff, and to Mr. James Johnston who designed and erected the plant.

The details of this process have not yet been made public and are, therefore, not available, though we trust they will be in the near future.

This can be said, that by this process refractory silver compounds such as sulph-antimonides, which are with great difficulty dissolved by the ordinary cyanide process are broken up and desulphurized and rendered readily soluble. This process not only increases the extraction, but shortens the time of treatment.

The importance of this discovery may be realized when it is said that the process is equally applicable to the cyaniding of refractory gold ores.

The process, therefore, marks a distinct advance in the art of hydro metallurgy and will undoubtedly be generally used in the treatment of refractory gold and silver ores.

In conclusion, I might say that I have not attempted to touch on the relative efficiencies of the different mills, as this is a very delicate question and is as complex to the mill man as the origin of ore deposits is to the geologist.

THE INFLUENCE OF DEPTH ON THE CHARACTER OF METALLIFEROUS DEPOSITS

By J. F. Kemp.

Modern improvements in the art of mining have made possible the sinking of shafts to greater depths. The copper mines on Keweenaw Point, Lake Superior, have several which exceed 5,000 feet and a larger number between 3,000 and 4,000 feet. The deepest of these shafts attains the lowest point beneath the earth's surface yet reached by man himself, but as is generally known, the drill, although not in search of metals, has gone 1,500 or more feet deeper. We are thus learning by actual observations the mineralogical conditions at increasing depths and also the effect of depth upon values.

The questions thus raised have three sides, all of much interest. On the one side is the actual engineering problem of deep mining. Assuming that ore maintains values such as we customarily obtain to-day, we may raise the question, how deep is it feasible to sink for its extraction? Hoisting cables, when used in single lifts, have a limit beyond which their own weight makes them impracticable. Hoisting must therefore be performed in several steps, and power must be transmitted to some sort of engines at successive depths. Rock pressure upon excavations becomes very great, making the support of roof and walls increasingly serious. Water can, however, almost always be impounded in upper levels, so that pumping need not be a drawback, but in regions of recent vulcanism, such as the Comstock Lode, it may be an important factor in depth. Happily, well-nigh universal experience shows that water is practically limited to the upper one or two thousand feet of the earth's crust. Increasing temperature is, however, a great handicap on the miner. If, as in the deep mines of Keweenaw Point, men must work in confined drifts and stopes at the temperature of a hot summer day, only the exhaust of compressed air from the drills makes conditions favourable for effective labour. Some years ago, Dr. Alfred C. Lane, at the time State Geologist of Michigan, the state which contains the very deep mines, discussed the question, "How deep can we mine?" and reached the conclusion that 10,000 feet was the practical limit. Were, however, unusually rich ore to be had, a somewhat greater depth might be reached.

On another side the whole problem is affected by what we have learned with regard to the values of ore with increasing depth. Recorded experience is multiplying, and at least two observers have summarized worldwide results in mining. To this topic we will return in a moment, after stating the third point of view, which is the purely scientific one of the effect of increasing depth upon those geological conditions which influence the percipitation of ores. In casting light upon this phase of the matter we have the results of some artificial experiments in producing minerals and in the behaviour of rocks under pressure which are of decided interest.

It is also important, in the preliminary way, to bear in mind the metal or metals in whose search our deepest shafts have been sunk, and to comment on the types of ore-body which they have developed. In the citations below a general summary of the deepest is given and to this one or two others may here be added. Copper in the native condition is the object of deep mining on Keweenaw Point and is a very unusual form of this metal. We would normally expect sulphides. The ore-bodies now sought are not in veins or deposits which fill old fault lines or crushed zones and their attendant waterways, but are impregnations of conglomerates and amygdaloids. There are, indeed, a few old mines based upon fault fissures, but they have never been followed to depths beyond the ordinary. The precipitation of this vast quantity of a native metal which is found in the usual course of mining only in the gossan, presents an exceptional problem. The native copper has been followed nearly or quite a vertical mile below the level of the ground-water and obvi-

A paper read at Toronto Session, International Geological Congress, August, 1913.

ously cannot be due to descending surface waters when the enclosing rock had any such attitude with regard to the surface as at present. These deep mines do not throw much light on the circumstances attending the ordinary precipitation of sulphides.

The other very deep mines, say, below 4,000 feet, are not many and have chiefly been sunk for gold. Two shafts developed saddle reefs in Victoria, and one, doubtless soon to be the deepest of all, follows a vein at Morro Velho, in the State of Minas Geraes, Brazil. The deep shafts in Kolar district, India, seek gold-quartz. The deep shafts in the Transvaal have likewise been sunk for gold, but, of course, not upon ordinary fissure veins. The famous Adalbert shaft at Przibram sought silver and attendant base metals down to 3,600 feet. On the Comstock Lode silver and gold were the objects, and the deepest shaft was 3,350 feet. Copper, with attendant silver, has already been followed to 3,000 feet at Butte, Montana, in sulphides and sulpharsenides. Silver-bearing galena in brecciated quartzites has been developed to 2,500 feet below the crest of the overlying ridge at Wardner, Idaho. Tin in cassiterite has been obtained at still greater depths in Cornwall. Yet in summary we must admit that the very deepest shafts of to-day have had native copper or gold-quartz as their objectives, and the deepest experience which is now available relates to these two metals. We do know, however, aside from such pyrite as may occur with native gold, of sulphide ores, from 2,500 to 3,600 feet below the present surface. In time additional data will undoubtedly be gained regarding others.

Returning to the second point enunciated above, there is no doubt that, in most cases, values in ores decrease in depth after a moderate section of the vertical extent of the vein has been passed. This experience is not universal but it is the rule. The subject is generally discussed in our larger text books on ore deposits, and to these and to several older papers, two important ones have been added in the last two years by engineers of wide experience. If, therefore, the yield of veins or other forms of ore-bodies is considered at the extreme depths now reached in mining, say, 3,000 to 5,000 feet, we must realize that general experience points to lessening values, and the commercial probabilities are discouraging for any new and unexplored property. The experience thus far gained, as noted above, chiefly relates to copper and the precious metals, and to gold much more than to silver.

Several considerations are, however, of interest. In all ore-bodies involving sulphides of copper; to a large degree in those containing gold in association with pyrite; and to an important degree in those involving sulphides of lead and zinc, the three zones in vertical order from above downward, viz., the oxidized zone, the zone of enrichment and the zone of sulphides, must be considered. They have led to important changes in the distribution of values. Even gold itself, when associated with pyrite and manganese, and not in the presence of calcite or dolomite, undergoes secondary enrichment, as W. H. Emmons has recently and acutely shown.

The oxidized zone does not extend below the permanent ground-water level. It is of no importance in connection with the questions before us, except in very arid regions, where the ground-water lies unusually deep. Even then, however, the depths are not such as we are at present considering.

The extent of enrichment in depth is a matter of greater interest. It primarily depends upon the vertical depth to which we are prepared to admit that descending, acidified, metal-bearing solutions, produced by the leaching of the oxidized zone by meteoric waters, may slowly diffuse themselves in the standing ground-water. Obviously, the chief reactions will take place near the ground-water level. We cannot reasonably expect the influence to extend very far. The production of oxidized and enriched ores of zinc is practically limited to a few feet above and below the water level. Lead is very intractable and its enrichment is practically a matter of oxidization and removal of other and more soluble associates above the water level. The behaviour of silver is a matter on which we need light and on which there is a difference of opinion among engineers. Some have regarded the argentite of Mexican silver mines as the result of secondary enrichment and have inferred its disappearance at comparatively moderate depths. On the other hand, in the microscopic study of at least one suite of ores, from the State of Guerrero,—in the endeavour to decide this point, since it affected exploration below a fault,—the writer could find no evidence that the argentite was not one of the original vein minerals. Explorations subsequently undertaken seemed to justify this conclusion, as the vein, with ores unchanged, was found below the fault. Depths of 700-800 feet were involved. Silver becomes so readily locked up as the relatively insoluble chloride, ceragyrite, through the precipitating influence of ordinary surface waters, that it is not so favourable a metal for secondary enrichment as are several others. Gold, though at first sight a comparatively insoluble metal, does yield to the solutions afforded by oxidizing pyrite, in the presence of manganese, as was mentioned above. To what depth, however, the slow diffusion of descending solutions would bring the enriching effects below the water level is a question. Probably the range would not be great and the presumption is strong that the native gold found rarely in large nuggets at great depths in quartz veins is an original precipitate in the vein filling. For great depths, such as those in the Bendigo saddle reefs, it is impossible to refer decreasing yields to waning secondary enrichment.

Copper is the metal of pre-eminent importance in matters of secondary enrichment. Reported falling off in values as greater depths have been attained, has made the influence of this process of special importance. The appreciable decrease in copper percentages which were widely published fifteen years or so ago, regarding the Rio Tinto mines, called attention to it even at this early date. That enrichment may take place for several hundred feet below the permanent water level seems fairly well established both by the experience gained from the disseminated copper deposits ("porphyry coppers") of recent development, and by that gained in our deeper copper mines. In the disseminated copper mines experience shows that, from a condition of maximum enrichment, percentages gradually decline until, within a very moderate vertical range of a few hundred feet, we reach the original lean, copper-bearing and unchanged pyrite. In the great mines at Butte, of which we have descriptions from W. H. Weed, and more recently from R. H. Sales, the latter shows that the demonstrable, secondary chalcocite only extends a short distance below the water level, say two or three hundred feet, although the distance of the water level from the surface is remarkably variable in the

different mines. So far as the original vein-filling is concerned, there seems to be no identifiable mineralogical difference in vertical range, so far as we have yet gone, down to 3,000 feet. There is, however, a marked change as we radiate horizontally outward from a central area of copper minerals with no manganese and little or no zincblende, through a zone with decreasing copper and increasing zinc and manganese, to a zone with little or no copper and with silver in association with zincblende, a little galena and great quantities of rhodonite and rhodochrosite.

If, therefore, when we consider behaviour with depth, we focus attention upon the same minerals, at the most, lessening in quantity, or much the same minerals with lessening content of the precious metals,—in mass a very small part of the veins,—we would naturally seek the influence of physical conditions to account for less abundant or less profitable ore.

One other consideration should be first mentioned before briefly referring to the physical conditions. Vein formation in our workable deposits has usually taken place from one to several geological periods ago. Erosion has been active since and has removed an appreciable section of the rocks which existed when the deposition took place. In very ancient veins, such as appear in pre-Cambrian strata, the lost section may be important. Mr. Garrison has laid especial stress upon this phase of the subject, and has remarked Mr. Lindgren's inference that the lowest explored Bendigo saddle reef had formed when at least 7,000 feet from the surface; that the ores of the Mother Lode, California, had been precipitated at 6,000 feet; that the gold-bearing veins of the southern Appalachians must have been deposited over a vertical range of 7,000 to 8,000 feet; and the conclusion of Mr. F. L. Ransome that erosion has removed 2,000 to 5,000 feet of rock from Cripple Creek, Colorado. We may add that Dr. S. F. Emmons stated his belief, in his famous monograph on Leadville, Colorado, that the ores had been precipitated when 10,000 feet below the surface. Many other cases could be easily cited, but these will suffice to make clear that even the ores which we mine to-day, and which have been unaffected by secondary enrichment, were originally precipitated at much greater depths than the present workings. The physical conditions involved in vertical depth, down to 6,000 to 10,000 feet, would not seem to be of themselves prohibitive of the precipitation of commercial ore.

Still another feature of veins is the distribution of ore in shoots, with barren stretches between. Shoots succeed one another both in vertical and in horizontal distribution. Exploration is much more expensive at great depths than nearer the surface, and under these circumstances operators may much more easily become discouraged in the search for new veins when old ones become exhausted. We can hardly say that ore does not persist, even though it may not be commercially profitable to sink or drift for it.

The matter of possible cavities deserves a word of comment. While, as has been so ably shown by the honoured President of this Congress, Dr. Frank D. Adams, cavities are still possible at depths of 10 or 12 miles, yet large open spaces such as would form a resting place for ores, aside from replacement, would be naturally best developed within moderate distances from the surface. Mr. Rickard has commented upon this feature of the subject, and doubtless it is one of the serious factors influencing the final result.

As time passes, students of these phenomena seem to be increasingly convinced that the veins, such as would be considered in connection with profound depths, have been filled by uprising heated solutions. Since high temperatures generally favour solution and heavy pressures cannot be without their influence as well, decreasing temperatures promote precipitation with increasing efficiency as the surface is approached. Undoubtedly in these influences we have an explanation deserving confidence. There may well be a vertical range, wherein precipitating influences are at their best—one which corresponds with the section marked by our profitable ore bodies in the mines. The slow erosion of the tops of veins, with the attendant sinking of the groundwater level, serves further to enhance values by the processes of enrichment. Ore bodies of metals, other than iron, which have been precipitated at or immediately below the surface by uprising heated waters are extremely rare. Sulphur Bank, California, and Steamboat Springs, near Virginia City, Nevada, with their relatively small yields of quicksilver, are almost the only ones which suggest themselves. Mr. Lindgren has also remarked that ore bodies in purely surface flows of eruptive rocks are relatively rare. Ore bodies are much commoner in association with intrusive rocks or with others which have been deeply buried.

We are now pretty well assured both from the study of mineral springs and from the artificial production of some of the minerals common in ores, that the uprising solutions are alkaline in character. Only in the descending meteoric waters which leach the outcrops, do we find acid solutions. The deep-seated waters are carbonated and often charged with hydrogen sulphide. The descending waters are oxygenated. The most common and widespread sulphide in veins in general, is pyrite, and it has special claims to interest because of its parallel mineral, marcasite. Messrs. Allen, Crenshaw and Johnston of the Carnegie Geological Laboratory in Washington have recently made some experiments in the production of these two which are of extreme interest. On page 171 of their paper is the following passage: "The pyrite of deep veins, metamorphic contacts and hot-springs, as well as magmas, has been formed by hot solutions, and such solutions never contain strong mineral acids, but are generally, if not always, alkaline. The pyrite and marcasite of surface veins, on the other hand, are formed from cold solutions, which often contain considerable sulphuric acid." In their experimental production of pyrite, hydrogen sulphide was the quite invariable precipitant; the reduction of sulphates seems to be an assumption, not corroborated by experiment. With the reagents employed, pyrite formed very slowly at room temperatures, but much more rapidly at 200 degrees C. On p. 192 the following passage appears: "Pyrite, being a stable form, probably crystallizes under a considerably wider range of conditions than marcasite. The evidence of synthetic study is that the formation of pyrite is favoured by high temperatures and by solutions which contain little or no free acid. In accord with these we have the following geological deductions. First, pyrite is the product of hot-springs. In the springs of Carlsbad, which have a temperature of 55 degrees C, recent pyrite is observed. The waters contain sulphates and a trace of hydrogen sulphide and are slightly alkaline. The lagoons of Tuscany are depositing pyrite from their hot waters. Bunsen found that the hot vapours of the fumaroles of Iceland were gradually changing the ferrous silicate of the basalts

into pyrite. More important geologically is the fact that the product of deep veins by ascending waters is always pyrite, never marcasite. Such waters are naturally hot, and commonly, if not always, alkaline. We can now see that the separation of pyrite from a magma is entirely possible, while the temperature of any magma would doubtless be incompatible with the existence of marcasite."

As bearing on the problem of the continuation of ore in depth we can only conclude from the experiments and observations of Messrs. Allen, Crenshaw and Johnston that pyrite can precipitate at a depth fully as great as any shaft yet sunk.

Very similar conclusions have been established by Messrs. Crenshaw and Allen for the two sets of parallel minerals sphalerite and wurtzite and cinnabar and metacinnabar. On p. 396 of the citation they summarize their conclusions as follows: "Comparing the genetic relations of the minerals sphalerite and wurtzite, cinnabar and metacinnabar, with the genetic relations of pyrite and marcasite, we find certain remarkable regularities. The stable forms, sphalerites, cinnabar and pyrite, are always obtained by crystallization from alkaline solutions (solutions of the alkali sulphides), while the unstable forms, wurtzite, metacinnabar and marcasite, are obtained from acid solutions only. The stable forms may also be crystallized from acid under certain conditions. Of these, temperature and acid concentration seem to be the important ones.

Certainly with pyrite and marcasite, and in all probability with sphalerite and wurtzite, the higher the temperature the greater the percentage of the stable form obtained, while the higher the acid concentration at any temperature, the greater is the percentage of the unstable form obtained. These facts appear to agree remarkably well with the field evidence, which relates to the genesis of the natural minerals, while they give new significance to the general geologic distinction between deep-seated and surface waters in nature."

The experiments of these investigators clear up for us the fundamental chemical differences between the processes of primary precipitation and of secondary enrichment, but as regards the continuation of ore in depth, we can only say:

1. While there seems to be nothing to prevent precipitation at greater depths than we have yet reached, yet conditions seem to be specially favourable in those portions which lie between the present surface and 2,000 to 4,000 feet in depth.

2. Secondary enrichment has increased the yield of those portions of many veins which are above 1,000 feet in depth, the vertical extent of its action being limited to a relatively short stretch below the groundwater level.

THE COBALT AREA*

By WILLET G. MILLER.

In 1903, during the construction of the Timiskaming and Northern Ontario Railway, which is owned and operated by the Ontario Government, rich veins of cobalt-silver ore were discovered near what is now known as Cobalt Station. The railway track runs almost over the top of one of the most important veins yet found.

At the time the discovery was made, the veins attracted little attention, the discoverers not being men whose vocation was that of prospecting or mining.

Niccolite is a characteristic mineral of the area, and, as its German name, kupfer-nickel, indicates, its colour is somewhat like that of copper. Hence, it is not surprising that some of the first persons to see the deposits mistook the niccolite for copper ore, and, not having their attention drawn to the native silver, which occurred in profusion in parts of the veins, should have decided that the deposits were of the less precious metal. A sample of the niccolite, received at the Bureau of Mines towards the end of October of the year mentioned, aroused the writer's interest, and he decided to visit the locality from which it came.

The great Sudbury nickle area lies 90 miles to the southwest of Cobalt, and in a report on a trip of exploration to the vicinity of what is now Cobalt, in 1901, the writer had said:

"It will be seen from what has been stated on preceding pages that the district examined contains as great a variety of rocks as probably any other part of the province of equal area. . . .

"Although few discoveries of economic minerals have been made in this territory, it may reasonably be expected, judging from the character and the variety of the rocks, that deposits of value will be found when the district is more carefully prospected, as it will be in a short time, owing to the rapid settlement which is now taking place. . . . It would seem that at least some of the conditions of the Sudbury district are repeated in this more eastern field."*

Naturally, on the receipt of the sample of niccolite, it appeared that this prediction might have been verified, and that deposits of nickel vastly richer than those of Sudbury might have been discovered.

On examining the veins then discovered, four in number, all near the shore of Cobalt Lake, an unexpected and astonishing assemblage of minerals was seen, the most prominent being native silver, niccolite, smaltite and cobalt bloom. In the first paper he published on the area, describing one of the veins, the writer said:

"Here a perpendicular bare cliff, 60 or 70 feet high, faces west. The vein. . . . cuts this face at right angles, having an almost vertical dip. . . When I saw it first it had not been disturbed. Thin leaves of silver up to two inches in diameter were lying on the ledges and the decomposed vein matter was cemented together by the metal, like fungus in rotten wood. It was a vein such as one reads of in text-books, but which is rarely seen, being so clearly defined and so rich in contents."*

The veins are narrow, averaging not more than four inches (10 cm.) in width. This feature discouraged certain of the first mining engineers who examined the outcrops, and caused them to doubt whether the veins were of economic importance. However, the large number of veins and their great richness has more than compensated for their narrowness.

It was soon proved by comparatively little work that Cobalt was really a "poor man's camp." One of the first operators, for instance, extracted ore having a value of approximately $250,000 at a total cost of $2,500. Statistics show that during the period of mining in the

*Extracts from Guide Book No. 7, published by Geological Survey of Canada for the Twelfth International Geological Congress.
*11th Report, Ontario Bureau of Mines, p. 229.

area dividends distributed have been equal to over fifty per cent. of the value of the output.

In the earlier years of mining there were no refining plants, in North America at least, that could economically treat the ores. Owing to the unusual and complex character of the ores there was waste of other constituents in extracting silver, there being present in addition to the precious metal, arsenic, cobalt and nickel in important quantities.

The Cobalt area is not unique in Ontario in possessing an unusual ore, other representative economic minerals of the province when discovered being without a market or requiring the development of a refining process. The Sudbury deposits, for example, were opened up for copper, nickel being afterward found to be present. A considerable period elapsed before refineries were developed and a market made for the nickel by proving to the nations of the world its value as a constituent of steel for armour plate. Again, in the earlier years of apatite mining in Ontario, the amber mica, which is now so highly prized, associated with this mineral, was thrown on the waste heaps. And when the corundum deposits were discovered, a process had to be developed for milling the rock and a market had to be made for the material. Other instances could be cited, but the examples given show that the characteristic of the minerals mined in Ontario's pre-Cambrian rocks is uniqueness.

It is gratifying to know that within the comparatively few years that mining has been prosecuted at Cobalt, plants capable of refining all of the constituents of the ore have been erected in Ontario, the processes employed being either improvements on those in use elsewhere or invented especially for these ores, such as that employed at the Nipissing mine for the extraction and refining of silver. This metal is refined at several other plants, and white arsenic and cobalt and nickel oxides are produced. The plants for refining cobalt oxide in Ontario are of capacity sufficient to supply the world's demand for the material. The white arsenic produced from Cobalt ores represents about 20 per cent. of the world's output. Cobalt is the world's greatest producer of silver, its output representing about 13 per cent. of the whole.

In 1904, the year in which the first shipments were made, there were produced 158 tons of ore. The average percentages of the four metals in this ore were:

Silver. . . . . 5.34 per cent., or 1,309.33 ounces per ton.
Cobalt. . . . . 10.21 " "
Nickel. . . . . 8.86 " "
Arsenic. . . . . 45.56 " "

In 1905, there were shipped 2,144 tons of ore of the following composition:

Silver. . . . . 3.90 per cent., or 1,138.72 ounces per ton.
Cobalt. . . . . 5.50 " "
Nickel. . . . . 3.49 " "
Arsenic. . . . . 25.60 " "

The ore shipped till near the end of 1907 was sorted by hand, or with crude mechanical appliances. Since then extensive concentrating plants have been erected.

Production of Cobalt Mines, 1904—1912.

The following table summarizes the production of the Cobalt and adjacent areas:—

Year.	Ore shipped. Tons.	Nickel. Tons.	Nickel. Value. $	Cobalt. Tons.	Cobalt. Value. $	Arsenic. Tons.	Arsenic. Value. $	Silver. Ounces.	Silver. Value. $	Total Value. $
1904....	158	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905....	2,144	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906....	5,335	160	.....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907....	14,788	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908....	25,624	612	.....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909....	30,677	766	.....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910....	34,282	504	.....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911....	26,653	392	.....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912....	*21,933	.....	.....	†515	317,165	‡1,964	79,297	30,243,859	17,408,935	17,805,397
Total..	.....	.....	.....	.....	.....	.....	.....	155,815,839	81,731,115	83,184,268

*Does not include ore refined at Cobalt.

For some time after mining began at Cobalt, the ore was shipped to the sampling works of Ledoux and Company, New York. The richest shipment contained 7,402 ounces of silver to the ton, the next in order being 6,909; 6,413; 6.163 and 5,948 ounces to the ton. The average percentages of other metals in the 366 carload lots sampled by this firm were: cobalt, 5.99; nickel, 3.66; arsenic, 27.12.

Concerning the high-grade ore at Cobalt, Mr. R. B. Watson recently has said: "A typical ore carries 10 per cent. silver, 9 per cent. cobalt, 6 per cent. nickel, and 39 per cent. arsenic; the rest is lime, silica and smaller amounts of antimony, iron, sulphur, tellurium, etc.*"

The most productive vein in the area is that known as the Carson, on the Crown Reserve property. It has been estimated that this vein, with its extension on the Kerr Lake property, will have produced before being exhausted 20,000,000 ounces or more of silver from that part of it above the 200-foot level.

The richness of the ore in various mines is well shown by what it has cost, on the average, to produce an ounce of silver. In 1911, for example, the cost per ounce, including mining and all other expenses, given in the annual reports of certain companies, was: at the Crown Reserve, 10.761 cents per ounce; at the Coniagas, 8.8; at the Nipissing, 13.95, and at the Kerr Lake, 14.69.

The chief object in building the Timiskaming and Northern Ontario Railway was the development of the agricultural areas at the head of Lake Timiskaming, to the north of Cobalt. It was also felt that the railway would increase the value of the timber lands through which it passed, but, it is safe to say, the most sanguine supporters of the policy of railway building little dreamed of the mining development to which the construction of the road would lead. It is true that mining at Sudbury had been pursued for some years before it was decided to build the railway into the Timiskaming country, but Sudbury had never excited much interest among the people of Ontario. Those who were inclined to invest in mines had little faith in the mineral resources of their own province. The discovery of Cobalt,

Eng. and Min. Jr., Dec. 10th, 1903.
†Cobalt oxide, etc. ‡Refined.
*Eng. and Min. Jr., Dec. 7th, 1912.

however, has given confidence in the province's mineral industry and has led to the development of Porcupine and other areas tributary to the railway. The value of the ore produced at Cobalt, in less than ten years, is equal to about five times the cost of constructing and equipping the 252 miles of railway from North Bay to Cochrane, together with branch lines, and the dividends alone are equal to two and a half times the total cost of the railway.

Moreover, the discovery of Cobalt, which lies near the southern edge of the great pre-Cambrian regions that occupy nearly one-half the surface of Canada's 3,750,000 square miles of territory, has given confidence in these regions as storehouses of economic minerals and ores that future prospecting will bring to light.

The Rocks and Their Relationships.

At first, owing to the surface being covered with green timber and to the presence of much drift material, contacts and good exposures were difficult to find. Now, that the timber has been removed parts of the area have almost the appearance of a large model, e.g., between the northwestern face of Mount Diabase and Peterson and Cart lakes, or on the Nipissing property to the west of Peterson lake, where the loose deposits have been removed from the surface by hydraulicking.

From the maps of the area that have been published, it will be seen that there is considerable variety in the pre-Cambrian series. On the shores and islands of Lake Timiskaming, a few miles to the north or northeast of Cobalt Station, the Clinton and Niagara of the Silurian system also show prominent outcrops. Between the Niagara and the Pleistocene or Glacial there are no formations represented in the district.

The following table shows the subdivisions, based on age relations, that have been made among the rocks of the Cobalt area proper. Representatives of most of these subdivisions of the pre-Cambrian are found in other areas that have been carefully mapped in the surrounding region.

In the Porcupine gold area, one hundred miles to the northwest of Cobalt, the Keewatin and Timiskaming series are prominent. The Cobalt series is also present in this area, and certain dikes are believed to represent the Nipissing diabase of Cobalt.

In the Gowganda silver-cobalt area, which lies fifty or sixty miles to the west of Cobalt, the Nipissing diabase and Cobalt series occupy much of the surface. The Timiskaming series is found in good exposures in part of the area. The latter series has also been found at Swastika and Larder lake, at Abitibi lake, 75 miles north of Cobalt, and eastward across the boundary in Quebec. It is thus known to occur at various points over a large region.

It is possible that unconformities that have not been discovered exist in the pre-Cambrian of the Cobalt and adjacent areas. Moreover, the relationship which the Cobalt and Timiskaming series have to the fragmental rocks of the classic Huronian area of the north shore of Lake Huron is not known. Hence, in the following table the name Huronian is not employed. If the Huronian is considered to include all the post-Laurentian and pre-Keweenawan fragmental rocks of the region, then both the Cobalt and Timiskaming series come under this heading.

The dual subdivision of the pre-Cambrian into Algonkian and Archean, or Proterozoic and Archeozoic, employed by many authors, is not adopted by the writer, since he believes that the Grenville series, which includes limestones and other sediments of great thickness, is of pre-Laurentian age. Thus a dual subdivision of pre-Cambrian rocks, based on arguments that have been employed in its behalf, fails. If a name is desired for the pre-Cambrian rocks, to correspond with Paleozoic and Mesozoic, the well-known name Eozoic may be used.

Age Relations of Rocks of Cobalt and Adjacent Areas.

Palezoic (Silurian, Niagara).—Prominent outcrops of Niagara limestone, with basal conglomerate and sandstone, occur on some of the islands and the shores of the north end of Lake Timiskaming. (Great unconformity.)

Eozoic or Pre-Cambrian (Later Dikes).—Aplite, diabase, basalt.

Nipissing Diabase (Intrusive Contact).—This diabase, which is of such great interest in connection with the cobalt-silver veins, is believed to be of Keweenawan age. Certain aplite dikes are genetically connected with the diabase.

Cobalt Series (Unconformity).—The Cobalt series includes conglomerate, greywacke and other fragmental rocks.

Lorrain Granite (Intrusive Contact).—This granite occupies a considerable part of the Township of Lorrain and has large exposures elsewhere in the vicinity of Lake Timiskaming.

Lamprophyre Dikes (Intrusive Contact).—Lamprophyre dikes are to be seen near some of the mines at Cobalt.

Timiskaming Series (Unconformity).—Like the Cobalt series, the Timiskaming consists of conglomerate and other fragmental rocks.

Keewatin Complex.—The Laurentian, gneiss and granite, which in age lies between the Keewatin and Timiskaming, is absent in the Cobalt area proper, but is found in the surrounding region.

Under the heading Keewatin are grouped the most ancient rocks of the region. They consist essentially of basic volcanic types, now represented by schists and greenstones, together with more acidic types, such as quartz-porphyry.

With the Keewatin are included certain sediments, such as iron formation or jaspilyte, dark slates and greywackes, which probably represent the Grenville series of southeastern Ontario.

Certain dike rocks that are grouped with the Keewatin may be of post-Timiskaming age, but since they have not been found in contact with the Timiskaming series their age relationships are unknown.

(To be Continued.)

ON THE ORIGIN OF THE PORCUPINE GOLD DEPOSITS*

By Reginald E. Hore.

Gold occurs at Porcupine in quartz bodies of very numerous forms. Many of the deposits may be classed as one of four types*:—1, quartz veins; 2, quartz vein systems; 3, quartz masses; 4, quartz-ferrodolomite lodes. The quartz veins are well defined, single fissure fillings, commonly varying considerably in thickness and forming numerous lenticular portions, but having on the whole a somewhat tabular form. The vein systems are made up of two or more veins, close together and more or less parallel. The quartz-ferrodolomite lodes

*A paper presented at the Annual Meeting, Canadian Mining Institute, Toronto, 1912.

*Illustrations of these types were given in Canadian Mining Journal, November 1, 1910, pp. 649-656. Descriptions of a number of the deposits are given by A. G. Burrows, in his report on "The Porcupine Gold Area," pp. 20-31, 20th Annual Report, 1911, Bureau of Mines.

are made up of ferrodolomite traversed by numerous veins and veinlets of quartz. The quartz masses are of irregular and for the most part of unknown shape. Some have been described† as kidneys and chimneys. Others show a tendency to elongation in two directions and appear to be members of a series of thick lenticular masses lying at intervals along a fissured zone.

The rocks enclosing ore are of several different types. A common one is a gray sericite-carbonate-quartz schist that was probably originally a quartz porphyry. Other wall rocks include basalt, porphyrite, conglomerate and gray slate.

It appears that neither the form of the opening or the character of the country rock were the chief factors in the formation of the ore bodies. These are important factors to be considered in the study of the individual ore shoots; but will not enter into the present discussion. Attention is here directed rather to characters common to all. These characters indicate a common origin and by their nature give some clue to the process involved in the formation of the deposits.

Characters of the Gold Ore Determined Optically.—The ore in all cases is native gold* in pyritic quartz. The gold is partly in coarse grains, visible to the naked eye, but is chiefly in very minute particles, intimately associated with pyrite. Some of the gold is actually intergrown with pyrite; but most of it is not. Some of the gold intergrown with pyrite is in very small grains, visible only with the aid of a microscope, and it is quite probable that there are similar particles which are not visible on account of their smaller size. Some gold is in calcite or ferrodolomite. Galena, sphalerite and chalcopyrite occur frequently, but in small quantity. Tourmaline, feldspar‡, scheelite and some yet unidentified minerals also occur.

The pyrite associated with native gold is in some cases in large, well-formed crystals; but most of it is in small and, for pyrite, very poorly-formed crystals.

The gold and pyrite are not distributed uniformly through the quartz and are commonly most abundant near the wall rock or pieces of rock enclosed in the quartz. Large areas of vein material are quite free of opaque minerals.

The quartz in some cases has a ribboned appearance due to the presence of dark coloured aggregates of minerals in minute crevices. The aggregates are made up chiefly of pyrite, sericite, carbonates, chlorite and a brown serpentinous substance of unknown composition. The same minerals also occur irregularly through white quartz giving some of the ore a spotted appearance. From the mode of occurrence of these dark coloured aggregates it seems likely that they were formed after the quartz had been crushed. From the occurrence of gold with these aggregates it seems likely that some of the metal has been deposited much later than the quartz.

The quartz is made up partly of large grains, which probably represent the form in which it was originally deposited; but largely of very small grains, which have evidently been formed by subsequent crushing or granulation. The individual grains in almost all cases when examined in polarized light exhibit evidence of strains. In the specimens examined microscopically, most of the gold is in parts of the quartz which have been granulated.

The quartz contains very numerous fluid inclusions, and was therefore probably deposited from a hot solution at considerable depth. Such inclusions are very common in quartz which is known to have been deposited hot, as in the case of the formation of such rocks as granite. The mere presence of inclusions is not of itself sufficient evidence of high temperature and depth, for there is reason to believe that some inclusions have been formed after the solidification of the quartz. The inclusions are frequently arranged in rows, and some of these run through adjacent quartz grains without interruption. Many of the rows, however, terminate at the quartz grain boundary, and there appear to be fewer inclusions in the granulated than in the original quartz grains.

There are other characters which suggest that the solutions were hot and probably partly of magmatic origin. Pyrite is commonly formed from hot alkaline solutions. Tourmaline is frequently and scheelite occasionally present, and these two minerals are generally found in what are believed to be acid differentiation products. Sericite, so abundant in the wall rocks, is a mineral that is generally thought to be formed by hot solutions.

From optical examination it seems likely that the gold, pyrite and quartz were originally deposited from the same solution and that the solution was hot. Subsequently the deposits were crushed and fractured and secondary minerals were deposited in the fractures. It is probable that some of the gold was dissolved and re-deposited in other parts of the vein. It appears especially probable that the coarse grains were formed by such a secondary process.

Some writers have interpreted their observations to indicate that the fissures were first filled with barren quartz and that the gold was introduced later. It is of course possible that such was the case; but I can find no necessity for such an assumption and hence prefer the simpler hypothesis. The constant occurrence of quartz and pyrite with the gold and the paucity of gold in those enclosing rocks in which quartz and pyrite are not abundant, seems sufficient evidence for the assumption of a common origin for the three minerals. Gold, quartz and pyrite were probably deposited together, and, so far as I am aware, there is a lack of evidence that gold-bearing quartz has been introduced after the first filling of the fissures. Subsequent solution and redeposition of some of the constituents of the primary filling and of the country rocks would account for the phenomena observed.

Characters of the Gold Ore Determined by Assays.—Assays have shown that the gold is not regularly distributed through the quartz, but, as is commonly the case, it is chiefly in parts referred to as ore shoots. The ore is fairly high grade; but owing to the difficulty in distinguishing it from waste or mining it separately when distinction is possible, it is not improbable that the run of mine ore in some cases will be more properly referred to as low-grade. In the high-grade ore shoots the values have been found to be very irregularly distributed.

The gold is chiefly confined to the quartz veins or masses. The country rock in some cases contains pay values, but so far as I can learn there has not yet been found any important body of ore in rock that is not penetrated with quartz. The constant association of gold and quartz indicates clearly a common origin.

Assays show that the gold is chiefly in parts of the quartz near wall rock or pieces of enclosed rock, and especially in parts of the quartz that have been crushed. Most of the gold occurs with pyrite and non-pyritic quartz in the same deposit is commonly barren.

At the Hollinger it has been found that the occurrence of visible gold does not necessarily mean payable values, and that quartz streaked with fine lines of

†P. A. Robbins, Annual Report Hollinger Mine, Jan. 1, 1912, p 6.

*It is not unlikely that some tellurides of gold occur; but, so far as I can learn, none have been found. Mr. Robt. Harvie has found tellurides in similar deposits at Opasatica Lake, Quebec, which he described in a paper in vol. xiv., pp. 164-170.

‡C. W. Knight describes in Notes on Bureau of Mines Map, veins on Miller Middleton claims, having the composition of granite. See also A. G. Burrows' report, p. 19, 1911. J. Stansfield describes occurrence of feldspar in ore from Vipond Mine.

pyrite in the cleavage is generally more consistant in gold values than the clear masses carrying occasional spectacular showings. Mr. Robbins found the main vein to present an unbroken ore shoot for over 1,000 feet horizontally, to be 2 ft. to 20 ft. wide, and to be usually richer in the wide portions. The occurrence of galena was found to portend rich gold values and to a lesser degree the occurrence of sphalerite proved to indicate gold values. Large, blocky crystals of pyrite are usually attended by low values in gold, while finely crystalline pyrite occurs with relatively higher values.

It seems likely that the spectacular gold has formed by the growth of some gold grains at the expense of others in the immediate vicinity, and consequently much of the quartz near coarse gold is practically barren. The occurrence of gold with the poorly crystallized small grains of pyrite indicates that the deposition of the gold took place under conditions which were very unfavourable for the crystal growth. It is likely that the auriferous pyrite was deposited much more quickly than the non-auriferous pyrite. The different degrees of crystallization may have been due to rapid solidification from a hot solution in one case and slow growth from more gradual cooling or removal of solvents in the other. Evidently the conditions favourable to growth of large pyrite crystals were also favourable for the formation of coarse gold grains. Both are probably the result of redeposition under conditions quite different to those which obtained in the first deposition. The deposition in both cases, however, was probably at depth and from hot alkaline solutions.

The irregular distribution of the fine gold indicates that in the primary deposition there was a tendency for the gold and pyrite to segregate somewhat from the main mass of silica. There is no good reason to suppose that the contemporaneous deposition of gold, pyrite and quartz would result in very uniform distribution of the gold throughout the whole mass of quartz. The most favourable place for deposition of gold was evidently the vicinity of enclosing or enclosed rock.

Characters of the Gold Ores Determined by Mechanical and Chemical Treatment.—While all the ores are examined optically, it is done for the most part in a rather cursory manner, and by those who do not record their observations. The samples examined microscopically are very small and may not be representative. The samples assayed are much more numerous and larger, and we have found that the assays are in a general way such as might be expected from the ores described from optical tests alone. A consideration of the results obtained by milling and cyaniding should show whether the ore thus tested was similar to that examined microscopically and to the samples assayed.

Tests on the ores of the Dome and Hollinger Mines show them to be very free milling. Much of the gold is in clean quartz, from which it is very readily freed by crushing and then readily recovered by amalgamation. The remainder is rather readily recovered by regrinding and amalgamation, followed by cyanide treatment.

The results obtained in testing Dome Mine ore have been published in The Canadian Mining Journal, Feb. 15th, 1911, pp. 126-127. The ore was at first considered to be an ideal concentrating ore. The gold being closely associated with the pyrite, a high-grade concentrate was obtained. The tailings, however, were sufficiently valuable to warrant cyaniding. By regrinding the concentrate, it was found that a large percentage of the gold could be recovered by amalgamation. By grinding to 90 per cent. through a 200-mesh screen, 84 per cent. of the gold was recovered by amalgamation. The ore tested was found particularly free from cyanides, the only difficulty arising from the presence of a small amount of carbonaceous material, which made it necessary to lengthen the period of agitation to avoid a secondary precipitation. Mr. W. C. Merrill, designer of the plant, has recently been quoted as saying that the total recovery is expected to be not less than 95 per cent.

The results obtained in testing Hollinger Mine ore have been published in the first annual report, January, 1912. Tests for extraction were run upon a sample containing 2.1 oz. per ton. This sample was found to contain 4.86 per cent. of concentrates, and the concentrates contained 82.6 per cent. of the gold contents of the ore. (Shows intimate association of gold with pyrite, for very fine gold in clear quartz would not be in concentrate.) Following concentration the residue was leached with cyanide solutions, and after 114 hours' treatment, it was found that cyaniding had extracted approximately 60 per cent. of the remaining values.

In the second test the ore was ground in the mill to pass 120-mesh and split into two lots. The first lot was concentrated, the concentrates removed and the impoverished residue agitated by air in cyanide solution. After 34½ hours' treatment, the extraction by cyaniding of values contained in residues was found to be 95.1 per cent. and the combined extraction by concentration and cyaniding was 99.56 per cent. of the total original gold contents of the sample. The second lot of finely crushed ore was concentrated, but after pan-amalgamation of the concentrates, they were returned to the agitator to be treated with the tailings from the concentrator. The combined extraction by this method was practically 100 per cent., as the residue after 36 hours of cyanide treatment carried only a trace of gold. In these tests the concentrates amounted to approximately 37 per cent. of the total ore treated, and the consumption of cyanide was in the neighbourhood of two pounds per ton. Mr. Robbins states that the net result of the tests on Hollinger Mine ore was to show the necessity for fine grinding and also the advisability of extracting the concentrates for separate treatment.

Results of tests on ore from the Vipond Mine are given by E. M. Flynn in H. P. Davis' Handbook of the Porcupine Gold District, 1911, pp. 38-39. The ore was stamped to pass 20-mesh, passed over amalgamation plates, the pulp from the plates concentrated on Wilfley tables and the tailings separated into sand and slime. The sand was leached for 72 hours with 0.2 per cent. KCN solution. The recovery on the plates was 73.46 per cent., on the tables 14.06 per cent., and by cyanidation of sand tailing 3.20 per cent. Further cyanide tests proved that the extraction could be considerably increased by fine grinding of the sands. It was found that concentrate (25-1) from high-grade ore ($100 to $200 per ton) contains about the same gold as that from lower-grade ore ($20 to $30). The concentrate in each case was rather low-grade ($50 to $150), indicating that comparatively little gold is enclosed in pyrite.

From the intimate association of gold with pyrite, it is evident that on coarse grinding nearly all the microscopically visible gold would be contained in a concentrate comprising a very small part of the ore. Mr. Kirby's test, 82.6 per cent. of the total gold to be in concentrate con prising 4.86 per cent. of the ore.

From the microscopically visible gold enclosed in clear quartz and other light minerals, it is evident that many of the finer particles of gold would not be reached by cyanide solution unless finely ground. Mr. Kirby's test on the residue shows 40 per cent. unrecovered, and his screen test shows 61 per cent. of these values to be in sand coarser than 60-mesh.

Most of the microscopically visible gold associated with pyrite is not completely enclosed in pyrite or even in actual contact with it, and it is evident that if finely ground, it would be very readily amalgamated. All the mill tests show this to be the case.

From microscopic examination it is known that gold occurs in very minute particles, and it seems not unlikely that the invisible gold is present also as the native metal, but in particles of sub-microscopic size. The mill tests show results which would be expected if such very fine particles of native gold were present, and there seems no good reason to assume that the gold in pyrite is other than a mechanical mixture. There is then no evidence of the former existence of the gold in some mineral other than the native metal, and it is safe to conclude that part at least is in the form in which it was originally deposited.

Characters of the Wall Rocks.—The wall rocks are of several types, originally quite different, but by secondary changes having in common a high content of sercite, ferrodolomite and quartz. The wall rock of most of the ore bodies is a gray sericite-carbonate-quartz schist that was probably originally a quartz porphyry. Other wall rocks include basalt, porphyrite, conglomerate and gray slate. These are all much altered, and near the veins there is usually much pyrite present. It is commonly in well-formed cubical crystals. As a rule the amount of pyrite in the rocks is much greater than in the veins.

The characters which are common to all the wall rocks are of secondary* origin. It is evident that similar solutions penetrated and altered the different rocks and replaced some of the constituents by sericite, ferrodolomite, calcite, quartz and pyrite.

These minerals are especially abundant in the immediate vicinity of the quartz veins, and it is reasonable to suppose that they came through the fissures† which were subsequently filled by gold quartz. It is furthermore probable that the solutions came from the same source as the gold quartz.

Conclusion as to Origin of the Deposits.—We have in the Porcupine District pyritic gold quartz deposits enclosed in rocks characterized by an abundance of ferrodolomite, sericite and pyrite. The nature of the ore and the wall rock suggests that the gold was introduced into the fissures along with the chief constituents of the minerals mentioned. The solution which contained the gold probably contained also in some form iron, sulphur, silica, potassium and carbon dioxide. From the solution practically all the potassium and carbon dioxide escaped into the wall rocks and aided in the formation of sericite and ferrodolomite. Part of the iron and sulphur also escaped into the wall rocks and there formed pyrite crystals and contributed iron to the formation of ferrodolomite. Part of the iron and sulphur and nearly all of the gold and silica was deposited in the fissures themselves. It appears that the walls were more readily penetrated by some constituents than by the others, and in this way much of the water, carbon dioxide, potassium, sulphur and iron escaped. In proportion as these constituents escaped the solubility of the gold in the remaining solution would be decreased and the deposition therefore aided by removal of solvent as well as by lowering of temperature. The pyrite first formed in the veins was comparatively poorly crystallized and was probably formed quickly. The pyrite in the wall rocks and some pyrite in the veins that is probably of secondary origin is in well-formed crystals and evidently formed slower or at least under some more favourable conditions than did the original auriferous pyrite of the quartz veins. The gold and pyrite were not evenly distributed originally. Evidently in the first crystallization they tended to segregate here and there, and the especially favourable place for deposition was near the walls or around masses of enclosed rock.

After the filling of the fissures with quartz, gold and pyrite, the veins were shattered and the quartz granules strained or crushed. In the crushed zones a secondary set of minerals, including sericite, chlorite, calcite, ferrodolomite and pyrite and some gold were deposited. These probably originated in the vein and wall rocks. Much of the gold thus formed is in coarse grains, which probably grew by slow accretion of small particles by a process continued over a long period. It is probable that this coarse gold grew at the expense of the fine gold contained in the vein matter in its immediate neighbourhood, thus leaving much very low-grade quartz in the vicinity of the spectacular specimens. The coarse gold to which a secondary origin is here attributed, while showy, is usually quite subordinate in amount to the fine gold, much of which may well be still in the form in which it was first deposited with the pyrite and quartz. Some fine gold, however, is probably secondary, and there are cases in which the amount of secondary gold is greater than the amount of primary.

There is nothing to indicate that the character of the deposits has to any considerable degree been changed since the glaciers cleaned away the surface rocks, and there is therefore no reason for believing that the ore will show any appreciable dependence on the present surface. The secondary changes which have taken place are not surface alterations, but rather of a character which might be expected to take place at considerable depth.

From the information at present available, therefore, no remarkable change in the character of the ore with increasing depth is to be expected. It is also likely that in some cases at least similar ore shoots exist below those exposed. To what depth the individual ore shoots exposed at surface extend cannot be predicted. but unequal depths may be expected. Of those which had originally somewhat similar vertical dimensions, it is probable that some had lost very largely and others comparatively little by erosion. A first approximation is therefore obtained by assuming that one-half has been eroded. If we assume also that the vertical and lateral dimensions were originally somewhat nearly the same, our best guess, where no development work has been done, is that the ore shoot now extends to a depth equal to one-half the horizontal length. It is quite possible and, from the geological evidence, very probable that some of the deposits continue to great depth.

*Microscopic descriptions by C. W. Knight and A. G. Burrows of some of the wall rocks are given in the reports published by the Ontario Bureau of Mines. The ores and wall rocks of the Vipond mine were described by J. Stansfield in Canadian Mining Journal, Feb. 15, 1911, pp. 109-115. The ores and wall rocks at the Dome, Hollinger and Rea mines were described by R. E. Hore in a paper submitted to this Institute in 1911, pp. 171-184, vol. xiv.

†Remarkably similar characters were found by Lindgren in wall rocks of California gold quartz deposits. He gives descriptions and chemical analyses of these rocks in a paper on "Metasomatic Processes in Fissure Veins." Genesis of Ore Deposits read at Washington meeting (1900) A. I. M. E., and republished on pp. 586-588. In another paper entitled "Metasomatic Processes in the Gold Deposits of Western Australia," Econ. Geol. Vol. 1, 1905, pp. 530-544, Mr. Lindgren describes similar features of the Kalgoorlie gold fields, and concludes that the remarkable similarity of the rock alteration at the Mother Lode (California) mines to that at Kalgoorlie gold fields, and concludes that the remarkable similarity of the bearing veins from solutions practically identical in their general composition.

THE NICKEL DEPOSITS OF SUDBURY DISTRICT

By A. P. Coleman.

The nickel ores which give economic importance to the region are of a very uniform and monotonous character. In all the larger mines the ore consists of pyrrhotite in largest amount with subordinate quantities of pentlandite, (Ni Fe)S and chalcopyrite. The pentlandite may be finely disseminated through the pyrrhotite and not apparent to the eye, but polished surfaces of the ore, as shown by Campbell and Knight, prove its presence under the microscope. The ore always contains small quantities of the norite minerals and sometimes fragments of norite or country rock. The country rock may be any of the older formations, sediments of the Sudbury series, acid or basic eruptives, or Laurentian gneiss, without in any way affecting the ore deposits; but no ore deposit has yet been found without norite. "No norite, no ore," is the law of the district. There are, however, long stretches of the norite edge where no ore occurs, where the sheet is unusually narrow, or where the country rock bends inwards instead of outwards. There are cases where the norite edge is gossan covered continuously for more than a mile, as in the vicinity of the Murray mine.

The ore bodies may be divided into two principal kinds, marginal deposits, at low points or bays on the edge of the norite; and offset deposits, where channels lead out from such bays conveying the ore mixed with norite to various distances from the edge, sometimes even three or four miles.

The best example of a marginal deposit is at Creighton, where one of the largest bays of the norite edge has furnished the greatest nickel mine worked in the district or in the world up to the present. The Creighton mine began as an open pit, which is now nearly 300 feet deep, with lower levels worked by underground mining. The country rock is granitoid gneiss and the ore body which rests upon it dips 34 degrees inwards towards the central line of the nickel basin. The ore is unusually rich, containing about 6 per cent. of nickel and copper, the latter making up a quarter of the whole, and specimens showing pentlandite are often found. It may be distinguished from the enclosing pyrrhotite by its octahedral cleavage and brassy colour as compared with the bronze of the more common mineral. The greenish yellow of the chalcopyrite is more easily recognized.

It is interesting to find that the dikes of fresh diabase cutting the rock and ore in various directions are glassy against the ore, which was a good conductor of heat, and only fine grained against norite or gneiss where the chilling was not so rapid.

The best examples of offset deposits are at Copper Cliff, where a large bay of norite narrows towards the southeast into a dike-like band of norite and ore which ends in the great columnar ore deposit of No. 2 mine. The open pit gives a good opportunity to see the shape of a characteristic offset deposit, which has been followed downwards for more than 600 feet.

A quarter of a mile to the south is the once renowned Copper Cliff mine, a still better example of this type, which reached nearly 1,300 feet in depth on an incline of 77 degrees to the east, and for years supplied the richest ore in the district, averaging nearly 9 per cent. Most offset mines are richer in copper than the marginal mines and the Copper Cliff ore contained more copper than nickel, justifying its name.

Two other deposits have been worked to the southwest and south at intervals of a quarter of a mile and of three quarters of a mile, but they were of minor importance. All of these ore bodies are associated with some norite spotted with blebs of ore, but they show no surface connections with one another or with the main mass of norite and must have been supplied by devious channels between the shifting blocks of country rock. Whether these channels still exist beneath the surface or were above the present level is uncertain. Probably the present surface is thousands of feet below the original one, so that connections from above might have been eroded away.

The columnar deposits at Copper Cliff and No. 2 mine are not the most extraordinary of their kind, since two still smaller columns have been followed downwards for 1,600 feet at Victoria mine.

The Copper Cliff offset deposits occur in contact with a variety of country rocks such as granitoid gneiss and greenstone among eruptives, and greywacke and pink quartzite of the Sudbury series among sediments, without any change in the character of the ore; and they are cut by dikes of granite and diabase which have likewise had no appreciable effect in changing the original ores.

In addition to typical offset deposits where the connection with the basic edge of the nickel eruptive is manifest, there is one very important band of gossan and ore which runs nearly parallel to the edge of the norite with no suggestion on the surface of any connection. This is the Frood-Stobie offset north of Sudbury, the largest known body of ore in the district. There must have been subterranean channels through which the pyrrhotite-norite and ore reached their present position in this unique case. The Frood-Stobie offset runs as a narrow gossan covered ridge with one or two interruptions for nearly two miles from southwest to northeast, and touches several types of rock, such as greywacke and greenstone, but nowhere comes within three-fourths of a mile of the norite edge.

Diamond drill cores prove that the deposit dips at first with an angle of 60 degrees or 70 degrees toward the norite, while at a greater depth the inclination flattens decidedly suggesting a broad underground connection wih the parent eruptive sheet.

The Frood-Stobie offset has been proved to contain more than 35,000,000 tons of average ore and far surpasses in magnitude any other known ore body in the Sudbury region. It has already furnished half a million tons of ore, and shafts are now being sunk by both Canadian Copper Company and the Mond Company, so that it will soon add greatly to the quantity mined in the district.

*Extracts from Guide Book No. 7, published by Geological Survey of Canada for Twelfth International Geological Congress.

ANNUAL REPORT OF THE MINISTER OF MINES FOR BRITISH COLUMBIA FOR 1912

(Continued from August 15th Issue.)

Quantity and Sources of Ore Mined.

The total quantity of ore mined in 1912 was 2,688,532 tons, which was 472,104 tons more than in any other year, equivalent to an increase of 21.3 per cent. over the tonnage of 1910, previously the highest year. The percentage of production of the several districts was as follows: Boundary, 74 per cent.; Rossland, 9.07 per cent.; Coast, 8.03 per cent.; Slocan, 5.07 per cent.; Nelson, 1.94 per cent.; East Kootenay, 1.87 per cent.; all other parts of province, 0.02 per cent.

Taking the province as a whole there was 790 tons of ore mined during the year for each of the 3,402 men employed in and about the shipping mines. The quantities ranged, in connection with divisions or districts that produced more than 50,000 tons in the year, from 2,354 tons a man in Boundary district, down to 178 tons in Nelson division.

Output of Coal and Coke.

The gross output of coal mined in 1912 (which includes the coal made into coke) was 3,025,709 tons (2,240 lb.) as compared with 2,297,718 tons in 1911 and 3,139,235 tons in 1910. Had it not been for labour troubles at the mines of the Canadian Collieries (Dunsmuir) Limited, during the last quarter of the year, a result of which was that the output of those mines was about 150,000 tons less than in 1911, there is little doubt that 1912 would have been the record year for production of coal in the province. However, the year's output was only 113,526 tons less than that of the record year—1910—so that with this single exception it was greatly in advance of that of any other year. The net output of coal, that is, after deduction of 396,905 tons made into coke, was 2,628,804 tons, as compared with 2,193,062 tons in 1911 and 2,800,046 tons in 1910. In the last mentioned year, though, the quantity made into coke was somewhat smaller—339,189 tons. The coke production for three years was: In 1912, 264,333 long tons; 1911, 66,005 tons; and 1910, 218,029 tons. Only in one other year has there been a larger production of coke than in 1912, namely, in 1905, when the output was 271,785 tons. It will be seen that while there was a net decrease in output of coal in 1912, as compared with 1910, of 171,242 tons, there was an increase in coke of 46,304 tons. The difference in value of coal and coke produced in 1912, as compared with 1910, was $321,523, the respective totals having been $10,786,812 in 1912, as against $11,108,335 in 1910.

The gross production of the several collieries was as follows:

	Long tons.	
Vancouver Island—		
Canadian Collieries (Dunsmuir) Ltd.	741,569	
Western Fuel Co.	576,797	
Pacific Coast Coal Mines, Ltd.	151,589	
Vancouver-Nanaimo Coal Co., Ltd.	88,253	
		1,558,208
Queen Charlotte Islands—		
British Pacific Coal Co., Ltd.		32
Nicola Valley—		
Nicola Valley Coal & Coke Co., Ltd.	142,973	
Inland Coal and Coke Co., Ltd.	31,300	
Diamond Vale Collieries, Ltd.	3,310	
		177,583
Similkameen—		
Princeton Coal and Land Co., Ltd.	28,174	
United Empire Mining Co.	500	
		28,674
Crow's Nest—		
Crow's Nest Pass Coal Co., Ltd.	950,706	
Hosmer Mines, Ltd.	188,243	
Corbin Coal and Coke Co., Ltd.	122,263	
		1,261,212
Gross production of coal		3,025,709

Of the 264,333 tons of coke, the Crow's Nest Pass Coal Company produced 218,954 tons, and the Hosmer Mines, Ltd., 45,379 tons.

A table in the Report shows the output of coal and per capita production of the districts and province over a period of six years—1907-1912. Taking two years (for reasons previously explained 1911 is not taken), the following figures will be of interest:

	Districts. East Kootenay.	Coast.	Whole Province.
For year 1910—			
Gross tons of coal mined	1,365,119	1,774,116	3,139,235
Total number of employees	3,111	4,647	7,758
Tons of coal mined in year per employee	439	382	404
Number of men employed underground	2,374	3,529	5,903
Tons of coal mined per underground employee	575	502	532
For year 1912—			
Gross tons of coal mined	1,261,212	1,764,497	3,025,709
Total number of employees	2,410	4,720	7,130
Tons of coal mined in year, per employee	523	374	424
Number of men employed underground	1,780	3,495	5,275
Tons of coal mined per underground employee	708	504	574

Markets and Prices for Coal and Coke.

The following excerpt from the comments of the Provincial Mineralogist will serve to give brief information relative to the markets for the coal and coke produced, and prices ruling for the former:

"The coal fields of the province which are at present producing may be divided into main divisions—those of East Kootenay district and of the Coast district. These fields, from their geographic positions—the one at the extreme eastern boundary of the province, and the other at the extreme western edge—are in no way competitors in the market, their mar-

kets being quite separate and ruled by completely different conditions.

"The market of the East Kootenay field is provided primarily by the railways of the south-eastern part of the province and of the northern parts of the adjoining States of Montana and Washington, approximately two-thirds of the coal sold as such being exported to those states, while the other one-third goes to supply the demands of the south-eastern part of the province —its domestic needs, railways, steamboats, mines, and smelters. Coke, a product of the coal mines, is sold in the same markets, with the difference that the local consumption—chiefly by the smelters of Trail and the Boundary district—takes more than 80 per cent. of the product, while 20 per cent. is exported to the states mentioned. As regards the marketing conditions in this field, the East Kootenay collieries are, however, brought into direct competition with the collieries of Alberta just over the provincial boundary line, all these collieries being in the same coal field, with practically the same grade of coal and working under similar conditions. This competition has kept the price obtainable for coal from $2.25 to $2.50 a ton, with little probability of any material increase in price, owing to the facility with which new collieries can be opened and the very large reserve areas of coal in that district.

"The Coast district may be subdivided into two fields—the Nicola-Princeton and the Vancouver Island fields—in which the markets differ considerably. In the former field the consumption is chiefly by the local railways, while a small amount of coal finds its way to Vancouver, even under the handicap of what seems to be an excessively high freight charge. The Vancouver Island coal market is provided by the domestic and manufacturing requirements of the Coast cities, and of the ocean-going steamers calling at these ports. The demand for coal from the larger coasting steamers and from the railways has in the last two years diminished, as the Canadian Pacific Railway main line engines are nearly all burning California crude oil, and a large coasting steamer burning coal is now an exception. Notwithstanding the heavy consumption of crude oil, the coal sales have remained about constant, approximately 70 per cent. of the coal sold having been for use in British Columbia, 20 per cent. exported to the United States, and 10 per cent. to other countries, chiefly Mexico. In the Coast district the demand for export coal has been so great and constant, particularly on the seaboard, and the prices obtainable so satisfactory to the shippers, that it has permitted of the domestic price being kept at a figure so high as to admit of the importation from California of fuel oil as a competitive fuel, where conditions permit of its use. It would appear, therefore, that the present price of coal on the seaboard, of from $4 to $4.50 f.o.b, is not liable to decrease for some time."

Where the Bulk of the Metals is Mined.

Of the total of $555,500 for placer gold, $230,000 is from Cariboo and Quesnel divisions, $290,000 from Atlin, and the remaining $35,500 from other parts of the province, which are comparatively small producers of this metal.

Rossland mines contributed lode gold to the value of approximately $2,730,000, which was rather more than one-half of the total (of $5,322,442) for the whole province, Boundary district mines $2,167,000, Nelson division mines $362,000, those of the Coast nearly $52,000, and about $11,000 from other parts.

Of the total value of the output of silver—$1,810,000—Slocan and Ainsworth silver-lead mines are credited with $1,132,000, Boundary district (in which the precious metals occur in association with copper) $225,000, East Kootenay $222,000, Nelson $95,000, the Coast about $61,000, Rossland $50,000, and Lardeau $25,000.

Lead was produced chiefly in the Ainsworth-Slocan district and in East Kootenay. The former produced $877,000 out of a total for the province of $1,805,000, while East Kootenay's output was valued at $824,000. The proportion from Nelson division was $92,000, that from Lardeau $9,000, and a small quantity from Portland Canal division.

Boundary district produced copper to the value of $5,453,000, the Coast $2,536,000, and Rossland $415,000. The small remainder of the total of $8,408,000 was from Nelson division.

The production of zinc was about $308,000 from Slocan mines and $8,000 from North-east Kootenay.

Some Noteworthy Features of Report.

In addition to much interesting and valuable comment by the Provincial Mineralogist, under the head of "Progress of Mining," there are other features of the report that are noteworthy. These include the reports of the Provincial Assayer and the Secretary of the Board of Examiners for Coal Mine Officials, respectively; those of the gold commissioners for the more important of the districts; the several special reports and compilations by the Provincial Mineralogist, and an illustrated report by Mr. C. F. J. Galloway on the "Coal Measures of the Peace River Canyon."

Among subjects of interest concerning which there also is information are the following: Reports of the Provincial Mineralogist and Mr. Geo. Watkin Evans on the Groundhog coalfield; that of the Provincial Mneralogist on his further investigations into the alleged finding of platinum and metals of that group in certain dikes in the vicinity of Nelson; several short reports on field work by the Provincial Assayer; on Dease Lake district, by the Provincial Mineralogist, and a comprehensive review of coal mining in the province by the same official. A valuable feature is the lengthy report of the Chief Inspector of Mines (Mr. Thomas Graham), who took office on January 1, 1912, in which are included a review of accidents in coal mines, mine rescue work, first aid to the injured, metalliferous mine accidents, an account of attendance at the Fourth Annual Convention of the Mine Inspectors' Institute of the United States of America, held last summer at Columbus, Ohio, and a report on an explosion at the Diamond Vale coal mine in March, 1912. The several reports of the district inspectors of mines are also of value.

Report is Well Illustrated.

Reproductions of photographic views are numerous in the report, many of the half-tones being excellent, and well printed. Zinc-line cuts and lithographs are also used for illustrative purposes; among these is a sketch map of part of Laird, Stikine and Skeena mining divisions, compiled and drawn by Mr. Harold T. Nation, of the Provincial Mineralogist's office.

A full index makes the report complete. Generally this publication is well up to the high standard reached in other recent years, and is a really useful publication, reflecting credit on the Provincial Mineralogist, who did the chief work in its preparation, on the officials who assisted him, and on the British Columbia Government printing office for its excellent printing and press work.

MICHIGAN COPPER MINERS' STRIKE

A representative of the Western Federation of Miners has given out the following statement in reply to that of the operators, from which we quoted in our last issue:

"At a later date I may compare the records of the Mine Operators' Associaton with that of the Western Federation of Miners. When I do it will not be necessary for me to bolster up our cause with such falsehoods as disfigured the operators' statement. The naked truth will be sufficient to win the plaudits of mankind for an organization that has been instrumental in putting more eight hour laws on the statute books of states and provinces than all others combined, has raised wages, improved working conditions, has been the voice of the silent ones who could not tell the story of their wrongs and whose individual protests were met by a time check in the hands of employers who were ruthless toward human rights. The mine operators of Michigan may eulogize themselves. No one else will. The 5,000 mine workers who have left the district because of wages and working conditions and the solid organization of those who remain makes sufficient comment. The Western Federation of Miners has done all in its power to alleviate and improve the conditions of the metal mine workers. When western miners have asked for improved conditions the operator has pointed to Michigan with its low wages and long hours. They have complained of the unfair advantage Michigan competitors have. Michigan operators deluded themselves with the idea that a time check for men bold enough to express discontent and a judicious use of "con" seasoned with grape salt tears at the miners' picnic could take the place of decent wages and working conditions. But neither tears nor fine words nor time checks can satisfy the workers' demands. The same men who are eulogized at picnics are lined up in the Federation and will not be satisfied until their demands are granted.

"To say that men who have been working from ten to thirteen hours a day do not desire the eight hour day enjoyed by other miners is to fly in the face of common sense. To say that miners working on company account for about $2.70 a day, and when on contract sometimes get a cipher with the rim knocked off; to say that such men will not accept a minimum of $3 a day, except under the duress of a mob, does not sound over-reasonable. That is on a par with many other statements. They wanted them so badly that not even the sheltering arms of the troops nor the tender carresses of Waddell thugs are able to seduce them from their allegiance to the union.

"To say that surface employees, many of whom enjoy the princely wage of $1.85 per day, do not desire and need an increase of 35 cents a day will not appeal to anyone who knows what is required to decently support a family. The hurried call for troops and the Governor's eager response, the evident desire of the commanding officers to put the mines in operation show the forces against us. Men with the instincts of justice and fair play will condemn the call for troops, the response to the call, and the use that is now being made of them—and all for the purpose of saving money for the mine owners and not for the preservation of peace.

"To meet representatives of their employees in conference would break a long record for disregarding the rights of others, to grant their modest demand would give peace to a community and a small measure of justice to those who have long been denied consideration.

"During the thirty-five years of the existence of the organization in Butte, Montana, twenty of it under the Western Federation, during which there have been no quarrels between the employees and employers, refutes some charges made very effectively. The men of Butte are the best paid miners on the continent, and relations between the union and the mine operators are as satisfactory to both parties as can be found. Why should not Michigan operators emulate the example of those of Butte?"

THE CONDITION OF THE MINING INDUSTRY IN LONDON*

By A. G. Charleton, M. Inst. M.M., A.R.S.M.

Artificial and sudden "booms" are always bad, since they injure legitimate mining business, but we need, in order to make constant and steady progress, to promote sound undertakings, and new ventures are necessary to maintain mining in a flourishing condition. There can be no doubt that mining business in London at the present moment, unfortunately for everybody concerned, lacks that support from the public which is essential for its healthy development, and which formerly it used to command without any difficulty.

The present "slump" in mining is not confined to London, of course, but it is perhaps at its worst here, and the only way to lift it to its proper position is, I believe, to let the public share in its successes in place of letting them in for a succession of failures, and to put the control of operations in the hands of directors and of technical men of unquestionable professional standing, who will look after their interests properly. It is equally futile and dangerous either to generalize or to dogmatize too much in regard to mining, because it presents so many exceptions to the rule; but one may confidently hope that as time goes on the number of failures will be minimized, as education extends and the ethics of finance, as well as the ethics of the profession, are put upon a higher plane, which, properly directed, is bound to come about. It is necessary, however, to educate the public as well as the mining engineer in this conenction, and mining requires new life put into it to be lifted out of the grooves and ruts into which it has lately sunk.

In a paper which I presented to the Institution of Mining and Metallurgy in 1911 I commented upon the future of the mining industry from an economic standpoint, and pointed out the magnitude of the interest involved in the mining and metallurgical industries of the British Empire. The value of mining as a national industry of the first importance cannot be disputed, and Mr. Bedford McNeill, in his presidential address to the Institution of Mining and Metallurgy,

*From Financial Times, London.

delivered on 13th March last, pointed out "the close association of mining and capital," and justly remarked that "at practically all points (commencing at a minimum when prospecting) the mining engineer is in close contact with finance." "It is in connection with the finding and losing of capital that so many difficulties and perils occur to the members of our profession."

The record of the British enterprise will undoubtedly suffer a serious blow if bona fide mining enterprises fail to secure that consideration and public support which they have been accustomed to receive in the past from financiers.

The speculative nature of mining ventures generally cannot, of course, be disputed; but, as Mr. McNeill observes, "each successive advance of the science of mining ought to tend to equalize its increasing hazards." Nor can we lose sight of the changing conditions of the present century, both in technical progress and in financial practice, and the consequences of international competition and the extension of railways in different parts of the world. But the general trend of modern progress, particularly in the matter of technical mining education, should tend to make mining less hazardous than it was formerly, particularly if the higher standard of ethics, that I believe now obtains generally amongst mining men, is taken into account; and it is a most important factor.

The reasons advanced by recent writers for the "slump" in the mining industry do not strike me by any means as covering the ground completely, and when the ebb ends, as it will do in time, the stream of mining business will probably flow along as it used to do, but along different channels perhaps, to those which it has been accustomed to follow. You cannot change industries or malpractices in a year or a day, but they can be, and have to be, altered in process of time to meet the conditions of the day, as the public are contsantly demanding change and novelty. And they get new dresses and new dishes; but the essential components and the flesh beneath remain the same, whilst we learn from experience new and improved methods of mining and new ideas upon finance.

Causes Summarized.

If we seek and probe the true causes which are responsible for the loss of popularity from which the mining industry is at present suffering, I venture to think that some advance may be made by locating and diagnosing the disease, for it is important to prevent dry-rot—which can be dealt with—spreading. The causes may, I think, be briefly summarized as follows:

1. The excellent security and rates of interest yielded by "gilt-edged" securities.
2. Booming trade, calling for all the available cash for investment in industrial business.
3. Mining scandals and overcapitalization, which have frightened shareholders and done injury to legitimate mining promotions.
4. The higher cost of living, which, leaving them no margin for acquiring interests in mining, has heavily taxed a number of small capitalists.
5. The practical disappearance of the old-time company promoter, who appealed to the public direct.
6. The failure of the public to discriminate between mines of different kinds like those of the Rand, and mines of a more speculative nature, since the lives of mines, like many of those in the Transvaal, are known with almost mathematical certainty, and their revenue and expenditure can be very closely estimated. As a result of this, the uninformed public have been led to expect that the same can be done in all cases, which is not, of course, the case; and to expect all mining ventures to be of this gilt-edged mining class.
7. The general policy of the big financial houses, into whose hands most of the mining business has drifted —namely, that of giving attention only to developed mines whose "present value" can be calculated fairly closely. (In fact, British engineers are not "prospecting" and London financiers are not backing them in exploring and opening up the "black-blocks" of our colonies and elsewhere, in searching for promising mineral deposits as they used formerly to do, and one would imagine that the chances, on the whole, were more in their favour now than they used to be).
8. The fact that the Stock Exchange are disposed to run mining shares too quickly up to a price at which they will not yield a rate of interest that the public expect in order to give them a fair run for their money.
9. The general state of unrest in countries like Mexico, where the mining industry is extensively carried on, and local labour troubles in Australasia and elsewhere.

The causes referred to in Nos. 1, 2 and 3 have been frequently discussed in articles and letters in the press, but little notice has been taken of the other outside influences which I have mentioned.

There have been, it is true, no notable new gold discoveries made during the past three or four years, and the value of mines that have been discovered has been discounted before the shares have reached the public. Of the new mines placed on the market, it is rare to find one that has exceeded expectations; in fact, the general rule has been to fail to come up to financial exigencies, and whilst the promoters may have made money on the deal the public have lost. So long as it is a case of prizes for the one and blanks for the other, just so long will the public hold aloof from the industry which it is so necessary to support. It is their money which makes mining enterprise possible, and when their capital is cut off, as at present, the industry suffers, carrying with it promoters and directors, who are losers in the long run by this short-sighted policy, and incidentally dragging the mining profession after them.

The vast improvements made in economic geology, metallurgy and mining engineering of late years have caused mining valuations to become much more exact, so that the buyer and seller know the value of their deals and such risks as they have to run; hence there is not the excuse there was formerly for over-capitalization or the flotation of valueless mines. If the shareholder had a fair chance to come in on bed-rock to share in the profits to a reasonable extent, and could see his shares gradually increasing in value, in the case of a good property in process of development, he would view mining in a different light and help the industry forward. Members of the mining profession have been gradually opening their eyes to this state of affairs, and in proof of this I may quote a well-known mining engineer, who has written:

During nearly four years spent in Mexico I have never met a representative of an English company who was not looking strictly for large developed properties with ore reserves and good looking bottom levels. In addition he expected to obtain easy terms and to be able to float the property immediately, and to make large profits after having provided working capital.

A developed mine rarely possesses great opportunities for new discoveries; it therefore lacks the allurement of a favourable undeveloped property which might be classed as a speculation. If only mining investments are to be endorsed we must in future confine ourselves to the mines that are now developed. This would kill the mine industry.

While the mining profession is rusting a few wealthy mine operators are gaining a monopoly over the mines and metals of the world. Mine finance companies would be more successful if they would begin to look more strenuously for favourable "prospects" and endeavour to make "mines" instead of working the "markets."

All professional men would like to see the public look upon mining shares as titles to properties instead of gaming chips.

It is time that mining people generally in London took steps to restore and maintain public confidence in mining enterprises.

Some strong remarks have been made recently, with perfect justice, about the use sometimes made of information before it reaches shareholders, and just as the officials of a company are usually precluded from dealing in its shares without the knowledge and permission of the board, the same useful provision in respect of everyone concerned in the management of a company, if put into force, would certainly do much to restore confidence in the industry. Another point to which attention has lately been directed is the suggestion that a mining engineer ought to be upon every board, so as to ensure that all technical reports were thoroughly understood and questions arising out of them might be dealt with, and not shelved without proper consideration.

Necessity of Opening Up New Fields.

But granted that these changes and improvements in practice were made, the necessity of opening up new fields for the industry still remains paramount. Little has been done in London of late years to open up new mining fields, and we need the discovery of some new and great gold field to galvanize mining into renewed activity. London did not share in the early development of Cobalt or Porcupine, or other such discoveries that have been made in recent years. In spite of the great advancements made of late by the engineering profession, prospecting and developing mines has been looked upon—without any sufficient reason—with distrust. It has been either from America, Germany or our Colonies themselves, that money has been found for this essential prospecting and development, which is the key to fortune in mining in most instances. You cannot win big prizes in business without taking certain chances and risks; even given the skill and knowledge that can alone command success, when it comes to the point of applying them to a definite object.

In America the trouble in regard to "prospecting," to which I have referred, has been recognized as being a serious one, and a commercial organization was started in Colorado to encourage "prospecting," it being noted that a decline of 33 per cent. had taken place in the production of metals in the State of Colorado in ten years. The Denver Chamber of Commerce, co-operating with other commercial bodies, solicited funds and appointed a committee to make contracts with prospectors and to furnish necessary outfits for a season. Money was raised and 34 parties were sent out, who made 43 "locations." The committee were of opinion that the claims held warranted further development, and a "development company" was formed to work them under the direction and management of a number of eminent engineers and leading financiers. I am not aware of what measure of success it met with, but it appears to have been a serious attempt to promote mining interests, and the people concerned in it seem to have got a fair run for their money.

The second stage—that is, after a mine has passed the point of being a mere "prospect"—is, in my opinion, the one in which the public should be encouraged to participate, because they stand the chance of making most profit out of it, provided that the undertaking is honestly financed (without having to pay too dearly for promotion expenses), intelligently directed and technically well managed.

COMPANY NOTES

MOND NICKEL COMPANY.

The thirteenth ordinary general meeting of the Mond Nickel Company, Ltd., was held yesterday at the Hotel Windsor, 46 Victoria street, S.W., the Rt. Hon. Sir Alfred Mond, Bart., M.P., (the chairman), presiding.

The chairman, in moving the adoption of the report and accounts, first dealt with the figures in the balance sheet, and remarked that the first item on the credit side showed an addition of £8,938, which had practically all been expended in the development of the company's mines in Canada. In the next item, the smelting and refining works, there was a large addition of over £168,000, which the shareholders would have anticipated from last year's report, in which the directors informed them that they were building a large new smelting plant at Coniston, Ontario. The largest part of the expenditure was in connection with this new smelter, and the balance was incurred in increasing the refining works at Clydach, in South Wales. On the other side of the balance sheet they had written off the reserve suspense account, £35,000. which represented the greater part of the balance of the old smelting plant, which they had abandoned since the beginning of the current financial year, when the new smelter was started. He was informed that approximately £10,000 would be required next year in order to complete the writing off of that item. The shares in other companies showed a slight increase, which was largely a nominal one. In order to deal with the housing difficulties in South Wales, they had to extend the cottage accommodation for the workmen, and a small internal company was formed for the purchase of the land and the erection of the cottages. The increase in this item consisted almost entirely of shares which they had taken in this new estate company. The suspense account had been increased by £4,000. During the year they had taken an option on a very important property in Ontario, and they always put money which they paid for options to suspense account, pro tem, so that if they did not take up the property they could write it off. The balance at credit of profit and loss account showed the very substantial and gratifying increase of £47,000 over that of the last financial year. He thought shareholders were to be congratulated on this very fine increase in the year's trading. With the sum carried forward from profit and loss account last year of £41,381, the

total amount to the credit of profit and loss account after deducting fees was £232,429.

Appropriation of the Profits.

The directors proposed to deal with this balance as stated in the report. The dividend on the preference shares, being fixed, called for no comment. The directors had decided to make a substantial increase in the dividend on the ordinary capital. They had, he thought, a right to claim that they had acted in a conservative manner in regard to their dividend distributions. The business was a growing one, and they had every reason to anticipate a much greater development in future years to what they had seen in the past, but they had always felt it right not to pay away their profits up to the hilt. On the other hand, they thought the shareholders were entitled to a reasonable percentage of the year's earnings. The board, therefore, decided to increase the dividend to 21¼ per cent., which was an increase of 5 per cent., and would absorb the sum of £60,031. The dividend on the deferred capital moved automatically with the profits distributed on the ordinary capital. The premium on the debenture stock offered last year—namely, £3,750—had been placed to reserve, and it was proposed to place £16,250 to reserve, compared with £15,000 last year. This would bring the reserve fund up to £220,000, which he thought was a respectable figure for a company with an issued capital of £750,000. The directors had also decided to place to reserve suspense £40,000, compared with £20,000 last year. By writing off £35,000 they reduced the present reserve suspense account to £5,000, and the board felt it a wise thing to re-establish this account to a reasonably larger amount. The balance to be carried forward this year was £49,525, compared with £41,381 last year, so that they had a very substantial balance forward, which they could deal with at any time when they thought it desirable to do so. As stated in the directors' report, the progress of the operations of the company in Canada and England had been very satisfactory. Last year he mentioned that they were building a new smelting plant at Coniston, Ontario, on the most improved and up-to-date lines. It had been a long and difficult task to erect this plant in a country where they had a very long and severe winter. They were promised that the plant would be ready to operate this June, and he was glad to be able to say that so accurate was the planning and estimating of the staff in Canada that the date they gave for its completion, more than two years ago, was anticipated by a fortnight. The plant since it started had been running continuously and seemed to be in every way successful. It was a very fine plant, and occupied a very fine situation, and he and some of his colleagues intended to visit it this autumn. During the year they had been continuing the erection and the extension of the company's works in South Wales, to which he referred last year. The work was progressing satisfactorily, and it was expected that during the present financial year the plant would be completed.

Further Mining Properties Acquired.

As he had already mentioned, they had taken an option of one important property in Canada, which they were examining now, and on which it would be premature to express an opinion, but he might say, for the information of the shareholders, that since the closing of the last financial year they had acquired some further valuable mining properties in the neighbourhood of the properties they already possessed in Canada. They had a good opinion of those properties, and the examination which had been made of them seemed to promise valuable results. The ore reserves of the company at the present time were very much larger than they had ever been in the history of the company, and on conservative data they had no reason to doubt that the mines they possessed would supply the company with raw material for many years to come. There was no doubt that the nickel business was a developing one; it was growing every year, and as they had, in his opinion, the finest and cheapest refining process which existed to-day in the industrial world, they would be foolish not to take every opportunity of extending and developing the business from what it was now to a very much larger thing in the future.

Dr. Bernard Mohr proposed the re-election of the retiring directors, Sir Alfred Mond, Mr. Robert L. Mond, and Mr. Emile S. Mond.

Mr. Robert Mathias seconded the motion, which was unanimously agreed to.

PERSONAL AND GENERAL

J. G. McMillan, who has been making harbour surveys at Moose Factory, James Bay, returned to Toronto August 8th, and went west on the C2 excursion of the Geological Congress.

Mr. Fred Murphy, formerly of the Canadian Copper Company's staff at Copper Cliff, and now chief engineer of the Crow's Nest Coal Company, was among those who guided the C2 excursion party to the properties at Coal Creek. Mr. Murphy is resident at Fernie, B.C.

Mr. Neil Macdonald, formerly connected with development of mining properties in Northern Ontario, is now engaged in exploration of properties in the Rice Lake district, Manitoba. Mr. Macdonald's headquarters are in Winnipeg.

Hon. Louis Coderre, Minister of Mines, Ottawa, accompanied the C2 excursion to British Columbia, and is now at Vancouver.

Among those who visited Sudbury, Cobalt and Porcupine on the C6 excursion were: Dr. Richard Beck, of Freiberg, Germany; Dr. Alfred Bergeat, Universitat, Konigsberg; W. S. Bayley, Illinois; Sir Thomas Holland, England; Dr. J. P. Krusch, Berlin; H. B. Patton, Colorado; Dr. J. J. Sederholm, Finland; Dr. C. H. Smyth, Princeton; Dr. J. E. Woodman, New York; Dr. J. Stansfield, Montreal.

Dr. Donald G. Forbes, an experienced mining engineer, who some years ago was in charge of the Silver Cup, Nettie L. and other mines in Lardeau district, British Columbia, is this field season investigating mining conditions in several Coast mining districts, for the purpose of reporting thereon to the British Columbia Department of Mines.

Mr. Robert R. Hedley, of Vancouver, B.C., has commenced doing preliminary work on the Tassoo copper property, situated on the west coast of Moresby Island, of the Queen Charlotte group, on which property there occurs an ore body more than 300 ft. wide.

Mr. W. H. Trewartha-James, for several years general manager for the Tyee Copper Company, operating in British Columbia, was recently reported by English journals to have returned to London from Northern Nigeria.

Mr. Con Wolfle and associates, of the State of Washington, have bonded some mineral claims situated in the neighbourhood of Quatsino Sound, and intend to proceed with the development of them.

Mr. R. B. Lamb, of Toronto, is in Nevada on professional work, until the end of September.

The Roberts and Schaefer Company, engineers and contractors, Chicago, have closed a contract for the building of a 600 ton capacity Holmen coaling station at St. Lambert, Quebec. Price $17,000.

Mr. W. H. Taylor, of Spokane, Washington, is mining engineer in charge of development work on a group of mineral claims bonded by Mr. P. Clark, and situated in Summit camp, in the vicinity of the headwaters of the Tulameen River.

The Committee of Management of the International Engineering Congress, 1915, takes great pleasure in announcing that Col. Geo. W. Goethals, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has consented to accept the honorary presidency of the Congress, and will preside in person over the general sessions to be held in San Francisco, September 20-25, 1915.

The B. F. Sturtevant Company, of Canada, Limited, have arranged for a plant in Galt, Ont. From this plant the company will handle all business in Canada, and also export to England, Australia and other foreign countries. Some of the more important apparatus which will be built are fans and blowers, planing mill exhausters, propeller fans, heating and ventilating apparatus, fuel economizers, mechanical draft, steam turbines, vertical engines, generating sets and stokers.

The members of the C2 excursion now visiting mining districts in British Columbia and Alberta, are: E. M. Anderson, Geological Survey, Edinburgh, Scotland; John Ashworth, M.E., Manchester, England; Sir Augustine Baker, Dublin, Ireland; H. E. Boeke, Dr., Professeur Mineralogisches Institut, Halle a.S., Germany; Dr. O. B. Boggild, Professeur Mineralogical Museum, Copenhagen, Denmark; Dr. L. H. Borgstrom, Universite Helsingfors, Finland, Russia; A. H. Brooks, Geological Survey, Washington, D.C., U.S.A.; R. W. Brock, Director Geological Survey, Ottawa, Canada; C. Camsell, Geological Survey, Ottawa, Canada; Cosmo T. Cartwright, Mines Branch, Department of Mines, Ottawa, Canada; J. Charbonnier, manager West Canadian Collieries, Ltd., Blairmore, Alberta, Canada; Dr. C. H. Clapp, Geological Survey, Ottawa, Canada; Hon. Louis Coderre, Minister of Mines, Ottawa, and Secretary of State; Mrs. Coderre; Lorent Edward Theodor Dahlblom, Bergmastare in Gefle-Dala District, Falun, Sweden; William J. Dick, Commissioner of Conservation, Ottawa, Canada; D. B. Dowling, Geological Survey, Ottawa, Canada; Rev. Pierre Dupaigne, Licencie-es-Sciences, Professeur des Sciences Physique et naturelles au Seminaire de Philosophie, Montreal, Canada; George Loudon Dunn, Annahill, Kilmarnock, Scotland; Dr. B. E. Fernow, Dean of Faculty of Forestry, University of Toronto, Toronto, Canada; Mrs. Fernow; O. S. Finnie, Department of the Interior, Ottawa, Canada; H. Frechette, Mines Branch, Department of Mines, Ottawa, Canada; H. E. T. Haultain, Prof. of Mining Engineering, University of Toronto, Toronto, Canada; Mrs. Haultain; Samuel McLare Gardner, Mount Vernon Colliery Co., Ltd., Glasgow, Scotland; Prof. J. C. Gwillim, School of Mining, Kingston, Canada; Prof. Dr. B. Gurich, Hamburg, Germany; Bernard Hobson, F.G.S., Sheffield, England; Dr. Thos. Cramer Hopkins, U.S.A.; R. E. Hore, Editor Canadian Mining Journal, Toronto; Dr. F. R. van Horne, Case School of Applied Science, Cleveland, Ohio, U.S.A.; Dr. J. P. Howley, Director Geological Survey of Newfoundland, St. John's, Newfoundland; Mark Hurll, Glasgow, Scotland; John McGlashan Redholmn Hurll, M.E., Glasgow, Scotland; M. Inouye, Director Geological Survey of Japan, Tokio, Japan; Hy. Goodson Ives, Andover, New Hampshire, U.S.A.; J. T. B. Ives, F.G.S., Andover, New Hampshire, U.S.A.; Gerald Jarvis, Arnprior, Ontario, Canada; Chutaro Kido, Superintendent of the Geological Institute of the South Manchuria Railway Company, Dairen, Kantoshu, Manchuria; G. Kennedy, Toronto, Canada; Paul Kukuk, Bergassessor a. D., Bochum i.W., Germany; Leon Jean Benjamin de Lamothe, General de Division, Inspector de Etudes techniques de l'Artillerie, 1 Place St. Thomas d'Aquin, Paris, France; H. M. Luttman-Johnson, H.M., F.R.G.S., Petworth, Sussex, England; C. Lebling; O. E. LeRoy, Geological Survey, Ottawa, Canada; E. Maier, Professeur titulaire en gelogie Universite de Santiago, Santiago, Chili; Dr. Siegfried G. Martius, Assistant am mineralogischpetgraphischen Institut der Universitat Bonn, Bonn a Rh., Germany; J. G. McMillan, 225 Geoffrey St., Toronto, Canada; J. McEvoy, Mining Engineer and Geologist, Toronto, Canada; Mrs .McEvoy; Jean Morel, Ingenieur civil des Mines, Boitsfort pres Bruxelles, Belgium; Donald Sutherland McIntosh, Prof. of Geology, Dalhousie University, Halifax, Canada; Bedford McNeill, London, England; Mrs. McNeill; Dr. Edward Thomas Mellor, Geological Survey, South Africa; Benjamin Leroy Miller, Professor of Geology, Lehigh University, South Bethlehem, Penn., U.S.A.; Frederick B. Peck, Lafayette College, Easton, Penn., U.S.A.; Mrs. Peck; Sidney Powers, Inst. of Technology, Boston, U.S.A.; Dr. G. Saugrain, Geologue publiciste, Paris; S. J. Schofield, Geological Survey, Ottawa, Canada; J. T. Singewald, Jr., Associate in Economic Geology, Johns Hopkins University, Baltimore, Maryland, U.S.A.; C. Spruy, Anvers, Belgium; J. T. Stirling, Chief Inspector of Mines for Alberta, Edmonton, Canada; T. Surzycki, Petrokow, Pologne-russe, Russia; W. J. Sutton, Victoria, B.C.; F. T. Thwaites, Madison, Wisconsin, U.S.A.; Dr. P. F. Hubrecht, Batavia, Netherlands-India; J. H. Valiquette, Bureau of Mines, Quebec, Canada; Stephen Vivian, Inst. M. and M., London, England; H. B. Wallis, London, England; A. G. B. Wilbraham, London, England; Dr. A. W. G. Wilson, Mines Branch, Department of Mines, Ottawa, Canada; Prof. Dr. Th. F. Wilhelm Wolff, Kgl., Landesgeologe, Frohnau b. Berlin, Germany; R. B. Murray, London, England; J. B. Tyrrell, Toronto, Ontario; Dr. B. Weigand, Deutsche Geolg., Geselschaft, Elsoss, Germany; C. W. Wright, Ingurtosu, Sardinia, Italy; Mrs. Wright; Dr. R. Zuber, Professor of Geology, University of Lemberg, Austria. Twenty-one countries are represented by these men. The party has visited the gas producing district at Medicine Hat and the Crow's Nest Pass Coal district. Thence the party proceeded up Kootenay Lake and visited the copper deposits at Phoenix. The Granby Consolidated smelter at Grand Forks, the British Columbia Copper Co.'s smelter at Greenwood, the Trail smelter and Rossland gold and copper deposits. After visiting Vancouver and Victoria the party will visit the coal mines in the vicinity of Edmonton, Alberta, and travelling east on the new National Transcontinental Railway to Cochrane, will come south to Toronto on the T. and N. O. Railway. On Friday, Sept. 5, the party will visit the gold mines at Porcupine, and on Saturday the silver mines at Cobalt. Toronto will be reached on September 7.

SPECIAL CORRESPONDENCE

COBALT, SOUTH LORRAIN AND GOWGANDA

Owing to the barrenness of a portion of the Carson vein the dividend has been reduced from 5 per cent. a month to 2 per cent. The dividend has always been paid in the form a 2 per cent. regular and 3 per cent. bonus. This dividend of 5 per cent, or over $88,000, has been a strain on the Crown Reserve resources for some time, but the inevitable cut might have been postponed for some months, or perhaps a twelvemonth longer, if a certain part of the Carson vein which had been counted on to produce as high grade ore as the other sections of the vein had not suddenly shown barren. The values ran out of the vein about February, but development proceeded in the hope that they might be picked up again. The secret was extremely well kept. It is most probable that the news of the barrenness of a section of the vein did leak out from Cobalt to Toronto, but it was not sent to directors. Col. Carson accepted the inevitable, frankly explained the cause of the drop in the stock, and announced the cut in the dividend. The only criticism to be heard in camp is that the cut was not made at once when it was discovered to be inevitable. It would then have been possible to slacken the terrific rate of production and get down to a low grade basis with reduced costs.

The construction of the pipe lines from Kerr Lake to Giroux Lake is being rushed with all expedition, and pumping should commence about the first week in September. The scow has been almost completed, and the two centrifugal, 3,000 gallon pumps have arrived and can at any time be unloaded on the scow and placed in a position to work.

Development below the 200 foot level of the Crown Reserve has not produced much ore, and the resources of the mine are confined to its lateral development above the 200 foot level and the as yet unprospected territory under the waters of Kerr Lake.

The Nipissing mines for the month of July shipped ore of an estimated net value of $314.115. Some of this ore, however, is customs to the Nipissing's high grade mill. The company mined ore of an estimated net value of $224,216. During July the high grade mill treated 177 tons and shipped 531,099 ounces of silver. The low grade mill treated 7,268 tons, or almost 250 tons per day.

All the stopes at the third level of shaft 73 continued to produce a large amount of ore. The main vein has a greater height at the north end than was at first expected. The faulted extension of one of the branch veins at the third level was encountered and has a width of from two to four inches and assays three thousand ounces. Ore has been found at the fourth level for the first time. The fourth level has a depth of 330 feet, and was expected to be just below the Keewatin conglomerate contact. The north drift is in conglomerate at a distance of 195 feet from the winze. The vein in the face is two to three inches wide of 300 to 400 ounces. A raise just back of the drift shows higher values ten feet up.

The hydraulic is working on Little Silver Hill near vein 27. A vein from two to three inches wide was uncovered near vein 27 and running at right angles to it. The vein is decomposed and shows no solid material at the surface and assays 63 ounces from the mud. Some open cutting was done on vein 128. It is one inch wide, and while not uniformly high grade, there is some amount showing rich ore. The vein has a length of a hundred feet.

The Gifford mine is to be dewatered at once. A syndicate of Montreal and Toronto men, many of them connected with the Crown Reserve Mining Company, have been picking up Gifford stock on the market for some time. They have now 400,000 shares out of the 600,000 shares of a par value of 25 cents each. The Gifford is partly in Keewatin and partly in granite and adjoins the Beaver. Some time ago a shaft was sunk on contact to the 200 foot level and some drifting done, but nothing of importance discovered.

For the past two months the Cobalt Lake production has been at the rate of 25,000 ounces a week. June and July each showed an output of 100,000 ounces of silver. Alterations and additions to the mill allowed the company to go on this basis of production. Of this amount 80,000 ounces came from the mill concentrates, while 20,000 ounces is accounted for by high-grade ore sorted underground.

Speaking of the drainage of Cobalt Lake, it is hoped that the matter will be before the mining commissioner at his first sitting in September. The plans and specifications will first be presented to the Provincial Board of Health.

On the York Ontario mine a rich shoot of ore has been picked up on the intermediate level between the 70 ft. and the adit level. The vein is from three to four inches of silver in the calcite and holds good for 20 feet. Forty bags of high grade ore have already been taken out from the drift. Two cars of concentrates and high grade ore will be shipped from the mine the latter part of this month.

The Timiskaming and Hudson Bay Company paid its 49th dividend on August 19th. They now have the remarkable record of paying 23,500 per cent. on capitalization, or $1,823,835. The last dividend was for 300 per cent. as usual.

The Right of Way Mining Company has taken an option on the Flynn group of claims in Lebel Township. The properties number seven in all and lie due south of the Tough-Oakes.

Ground has been broken for the new Northern Customs mill on the site leased by them on the Nipissing property near 104, just north of the town. The four acre site has already been cleared of all underbrush and a gang of men has started on the excavations. The intention is to build a hundred stamp mill, though a battery of only eighty will at first be installed. The eighty stamps will give a capacity of 250 tons daily, and for the present will take care of all the contracts held by the company. The flow sheet will be almost identical with that used at the old mill. It is expected that the new mill will be in operation some time before the end of the year. It is a fact that three-fourths of the machinery can and will be manufactured in Northern Ontario at the Wabi Iron works.

The Chambers Ferland is now sinking a shaft to endeavour to pick up the extension of the Nipissing 64. It has now reached a depth of 40 feet. Crosscutting will commence at between 200 and 300 feet, as prospects appear expedient. The shaft is entirely in the conglomerate. This is an endeavour to open up a section of the Chambers Ferland never prospected before save on the surface.

PORCUPINE, SWASTIKA AND KIRKLAND LAKE

Financing of future operations of the McIntyre mine will be made by the issuing of bonds to the extent of $250,000. Of this $200,000 is to be offered to shareholders. The proceeds will be used to pay off the heavy debts of the company, extend the mill, and carry on development work.

At the Tough-Oakes property in Kirkland Lake the station has been cut at 200 feet. It is expected that drifts will be started on the main vein at this level in a very short time now, while the shaft will be carried down to the 300 foot level. The vein at 200 foot level shows from 14 to 16 inches of high grade ore, though it is split up into several stringers.

The Hollinger Gold mines report for July shows a gross profit of $129,146 for the four weeks ending July 15th. The profits for the current year to date amount to $851,667. The surplus after dividends have been paid amounts to $573,469. The average value of ore treated was $19.70 per ton, against $16.50 last month. Working costs per ton amounted to $6.209 as against $5.473 in June. Work upon the winze below the 300 foot level has been continued and the winze has now reached a depth of 113 feet. The vein dipped out of the winze at 94 feet. The winze will be carried to a depth of 125 feet, and the next level will be established at 425 feet.

The mill ran 87 per cent. of the possible running time, treating a total of 10,056 tons of an average value of $19.70 per ton. The approximate extraction was 96.5 per cent. Milling costs amounted to $1.648 per ton milled.

The Alexo nickel mine, near Iroquois Falls, shipped 22 cars of ore containing 1,588,500 pounds, during the month of July.

Good results are being obtained by the syndicate leasing the Rea mine at Porcupine. The ore taken from the dump and the stope at the 100 foot level and being fed to the five stamps is running well.

NOVA SCOTIA

Dominion Coal Outputs.—The coal output in July was the largest yet recorded from the Dominion mines, being 425,635 tons, compared with 409,125 tons in July, 1912, and with the highest previous output of 422,343 tons produced in October last. The individual collieries had outputs as under:

No.	Tons.
1	48,331
2	69,515
3	10,636
4	34,018
5	18,770
6	25,942
7	21,369
8	6,638
9	34,733
10	16,514
11	5,414
12	29,175
14	38,235
15	21,748
16	24,917
21	14,158
22	5,495
	425,635

The production from mines Nos. 14, 15, 16, 21 and 22 was the best yet obtained. The output from No. 7 Colliery has only once been exceeded, namely, in July, 1910. Satisfactory as the outputs were, they might have been much greater but for the decided shortage of men.

The total output for the seven months ending 31st July was 2,720,765 tons, compared with 2,533,283 tons for the same period last year, showing a gain of 187,482 tons.

The output of the Springhill mines in July was 31,409 tons, compared with 31,147 tons last July. For the seven months ending July the total output was 225,206 tons, against 244,241 tons last year, showing a slight drop in production, due, of course, to the mine fire last December.

The production for August from the Cape Breton mines will probably reach 405,000 tons, and will probably be less than the output in August, 1912, as in this year the month contains one working day less than last year.

BRITISH COLUMBIA

Aufeas Gold Mines, Ltd.

The West Yale Review reports that on the Aufeas property, on Wardle Creek, the vein has been entered at 385 feet from the portal of the lower tunnel and at a depth of about 450 feet. The ore is similar in character to that found at the outcrop, samples of which assayed from $23 to $30 in gold and also contained a high percentage of arsenic. There was 9 feet of ore and the hanging wall had not been reached. It is intended to construct an aerial tramway and ship ore to the smeltery at Tacoma, Puget Sound, Washington.

In this connection the following excerpt from a report by Mr. Chas. Camsell, published in the "Summary Report of the Geological Survey," for 1911, will be of interest: "A group of three mineral claims, known as the Jumbo group, is situated on the west side of Silver Creek, about four miles south-west of Hope. The claims lie in a steep narrow gorge at an elevation of about 1,000 feet above the sea. The country rock is massive grano-diorite, in places sheared and traversed by fissures. The ore deposits lie in the fissure veins and have a width averaging about eight inches. They contain dull coloured arseno-pyrite and a little chalcopyrite in a gangue of quartz, and gold is the principal valuable metal in them. The value of the ore in the fissure ranges from $10 to $60 to the ton. The claims are devoloped by three tunnels of varying length, and several open-cuts. These claims and adjoining locations are now owned by the Aufeas Gold Mines, Ltd., which has recently made successful arrangements for financing the development of the property. The company intends building a wagon road from the Interprovincial highway at the mouth of Wardle Creek to the camp, and proceeding with the construction of permanent camp buildings, including cook house, bunkhouses, storehouses for supplies and tools, the laying of pipes to supply the camps with water, and the clearing of the right-of-way for an aerial tramway. As soon as the road and camp shall be ready for use, work on the lower tunnel will be begun and will be continued until the vein shall be reached."

It would appear that development work has been carried out, as proposed, and that results are very much better than surface indications gave promise of, for the vein lately cut at depth was only about a foot in width at the surface, where it was uncovered for a length of more than 300 feet.

An Official Review.

The following information has been taken from a recently issued pamphlet, compiled by officials of the

Mines Branch of the Canada Department of Mines, under the direction of Mr. John McLeish, Chief of the Division of Mineral Resources and Statistics. The pamphlet has been prepared primarily for distribution at the International Exhibition at Ghent, Belgium. It was also intended to distribute copies of it at the International Geological Congress, held August 7-14 in Toronto. The excerpt here given relates only to British Columbia, which is shown as having an area of 355,835 square miles and a population in 1911 of 392,480. A statistical table gives quantities and value of individual mineral products for two years, 1911 and 1912, the total for the former having been placed at $21,299,305, and for the latter at $30,076,635. (In passing it may be mentioned that the Annual Report of the Minister of Mines for British Columbia shows a total value of $23,499,072 for 1911 and $32,440,800 for 1912.) After the table comes the general information, as follows:

"For many years British Columbia was the premier mining province of Canada, and was only displaced in so far as magnitude of output is concerned in 1907, when Ontario forged ahead. In a certain sense, this province is still of first importance, owing to the fact that mining is probably its most important industry. Physiographically the province embraces a series of mountain ranges beginning at the Rocky Mountain range, forming the eastern border, and extending to the Pacific coast.

"Coal and metalliferous ores, including gold, silver, copper, lead and zinc, together with clays, building stone and gypsum, constitute the chief mineral resources. Antimony, platinum, molybdenum and mercury are also found.

"With the exception of the placer gold mining of the Cariboo district, active productive mining operations are at present confined principally to the extreme southern portion of the province and to a district on Vancouver Island, and on the coast. The chief centres of activity are the Crow's Nest coal mines, the metalliferous mines of East and West Kootenay, of which Moyie, Ainsworth, Slocan, Sandon, Nelson, and Rossland are important centres, and the Boundary district, including Grand Forks, Phoenix, Greenwood and Hedley, Britannia Beach and Texada Island on the coast, and Nanaimo and Comox on Vancouver Island. The Portland Canal district has recently assumed considerable importance.

"Much prospecting and development is being undertaken at many points on or near the coast, while the construction of the Grand Trunk Pacific Railway will provide easy access to a number of districts in that portion of the interior which it traverses.

"Important smelting industries have been established at Trail, Grand Forks and Greenwood, in the southern interior, and at Ladysmith on the coast, the fuel for which is provided by the coal mines of Comox, the Crow's Nest, or of Alberta. A new copper smelting plant will be in operation at Anyox or Granby Bay in December, 1913.

"Mining locations are granted under the laws of the province to discoverers, for nominal fees, and absolute titles may be obtained by developing such properties. The mining laws include a 'Placer Mining Act,' 'Mineral Act,' 'Inspection of Metalliferous Mines Act,' 'Coal Mines Act,' 'Coal Mines Regulation Act,' etc., and full information respecting miners' certificates, the mining law and regulations, mining reports and maps, etc., may be obtained on application to the Provincial Mineralogist, Victoria, British Columbia."

Ore Receipts at Trail.

Ore receipts at the Consolidated Mining and Smelting Co.'s smelting works at Trail during four weeks ended July 31 were as under:

	Tons.
East Kootenay—	
St. Eugene	66
Sullivan	2,602
	2,668
Ainsworth—	
Bluebell	458
No. 1	400
Retallack & Co.	110
Silver Hoard	174
	1,142
Slocan—	
Lucky Jim	29
Meteor	24
Rambler-Cariboo	378
Richmond-Eureka	62
Ruth	36
Slocan Star	30
Standard	710
Van-Roi	35
	1,304
Nelson—	
Emerald	64
Queen	74
Silver King	131
Yankee Girl	371
	640
Rossland—	
Centre Star Group	11,824
Josie (Le Roi No. 2)	1.501
Le Roi	4,386
	17,711
Boundary—	
No. 7	236
Hazelton District—	
Silver Standard	286
Republic (U.S.A.)—	
Belcher	248
Ben Hur	658
Knob Hill	150
	1,056

Slocan Notes.

Diamond drilling is in progress in the Van-Roi mine, in the vicinity of Silverton. An office note sent out by the company's head office in London, England, was as follows: "The work in the deep levels, Nos. 7 and 9, having established the probability that these had been driven, not on the main vein, but on a southerly vein, a policy of diamond drilling is therefore being adopted as the most rapid, efficient and economic means of exploring the large block of main vein which presumably exists in the vicinity of these workings. During the carrying out of this policy it may be necessary to temporarily suspend milling operations." Work at the company's concentrating mill on Four-Mile Creek has consequently been suspended.

A map of the Slocan mining district has been prepared by Miss Ada I. McDougald, of New Denver, who took Messrs. Drewry and Twigg's map, used in the Report of the Zinc Commission in 1906, and drew it to twice the former size, making it 37 by 52 inches.

Instead of a number on each claim, the name has been used—a useful improvement. The map has been brought up-to-date by the inclusion of all Crown-granted mineral claims in the district, and adding to the detail in other ways. So much work has been involved that the young lady has found it necessary to make a charge of five dollars each for blue-prints of the map, concerning which enquiries have come from even as far south as New Mexico.

Granville Mining Co., Klondike, Yukon.

On August 2 The Mining Journal, London, included the following information relative to the Granville Mining Co., operating near Dawson, Yukon, in its "The Mining Market" comments:

"Granville Mining.—From a circular issued by the company, it appears that the assets have now taken the following form, the dollar holdings being converted at $4.85 as the equivalent of £1:

"Canadian Klondike Mining Company—	
Six per cent. convertible debentures	£ 339,381
Shares	448,455
Canadian Klondike Power Company—	
Six per cent. debentures	247,422
North-West Corporation shares	1,020,000
	£2,055,258

"The company has temporary loans outstanding amounting to about £50,000.

"The Canadian Klondike Mining Company has an authorized capital of $8,000,000 shares and $2,000,000 debentures.

"Of the shares the Granville Company holds 2,750,000 and J. W. Boyle 3,825,000, the remaining 2,000,000 being held in reserve for conversion of debentures. The debentures in issue, $1,646,000, are held by the Granville Company.

"The Canadian Klondike Company holds the whole of the company's interests on the Klondike watershed. Dredging began this season, and up to the present the output has been: Up to May 31, 5,189 oz.; June 1 to 28, 10,202 oz.; June 29 to July 26, 13,402 oz. gold. Mr. Boyle estimates the profits of the company for the current year at about $1,000,000.

"The North-West Corporation represents the holdings in the Indian River watershed. The nominal capital is £1,500,000, out of which the Granville Company holds £1,020,000, the North-West Syndicate £190,000, and £140,000 more was subscribed as working capital, leaving £150,000 in reserve. The plant is expected to come into operation next year.

"The Canadian Klondike Power Company has a share capital of $1,500,000, all of which is held by the Canadian Klondike Mining Company, and $1,500,000 six per cent. debentures, of which the Granville Company holds $1,200,000. The company owns and operates a water-power and electric generator station, which supplies power to the Canadian Klondike, the North-West Corporation, and also to the Yukon Gold and other customers. The Canadian Klondike Mining Company has guaranteed that the income of the Granville Mining Company from its holdings of shares and debentures of the Canadian Klondike Mining Company, and debentures of the Canadian Klondike Power Company shall up to February 20, 1928, not be less than $240,000 per annum. The capital of the Granville Mining Company is £1,500,000, of which £1,400,000 is issued. There are £900,000 six per cent. debentures in issue out of an authorized £1,000,000."

STATISTICS AND RETURNS

B. C. ORE SHIPMENTS.

Shipments for week ending August 18, and for year to that date, are:

	Week.	Year.
Slocan and Ainsworth.		
Standard, mld.	1,000	31,000
Van-Roi, mld.	700	18,007
Rambler-Cariboo, mld.	300	8,200
Bluebell, mld.	1,400	43,923
Standard	341	8,850
Silver Hoard	48	558
No. 1	12	1,953
Whitewater	38	236
Maestro	157	157
Noble Five	22	22
Other mines	.....	10,496
Total	4,018	123,392
Nelson.		
Queen, mld.	350	8,925
Mother Lode, mld.	500	12,000
Second Relief, mld.	150	4,300
Yankee Girl	171	3,248
Emerald	35	718
Silver King	238	500
Other mines	.....	20,768
Total	1,444	50,459
Lardeau.		
Ajax	44	254
Other mines	.....	56
Total	44	310
East Kootenay.		
Sullivan	386	22,599
St. Eugene	32	10,003
Total	418	23,602
Rossland.		
Le Roi No. 2, mld.	325	10,648
Inland Empire, mld.	275	2,925
Centre Star	2,914	91,790
Le Roi	432	35,658
Le Roi No. 2	391	13,616
Other mines	.....	199
Total	4,337	154,836

Consolidated Company's Receipts.

Trail, B. C.

Knob Hill	48	1,604
Ben Hur	233	8,118
Giant California	31	103
Bonanza	47	47
Standard	341	8,850
Silver Hoard	48	558
No. 1	12	1,953

Whitewater	28	226
Maestro	157	157
Noble Five	22	22
Centre Star	2,914	91,790
Le Roi	432	35,658
Le Roi No. 2	391	13,616
Sullivan	386	22,599
St. Eugene	32	10,003
Ajax	44	254
Yankee Girl	171	3,248
Emerald	35	718
Silver King	238	500
Other mines	.....	34,074
Total	5,620	225,098

SHARE MARKET.

(Courtesy of J. P. Bickell & Co.), Standard Bank Building, Toronto, Ont., Aug. 22.

New York Curb.

	Bid.	Ask.
British Copper	2.25	2.50
Braden Copper	6.87½	7.00
Giroux Copper	1.00	1.37½
Goldfield Cons.	1.62½	1.87½
Greene Can.	6.75	7.00
Chino Copper	39.25	40.00
Inspiration Copper	15.12½	15.25
Nevada Cons Copper	16.00	16.12½
Miami Copper	22.87½	23.00
Tonopah Mining	4.50	4.75
Tonopah Belmont	6.25	6.50
Tonopah Merger	.73	.74
Standard Oil of N. Y.	153.00	155.00
Standard Oil of N. J.	373.00	376.00
Standard Oil, old stock	1100.00	.....
Standard Oil Subs	725.00	.....

Sundry.

American Marconi	6.00	6.25
Canadian Marconi	2.50	2.75

Porcupine Stocks.

	Bid.	Ask.
Apex	.00½	.01
Dome Lake	.30	.32
Dome Ext.	.07	.07¼
Dome Mines	13.00	14.00
Foley O'Brien	.17	.20
Hollinger	14.75	15.25
Jupiter	.25	.26
McIntyre	1.50	2.00
Northern Exp.	.50	1.00
Pearl Lake	.28½	.29
Plenaurum	.75	.80
Porcupine Gold	.06	.07
Imperial	.01½	.02
Preston E. D.	.01½	.02
Rea Mines	.15	.30
Swastika	.04½	.05
West Dome	.10	.15

Cobalt Stocks.

	Bid.	Ask.
Bailey	.06	.06¼
Beaver	.28½	.29
Buffalo	2.20	2.40
Canadian	20	.23
Chambers Ferland	.17	.19
City of Cobalt	.45	.50
Cobalt Lake	.47	.53
Coniagas	7.00	7.20
Crown Reserve	1.50	1.51
Foster	.04	.06
Gifford	.04½	.05
Great Northern	.10½	.11
Hargraves	.02	.03½
Hudson Bay	67.00	70.00
Kerr Lake	3.35	3.50
La Rose	2.20	2.30
McKinley	1.73	1.75
Nipissing	8.90	9.00
Peterson Lake	.20½	.21
Right of Way	.03	.05
Rochester	.02½	.03
Silver Leaf	.02½	.04
Cochrane	.35	.50
Timiskaming	.25	.26
Trethewey	.27	.30
Wettlaufer	.11	.12
Seneca Superior	2.10	2.40
Lucky Cross	.15	.22

TORONTO MARKETS.

Aug. 25—(Quotations from Canada Metal Co., Toronto).
Spelter, 5½ cents per pound.
Lead, 5.75 cents per pound.
Tin, 44 cents per pound.
Antimony, 9½ cents per pound.
Copper, casting, 16¼ cents per pound.
Electrolytic, 15¾ cents per pound.
Ingot brass, 11 to 15 cents per pound.
Aug. 25—Pig Iron (Quotations from Drummond, McCall & Co., Toronto).
Summerlee No. 1, $26.00 (f.o.b. Toronto).
Summerlee No. 2, $25.00 (f.o.b. Toronto).
Midland No. 1, $19.20 (f.o.b. Toronto).
Midland No. 2, $19.00 (f.o.b. Toronto).
Aug. 25—(Quotations from Elias Rogers Co., Ltd., Toronto).
Coal, anthracite, $7.50 per ton.
Coal, bituminous, lump, $5.00 per ton.

GENERAL MARKETS.

Coke.

Aug. 22—Connellsville Coke (f.o.b. ovens).
Furnace coke, prompt, $2.50 per ton.
Foundry coke, prompt, $3.00 per ton.
Aug. 22—Tin, straits, 41.30 cents.
Copper, Prime Lake, 15.75 to 15.85 cents.
Electrolytic Copper, 15.60 to 15.70 cents.
Copper wire, 16.75 to 17.00 cents.
Lead, 4.75 to 4.85 cents.
Spelter, 5.87½ cents.
Sheet zinc (f.o.b. smelter), 7.75 cents.
Antimony, Cookson's, 8.37½ cents.
Aluminum, 22.50 to 23.00 cents.
Nickel, 40.00 to 45.00 cents.
Platinum, ordinary, $44.50 to $45.00 per ounce.
Platinum, hard, $50.00 to $51.00 per ounce.
Bismuth, $1.95 to $2.15 per pound.
Quicksilver, $39.00 per 75-lb. flask.

SILVER PRICES.

	New York cents.	London pence.
August 13	59⅛	27¼
" 14	59	27 3/16
" 15	59¼	27 5/16
" 16	59⅛	27¼
" 18	59⅛	27¼
" 19	59⅛	27¼
" 20	59¼	27 5/16
" 21	59¼	27 5/16
" 22	59¼	27 5/16