MINING AS A PROFESSION

INCLUDING FIRST STAGES OF METALLURGY

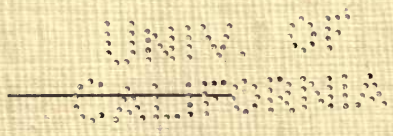
By HENNEN JENNINGS

AND

The Miner as a Pioneer of Civilization

By T. A. RICKARD

Being addresses delivered at the Semi-Centennial of the Columbia School of Mines in New York City, May 29, 1914



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MINING AS A PROFESSION, INCLUDING FIRST STAGES OF METALLURGY

By HENNEN JENNINGS

To consider man without the earliest primitive contributions of the miner and metallurgist takes us back to savagery. Man's greatest endowment is his wonderful and crafty brain cells with their latent powers of development, which have shown him the necessity of supplementing his own strength by outside aids, and then gradually and persistently obtaining the materials for his needs and fashioning them into tools of power, and finally incorporating and making them a veritable part of his being.

His first great advances were the commanding of fire, the use of stone implements, then wooden bow and arrow. By these he worked himself into the stone age, but was still brutal, weak, and with little historical recording power. It was not until he delved below the surface of the earth for materials that he was able to fashion the sword, spear, fire arms, protective armor, plow, hoe, pruning-hook, pitchfork, scythe, tires, axe, saw, plane, etc. It was only with metal tools that great agricultural development began, and it only reached its present magnitude when further supported by the metals in the form of railroads, steam vessels, harvesting machinery, etc.

Mining and agriculture are the only basic productive pursuits of man, and they are both fostered each by the other, and both dependent on mother earth. The one skims her surface, the other goes deeper. Agriculture furnishes man with food for existence, but mining gives him the materials for power, art, and civilization. Without metals the scientists' tools for experimentation and determination would not be possible, nor the great diffusion of knowledge and thought by means of the printing press, photographic appliances, telegraph, cable, and the telephone.

Nothing can more forcibly illustrate the might of man as given him by the metals than the modern battleship. What could all the war vessels of history, up to 20 years ago, do against one modern battleship adequately supplied with ammunition, if they were drawn up in open battle array? Could not this one ship, by its superior speed, gun power, and armor, annihilate at will the whole fleets of history, even if commanded by Vikings, Nelsons, and Farraguts? Is not the control of sea power the cardinal factor in war, and thus has not modern man become a war god indeed by means of his engineering genius?

In contrast to the bewildering might of the battleship's guns, with their 1400 lb. weight, and 2600 ft. per second velocity arguments, the metals have given man fingers so delicate, untiring, and accurate that

they can work and control threads so fine that fleecy muslins and laces grow in abundance under their touch.

Let us now deal with mining on a solid and broad statistical basis, attempting afterward to clothe the dry bones of statistics with further meaning.

In this brief sketch it is not possible to incorporate the statistics and results achieved in mining in all countries. What is selected, it is hoped, will be considered typical for all countries, and instructive to all interested in mining in a big way.

Great Britain produced more coal than all countries of the world put together until 1871, and more iron until 1885. The British Empire now produces 60% of the world's gold. It was only in 1899 that the United States surpassed Great Britain in coal output, and in 1897 took the decided lead in iron.

Germany's production of iron exceeded that of Great Britain in 1905, and it now mines about the same amount of coal. To Germany must be accorded priority in mining literature and technical training, as evidenced by the publication of 'Agricola De Re Metallica'[1] in 1556. The Freiberg and Berlin technical schools were founded in the 18th century.

The first English-speaking school of mines was that of the Royal School of Mines, London, founded in 1853. Although having but a small output of graduates per year, it has been distinguished for the scientific eminence of its professors and the loyalty and ability of its graduates.

The world's mineral production for 1912 shows that the United States produced 20% of the gold, 39% of the coal, 63% of the petroleum, 41% of the iron, 55% of the copper, and over 30% of the lead and zinc, which gives it an undisputed lead of any one country. The statistics of the United States are thus most representative, and, as the most available to the speaker, they will be extensively used. Difficulty of obtaining reliable, comprehensive mining statistics increases immensely as one goes back into the past, but, on the other hand, there is less and less to record.

It will be typical and instructive to examine the last official tabular statement of mineral products of the United States, as given by the Geological Survey for calendar years 1903 to 1912.

In the 32-year summary of the products, it is found that the production of the metals has increased from $186,000,000 to $867,000,000, or 475%; the non-metals from $173,000,000 to $1,376,000,000 or 775 per cent.

Analyzing the 10-year statement, it is found that there are 71 mineral products tabulated, all showing material yearly increases in production. Note especially the great and striking increase in the production of aluminum, mirroring, as it does, the successful metallurgical obtainment of a highly useful metal from abundantly distributed clay compounds. The increase in cement records the great growth of modern concrete construc-

[1]Translated from the Latin into English by Herbert Clark Hoover and Lou Hoover, 1912.

tion. The output of sulphur in various forms indicates the sulphuric acid consumption, and thus gauges the growth of the chemical and industrial arts. The phosphate rock showing points to the ever increasing helping hand mining is extending to agriculture.

Out of the total valuation of $2,244,000,000 for all the products from the United States, coal, petroleum, iron, copper, and gold were estimated at $1,579,000,000, or 70%. These metals are so representative and vital that a just and comprehensive idea of the growth of mining, metallurgy, and engineering can be obtained by following their production. This, in a broad way, can be best done by sketch diagrams, large units of products being plotted to small scale.

[2]Diagram No. 1 shows the yearly production for the world, all countries included, of coal, petroleum, iron, copper, and gold, from 1800 to 1912, and also gives the average London price back to 1873.

[2]Diagram No. 2 gives a similar showing of the same mineral products for the United States. The prices per unit for the products are estimated at pit's mouth and are extended farther into the past. It further shows the growth of the whole population of the country since 1800; the number of men engaged in mining since 1850; the increase in railway mileage since 1840; also the growth of deposits in all reporting banks in the United States since 1867.

From the world's diagram it can be calculated for period under review, that the last 15 years' production of coal has been equivalent to the 97 previous years. That the last 8 years' production of petroleum has been greater than all previous years in history. That the last 12 years' production of iron was equivalent to the 100 previous years. That the last 11 years' production of copper was equivalent to the 101 previous years. That the last 17 years' production of gold was equivalent to the 95 previous years.

In the same way the last years' production for the United States will be found to balance all the previous years. For coal, the last 11 years; petroleum, the last 8 years; iron, the last 11 years; copper, the last 9 years; and gold, the last 22 years.

The wonderful modernness of big mining can also be further realized by attempting to obtain any statistics of production previous to 1800, such attempts leading one to the belief that all the coal, iron, and copper mined in all ages, for the whole world, prior to this date would not amount to the probable world's production for the years 1913 and 1914. Petroleum practically came into use only in 1860. It is estimated that the total production of gold from 1493 to 1800 was $2,371,000,000, whereas from 1800 to 1912 it amounted to $12,411,000,000.

[2]Mr. E. W. Parker, of the United States Geological Survey, extended effective and kind aid in the obtainment of the data for the mineral production. The data for the bank deposit curve was taken from the National Monetary Commission Report. The growth of population, of miners, and of railways is as given by United States census returns. The discovery of gold in California and Australia caused the great jump of the gold curve 1850-1855.

It is seen that the selling prices of the mineral products at the London market and locality of output in the United States were higher in the early years than the later ones. Thus the present great increase in cost of living is not to be found in the unit advances of the products of the mineral kingdom. It is interesting to know that the cost per ton for coal at pit's mouth in the United States is less than the cost per ton at pit's mouth in Great Britain.

Fuels are most necessary for the metallurgy of the metals, and are storehouses of energy. In 1912 the United States' coal production was 534,000,000 tons, and petroleum 222,000,000 barrels. They both have great industrial value besides that of fuel, but our time will not permit of this consideration, or include natural gas in our estimates. To obtain some idea of the meaning of the force locked up in these enormous amounts of fuel, it is only necessary to calculate the work that would be given out if they were all (and which was largely the case) used for the production of steam-power, with at best not more than 15% of the latent power utilized.

Petroleum in the form of gasoline can be more efficiently used for power in the automobile and other forms of the gasoline engine, but reducing the 222,000,000 barrels to the coal equivalent of 51,000,000 tons, we would have the steam force of 585,000,000 tons of coal. Dividing this among 100,000,000 inhabitants would give 5.85 tons per capita. The equivalent of 5.85 tons in horse-power can be taken at 5850 horse-power hours or as much energy as would be given out at pumping by a man in 9850 days, or 27 years. This coal could thus give out force by the steam-engine equal to a population of 2,700,000,000[3] strong men.

The life of coal and petroleum deposits has been variously estimated. Should the increment of increase in yearly production continue, the known fields of petroleum would probably be exhausted within a comparatively few years, and coal in one or two centuries, but should the present population and per capita consumption not greatly increase, the coalfields might last one or two thousand years, and the petroleum possibly over a hundred.

Should fuel outputs continue progressively to increase, greater and greater numbers of the population must be employed in their mining; also a greater and greater percentage of people would be required to generate, control, distribute, and pay for the power manufactured. There must be, therefore, a point where the population becomes saturated with power and can use or pay for no more per capita. The less the workers, the less the number of hours they work, the less their efficiency, the sooner will this saturation be reached. This may still be a long way off, and may be greatly influenced by future invention, but approach is steadily being made toward it. It will be the determining factor for final outputs.

Under iron is included steel. The steel is often directly made from

[3]Kent estimates man's work pumping 10 hr. per day = 1,188,000 ft. lb. 2 lb. coal taken for hp. hour = 1,980,000 ft. lb.

iron ores and estimated as pig iron. This group includes tin, lead, zinc, quicksilver, aluminum, platinum, etc., but it is not feasible to deal with them all, and iron and copper in themselves are the mainstays and the most useful of the metals.

Metals in useful form can not be readily obtained from their ores without fuel. On the other hand, the fuels can not be chained to great service without the use of the metals—for example, in the form of steam-power. The metals can be made use of independently of the fuels in manufacturing power from falling water, rising tides, vigorous breezes, and possibly burning sun. They are essential, as has been explained, for all manner of necessary tools and implements. Of late copper, through dynamos and motors, has revolutionized the production and flexible use of power.

In considering the importance of the yearly production of those metals, it must be taken into consideration that they are not destroyed when once used as is the case in the fuel group. They are put into machinery and tools that may last for many years, and are again given new life by fire and fashioned into other tools and machinery whenever the economic conditions justify such regeneration.

On the other hand, the metals, including the precious, are far less abundantly distributed than the fuels, and their more speedy exhaustion is a matter far more imminent and serious. The utmost parts of the world have been searched for gold, silver, copper, platinum, tin, and nickel. Naturally the deposits of these metals that are in most striking evidence and abundance have already been found. In the future there will be less cream to skim, and a more thorough and costly exploration and prospecting resorted to. The exhaustion, even under the present basis of output, of the metals is not so very far afield, and their discovery, conservation, and right working becomes more and more a matter of importance and difficulty, and should be given serious consideration.

Under this group silver is usually included, but gold alone will be discussed. Gold has a limited use in the arts, also as an ornament, but its chief value is its concentrated and convenient standard of barter. Whether this started on a basis of caprice or custom, it is now firmly established on a labor basis of value.

Gold coins can be considered storage cells of human energy that give out a strong and genial current of trade confidence, circulating and binding trade, and bringing together industries of different peoples, in different lands, with different customs. The vitality and value of these cells is due to the labor elements poured into them—in other words, the human difficulty of their obtainment.

The history of gold mining is almost uncanny in that it has for ages shown success and failure so hand in hand that it has taken a full labor equivalent to obtain the gold unit.

In the greatest of all gold mines in history, those of the Transvaal, there are employed nearly 200,000 black and 26,000 white men to get out

a yearly return of $180,000,000, and this does not include the labor expended on the supplies and machinery shipped to the mines. It has been found that nearly three-fourths of the output, even of the successfully producing mines, has been required to meet the current working expenses.

The curves on the diagrams show that the other mineral productions have increased correspondingly with gold. Gold may be cheapened by future phenomenal discovery, but until then it rests on a firm foundation and supports vast structures of credit, which have grown in magnitude even more rapidly than the gold output, as is seen by the bank deposit curve on diagram No. 2. The deposits in 1867 were less than $1,000,000,000, and are now over $17,000,000,000.

It may seem a waste of human energy to pay so much in labor for the circulation of financial confidence, but confidence is necessary and vital, and easily disturbed. When nations can have sufficient confidence to do away with their costly war equipments of metal, they will probably also be able to do away with the gold metal standard. There does not, however, seem to be any immediate hope of their doing either, and the limitation of gold mining may be found rather in its increasing scarcity and difficulty of obtainment, as the present goldfields seem to have about attained their zenith.

[4]Diagram No. 3 shows the birth and growth in membership of the six main technical engineering societies of Great Britain, which, in 1912, totaled about 30,000.

[4]Diagram No. 4 shows the growth in membership of five of the technical societies of the United States, which, in 1912, totaled about 24,000.

The digrams show the sudden and sympathetic growth of membership of the societies compared to production of the minerals and is especially noticeable for the mechanical and electrical engineers when compared with the production of iron and copper.

The diversity of the mining and metallurgical societies can be accounted for by the different duties and responsibilities of the coal, iron, and metalliferous mining engineers, the latter being often called upon to do their work in distant lands far from professional aid or corporate guidance The splitting up of these societies in Great Britain makes the membership and production curves of the minerals less in parallel than is actually the case.

Upon diagram No. 4 the enrollment curve of students in all branches of engineering at Columbia is given, and again shows marked accord with the growth of mineral production. The Columbia School of Mines, the oldest and most renowned in the United States, is also a part of one of the largest and most important schools of applied science; although it is only one of the many in the United States. The Bureau of Education

[4]The curves of growth of Great Britain societies have been prepared by Mr. Edgar P. Rathbone. Those for the United States are as given by the American Society of Mechanical Engineers, January, 1914. The Columbia School of Mines curve has been prepared by Dean Goetze.

(Department of the Interior) in 1911 gave in round figures the total enrollment for the technical students in all schools, colleges, and universities of the United States, as follows:

Civil engineers	9,000
Electrical engineers	6,100
Mechanical engineers	7,000
Mining engineers	2,300

or a total of 24,000. Note how this is in tune with the membership of the engineering societies of the United States.

The number of technically trained men required by the mining industry has been most ably and interestingly dealt with by Professor Christy of the University of California in 1893, and President McNair of the Michigan College of Mines in 1905. They both show that although the number required was not then large in the aggregate, it was in ratio to the production and number of men engaged in mining.

Upon diagram No. 2, it will be noted that the growth of railway mileage is rather in parallelism with the growth of mineral products than that of the population of the United States. The relation of railroad transportation to mining is most marked and important, and was the subject of an able address given by Dr. Douglas to the graduating class of your School of Applied Science in 1906. He then showed that the production of iron and the building of railroads had kept step in the United States since 1840. He also showed by tabular statements that from 45 to 58% of the traffic movement of the United States was in connection with products of mines. Later statistics only confirm this statement, and would indicate an even higher proportion.

The object of the diagrams has been to place before you facts in general perspective, rather than accurate detail, and by using tracings so that the diagrams can be placed one above the other, the accord of all the growths shown can be better appreciated than by words. It is certainly interesting to see the great part that is being played by mineral products in the affairs of the world.

In a broad way, let us now try and read some of the meanings and lessons that the foregoing diagrams, statistics, and statements seem to give us. It would appear that mining and metallurgy, after dwelling in a lowland of drowsy accomplishment for centuries, then pioneered and stimulated by great gold discoveries, sprang into gigantic activity, and by leaps and bounds, all within the life of this School of Mines.

This has been brought about by the growth of knowledge through science, invention, and engineering, which first made clear the possibility, and finally the way, of the manufacture of power on a scale never dreamt of before, and thus giving man an almost Aladdin's power of summoning and enchaining a gigantic retinue of obedient impersonal servitors.

All branches of engineering have eagerly and ably contributed to this accomplishment, but they could never even have started without the miner.

Do not the force currents that have been generated from mining products, and controlled and set in circulation by engineering skill, supplement or supplant manual work and thus constitute the basic cause of the growth and might of modern wealth? Look at the indicator gauge of bank deposits, and thus bank circulation!

In contemplating this flow of force, are we not impressed with the analogy between the circulation of blood in our bodies, and the wealth currents in trade? Does not a sudden halt and stoppage mean paralysis or death in either case, for circulation is vital to trade as to life?

The arteries of commerce require veins for distribution and return as does the body. All parts of the body, even the brain, have limited absorbing power and must return the remainder to the moving blood currents, and thus the richest of men have but small individual wealth-absorbing power and must let the rest of the current go through them. They can be a great artery of flow, but not a terminal reservoir.

It is quite natural that bewilderment and unrest should follow the sudden might of this ever-growing flood of power summoned from the mineral kingdom—more time, more patience, and more industry are required to understand and govern it aright. Force uncontrolled or misunderstood is dangerous in proportion to its magnitude, but as it is harnessed and controlled by a serene and equitable understanding, so must it benefit and redound to the service and advancement of man.

To obtain the great production of minerals for the manufacture of force, and then its various useful transformations, has required not only the creation of huge and complex manufacturing tools, but also new great implements of finance, and thus the growth of the limited liability corporation and stock exchange has been in sympathy with the mineral production.

The precipitous curves in the diagrams all show that there must have been all manner and forms of human stimulus to have made the showings possible.

Over-eagerness to drink of the force fountains produced over-promotion and over-competition, which demanded in turn remorseless skimming of cream resources without any reckoning of the future, as is shown by the wasteful methods of mining and extravagant use of fuels, and the intensive, remorseless use of labor, both of hand and brain.

To obtain the effective dollar, for legitimate enterprise, by means of the stock exchange, many are circulated in demoralizing gambling.

The capriciousness of ore deposits is an acknowledged fact and problem in mining, and the wise balancing and weighing of probabilities and possibilities, so as to make good guesses, based on slender foundations, is the great and final accomplishment of the successful mining engineer.

Mining is not an unreasonably hazardous business if its capriciousness is recognized and if initial payments for unproved chances are not made too great, and expenditures for equipment are not undertaken upon insufficient foundations, and risks are averaged by spreading them.

Advantage has been taken by promoters and manipulators of the legiti-

mate uncertainties of mining, to excuse the wildest mining ventures and the exploitation of stock certificates, rather than ore deposits. This has handicapped legitimate mining by making it difficult to obtain promising initial prospects at sane prices for purposes of honest test. It also tends to belittle the good name of a basic industry upon which modern civilization rests.

The fallacy of the belief that mining can only thrive through the stock exchange is known to those who have been connected with big mining affairs and have seen that successful enterprises have been initiated and carried through dark days of slow development and depression, by people who have knowledge, courage, and money to back their convictions. The stock exchange shows its greatest activity when least needed, that is, in inflating success and exaggerating failure.

The transactions of the mining and other engineering societies, as well as the honest and high-class publications of the leading technical press, are giving such educational light that it is hoped and believed that mining exploitation by the stock exchange is very much on the wane.

To be fair to the stock exchange, it has often caused successful mines to be developed, which otherwise would not be worked at this time, but the profession with which I am dealing has not the stock exchange as its guiding star. It must nevertheless be acknowledged and understood that mining is not undertaken for making statistical showings, or for philanthropic purposes. Its fundamental idea is to make money for those who undertake it, and the success of the mining administrator or engineer is largely gauged by the return of profits he can show.

After the protection of the lives of his workmen, rightly the engineer's first duty is loyalty to the owners of the enterprise that employs him.

The owners, who put up only their own money, have a right to decide to what extent they make their business and engineering information public. But, when a limited liability corporation is formed, the case is entirely different, for this means the partnership becomes unlimited, and, as all partners have right to knowledge, the engineer's loyalty to his owners changes from the few to the many.

In writing reports for private owners, the engineer should protect himself and the public by placing before himself, and then on record, all facts obtainable in any way bearing on the problem, and then, and only then, write his conclusions, submitting the report to his principals upon condition that, if made public, it will be given in its entirety, or as edited by himself. The essence of engineering ethics is to obtain full truth, first for himself, then to give it in full to his employer. If this is done with industry and frankness, all the other ethical rules with which our engineering associations are struggling, will be but corollaries.

The secrets of mining should be more and more confined to those given by nature. Mining titles and laws should be established with more certainty, so the most generous and honest are not handicapped or preyed upon, by the most shady and dishonest.

The subject of the relationship and preparation of students for the mining industry has been a fruitful theme of papers in transactions, and addresses to colleges and universities, and it is not necessary for me to emphasize its importance.

The interlocking and parallelism of the educational needs of different branches of the engineering profession were clearly recognized and set forth by Professor Monroe ten years ago, who, at the same time, pointed out the necessity of a greater diversity of knowledge for the mining student than for any other branch of engineering. The decision of this University to demand from all applicants for engineering degrees a sound foundation of general culture before specializing, and equal to that preliminarily required in any other profession, is only in keeping with what I have endeavored to show to be the great responsibilities and powers, which have of late years been demanded of mining and other engineers.

It is obvious that in the early days of big mining the accomplishment and numbers of technically trained men did not equal or fit the demand, and that many forceful, talented, energetic men must have risen from the ranks to leadership. They were the first in the saddle, and, naturally, did not always see the full necessities of training, without which they themselves had succeeded. But assuming equal individual ability, the wastefulness of acquiring knowledge by only personal experience, and not by making use of the stored experience of others, must tell against the merely practically trained man.

The great self-made mining men of the past must be recognized and reverenced, both in the technical societies and schools, for they have been the pioneers and makers of history. Though in time a degree from an engineering school may, and should be, regarded as a first necessity, the demand for it should not be made retroactive.

The student of the future should only regard his degree as the trainer's certificate of efficiency and soundness, for a race and struggle, still ahead of him. Practice, as well as theory, is essential. The danger of only theory in formative years, even for the diligent student, is that the slowness of results and drudgery of practice become distasteful, and commercial success not so palatable or satisfying as to those who work their way up from the ranks.

Your school of summer practical training, giving students a preliminary contact with actual work, is excellent so far as it goes, and its success has been shown by how greatly it has been copied. It is to be hoped that even greater demand will be made by the schools for early practical experience, and to be rewarded by a post-graduate degree. Students who have worked for wages and have obtained approbation of employers, and have been thrown into intimate contact at the formative time of life with the ordinary wage earner, on equal terms, have obtained an experience most desirable and most necessary for the engineer.

In these days of impersonal corporation ownership, the closest and most intelligent link between capital and labor is that of the engineer. To be

of the greatest use he should know the life, ambitions, and viewpoints of each, and bring wisdom and sympathy to both sides, in the bitter and dangerous struggle that is now going on between those, so intimately bound and tied together, that the paralysis or death of one, means the same for the other. Such experience can only be advantageously obtained for the engineer, before he has assumed responsibility of leadership in dealing with labor.

It is the right labor viewpoint and basic principles of business economy that should be more and more given to mining and other engineering students.

Engineering training should not simply be limited to those certain to practice it—it should be used and looked upon as a gateway to leadership in all great business enterprises, for it is fundamental in its training, and teaches the necessity for accuracy, the search of truth, probing error, and the frank acknowledgment of limitations.

The gigantic forces set so recently in circulation by the miner and engineer must not only be better understood by the professional man, but also by all leaders of affairs. What is the use of a perfect engineering report, if but hazily and imperfectly understood by those who have to use it? As to general culture, do the old dumb-bell mental drills of the past, which might be well adapted for a different set of knowledge and economic conditions, hold good when the new economic conditions have revolutionized sciences, wealth, and opportunities of education?

Is the average attitude of the students in our great centres of learning, who so often place athletics and college social success above scholarship, indicative of the satisfying character of knowledge supplied?

Never before in the history of the world has there been more necessity for the clearness of vision and honesty of thought than now, when great overwhelming material force is flooding the world. False hopes, false ideals, false education, and revolutionary socialism, which only sees the wrongs and misery of the present, and the cure by annihilation of all good with evil, must be met by sane and strong training of future leaders, and from what schools can we hope to better obtain help than those of engineering?

In conclusion, it will be necessary to consider more closely mining as a profession, in which, of course, is included the early stages of metallurgy. The mining engineer must have some sound general knowledge of all other branches of engineering inasmuch as in the equipment and running of great mines and metallurgical plants he must make use of the training of engineers in almost all the other branches, and to obtain from them their best and hold their respect, it is necessary for him at least to appreciate the foundations of their specialties, intelligently to confer with them, and decide upon merits, rather than dicta.

In addition, he must have special knowledge and training in all pertaining to the discovery, working, and valuation of ore deposits. He must have also sound business experience and judgment to gauge the payability of new ventures, and this in turn requires that he should have had, in some

period of his career, a successful experience in management, requiring a knowledge of accounts and faculty of handling men. In distant lands he must have general information of many kinds, and linguistic attainment.

The legitimate uncertainties of mining throw peculiar temptations in his path, as these can be twisted to excuse failures of indolence and unfitness, and also be used as narcotics to conscience when temptation to dishonesty presents itself. His work is often far afield from the observance and guidance of owners or directors, and his work is not of a character that erects lasting monuments or stimulates either admiration or criticism. Thus character, industry, and tact are even greater requisites for true success than brilliancy of intellect.

Right character building, begun in such an institution as this, is the greatest benefit it can confer. This idea has been most fittingly expressed by one of its most beloved character builders, Professor Kemp, in University quarterly, December 1913.[5]

It must be a great satisfaction to this University and other kindred training schools for the engineer, to see how the great majority of the students have responded to their character builders, inasmuch as the records of this, and other high-class institutions, show that very very few of their graduates have succumbed to gross financial temptation.

Mining brings in touch engineers of different lands with different training, in such a way that general recognition and good fellowship are unstintingly extended (as the speaker must gratefully acknowledge) irrespective of nationality. Mining requires varied knowledge and gives scope for ability and character, and is a profession befitting the true gentleman as well as the adventurous strong man. It affords absorbing and interesting work, and, being basic and productive, extends opportunity for clean money prizes.

Each branch of engineering is based upon metallic foundations; each is dependent upon the other, and none could have reached its present magnitude without the others, but the miner gives to all the other branches the materials that knit them together, in common bond of usefulness making them effective in the art of "Directing the great sources of power in nature for the use and convenience of man."

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[5]"Many, as I have mentioned, follow courses of study in the natural sciences from interest in the subjects, but the student can not do so without reflex influence upon himself. He is, for example, obliged by the very nature of the pursuit to be accurate, precise, and orderly in thinking. False observations, careless records, or confusion of thought bring no results. Clearness and remorseless regard for truth must be all absorbing. There is and can be no attempt to make the worse appear the better reason; there is no complexity of motive; but simple and exact habits of mind must be cultivated. Results are to be reported to others and are certain to be checked in the future. There is, however, the constant pressure to have them right. An ideal is held before a man, which is not without its ethical response. While we can not say that is always manifested in the lives of scientific men, with all the force that we might wish, nor that every one of them is as truthful, direct, or accurate as he should be, yet, the influences of his pursuits are strong even if not altogether transforming."

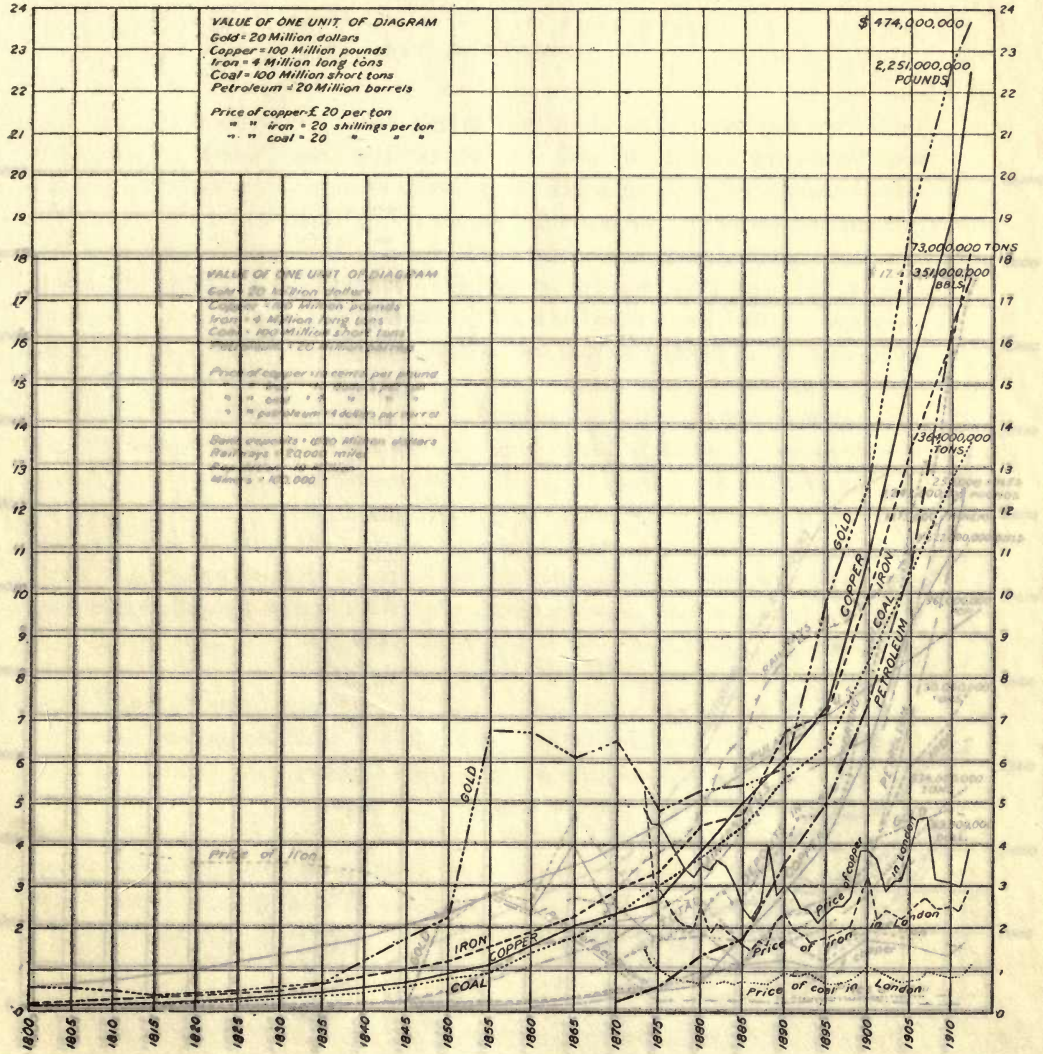

DIAGRAM NO. 1 — THE WORLD

DIAGRAM NO 4 – UNITED STATES

THE MINER AS A PIONEER OF CIVILIZATION

By T. A. RICKARD

It is a common saying that agriculture and mining are the two basic industries. When man rose above the brutish individualism of his primordial state and began to develop the social instinct, he turned to the soil, in order to win food for his family. He paused in his migration; the soil held him; it gave root to his rudimentary community; it gave him the chance to enlarge his energies. His tracks became highways; his rivers, avenues of trade; and as his traffic expanded, so his imagination widened, until, out of the crudities of communal development grew the complexities of civilization.

But the nomadic habit lingered; the spirit of the hunter survived in man; a wanderer and a wonderer he stood beneath the starry dome or the forest arch not knowing whether he were a guest or a captive in the domain of Nature. The hills beckoned; the seas called; the more venturesome left the tents of the tribe in search of material wherewith to fashion their implements. They sought iron for weapons, copper for tools, gold for ornament, and found them in various guise in the earth under their feet. They became miners. To those who delved successfully came power. Throughout the ages the more energetic and adventurous broke from the plough and forsook the cattle in order to explore and to exploit. They furnished the metals from which the artificers fashioned engines of power and machines of intelligence. They won the materials for a social structure that, based on stone and built in iron and copper, soared in many-storied tracery of steel to towers radiant with light and vibrant to the sky—towers so far above the common ground that man almost forgot his lowly origin and claimed kinship with the stars.

Civilization was developed on a metallic basis, not as regards money, for credit is the expression of an advanced state of society, but as regards implements and instruments, machinery and transport, facilities of living and of communication, all of which required the use of metals. The need of them and the consequent market for them induced enterprising men to probe the hills and scour the deserts in search of the mineral deposits that are distributed with such perplexing irregularity in the outer crust of the earth. These deposits were not to be found near the smiling cornfield or the gentle hillslope but in regions where geologic unrest had produced inequalities of contour and ruggedness of aspect, where the surface was bare of soil and the mountains exposed their heart of rock. The miner, therefore, left the sheltered valley and plunged into the outer wilderness. And in his wanderings, he found not only the metallic ore that was the

immediate object of his quest; he also discovered new tracts of agricultural land, and new dwelling places for his tribe. Returning home, he told the farmers and shepherds that fertile fields and lusher meadows were awaiting them across the range. They migrated thither, while he again adventured afar across the world, ever pioneering the advance.

This bare outline of a familiar story has already been punctuated by you with memories of the romance that has marked your own national expansion. The story of mineral exploration and racial migration is peculiarly the heritage of our people, the Anglo-Celts. It is the *motif* that runs through the drama of English and American history, more particularly during the last hundred years. Even in its barest outline it serves to suggest that the miner is the pioneer of industry and the herald of empire.

The first social organizations around the shores of the Mediterranean sent their prospectors to the hinterlands of Europe, Asia, and Africa. The gold of Ophir, the copper of Sinai, the silver of Laurium were part of the web and woof of those early civilizations. The mines of Iberia gave Hannibal the sinews of war against Rome, and the gold of Dacia strengthened the resources of Rome under Trajan. But the greatest adventure was that of the Phenicians who passed through the Pillars of Hercules into the western ocean in order to reach the far Cassiterides, the tin islands that in turn were to produce those Cornishmen to whom this earth is one big mine. After Carthage and Rome, in turn, had been overthrown, the mining industries of the known world were disorganized. Desultory operations persisted in Hungary, Spain, and Saxony, but the Middle Ages to the miner were as dark below ground as above. Even the discovery of America, which marked the beginning of a new world movement, was not connected with a real advance in mineral exploitation, although associated with the gaining of gold and silver. It is true, the wave of Spanish conquest broke over the American continent, penetrating the treasure-vaults of Mexico and Peru. But the Spaniard devastated, he did not develop. He gathered the harvest that the patient Indian had sown by the laborious toil of centuries. Cortez and Pizarro were filibusters, not explorers; they were pirates, not miners. The *conquistadores* were no pioneers of industry; behind them arose the smoke of ruin and the dust of destruction. Even the great sea-captains of Elizabeth were but the sequel to an epoch of spoliation. After them, and in their wake across the sea, came the men who from Cornwall and Devon, from Saxony and the Harz, brought the technique of mining to the new world, applying it peacefully to the mineral development of Mexico, Peru, and Chile, all along the regions previously ravaged by European freebooters.

But the great era of mineral exploration came with the discovery of gold in Australia and California. It was the prelude to a worldwide migration, an enormous expansion of trade, a tremendous advance in the arts of life, and the spread of industry to the waste places of the earth.

The color of energy began to tint the blank spaces on the map. The western half of the North American continent, all of Australia, the south-

ern half of Africa, the northern half of Asia, were invaded, penetrated, and explored by those in search of gold, or other metals, and as each successive mineral discovery was made by the miner he called upon his fellows to come and take a hand in the good work. He was the scout far ahead of an army of development. Trade follows the flag, it is true, but the flag follows the pick. Let us recall the story of that odyssey, and see for ourselves what human progress owes to its adventurous forerunners.

First we turn to the American argonauts, the men who sought the Golden Fleece in California. Even the dates in this story are fragrant with romance, for gold was discovered by James W. Marshall on January 24, 1848, and the treaty of Guadalupe Hidalgo, which ended the first Mexican war, was signed on February 2. In other words, California was ceded to the United States 9 days after the great discovery, which, at that time, was not known to either government, fortunately for both of them, and for many others. Marshall had built a saw-mill for John A. Sutter at Coloma on the south fork of the American river, only 35 miles northeast of Sacramento. When the mill was ready to start, Marshall saw that the tail-race, or ditch leading the water from the wheel, was not deep enough. He proceeded to deepen it by opening the floodgates to full capacity, so that th swift current would scour the bottom. The water was allowed to run all night. In the morning Marshall noted the effect, and while doing so he saw several yellow nuggets. He hammered one of them, and decided that it was metal; he bit it and found that it was soft; he boiled some of them in a kettle and proved them insoluble in water. Thereupon he went to Helvetia or Sutter's Fort, to tell his *patron* that he had found gold. Sutter tested the metal with nitric acid, some of which he found among his apothecary stores; he read the article on gold in his copy of the *Encyclopedia Americana;* he weighed the nuggets and compared them with coins; whereupon he also pronounced it gold.

That marked the beginning of the Golden Age in the foothills of the Sierra Nevada. Others found gold in near-by streams; the news traveled to the Atlantic seaboard, and thence to Europe. An excited migration began across the plains, over the Panama isthmus, around Cape Horn. The young, energetic, and adventurous hurried to the Eldorado that promised to fulfil the dreams of Raleigh's day. In 1851 California yielded $81,-294,700 in gold. It was no idle imagining, but an astounding fact. Nor does the output of precious metal measure the full consequence of the event. Cities were born, new avenues of commerce were created, the valleys of the Sacramento and the San Joaquin became the granaries of prosperous communities, the unknown territory in the middle of the continent was traversed and explored, the Great West leapt into vigorous life and became an integral part of the American domain. Moreover, among those enriched by the mines were men of initiative and imagination; like Balboa they stood on a peak in Darien; they saw the Pacific and the Atlantic as surely as he did, and to more purpose; they built a transcontinental railroad and tied California to the Union with links of steel.

You may say that most of these adventurers were not miners. I demur. What is a miner? He is the man who does the work of a miner, and that is, to extract ore from the ground. Most of the young and lusty men that rushed to California had never seen a mine, but that does not matter! They went to do the work of mining, and with the washing of the first panful of gold-bearing gravel they won the badge of Agricola. They had the machinery most used in mining; human muscle; they had the science most approved in that ancient art; organized common sense; they achieved the fundamental purpose of mining: to exploit mineral profitably. They came, they worked, they conquered; and from their labors has arisen a great and glorious commonwealth.

Among those that went to California was E. H. Hargraves, an Australian, who was led by the analogy of geologic conditions to suspect the occurrence of gold in his own country, New South Wales. Returning thither, he was able on April 3, 1851, to inform the Colonial Secretary that gold existed at Lewis Ponds and other localities. He furnished ample proof of his statement, and was suitably rewarded. Hargraves was a man of exceptional intelligence, and the discovery that he made was among the least fortuitous of those that have changed history. It led immediately to search for gold elsewhere in the Australian colonies, then consisting of a few small and scattered settlements along the southeastern coast. In August of the same year a discovery at Buninyong, near Ballarat, started the first big rush to the Victorian goldfields. Sailors left their ships at anchor in Port Philip bay; clerks jumped off their stools to rush to the diggings; every able-bodied man shouldered his blanket and trudged through the bush to engage in the treasure hunt. After all the local population had stampeded, the news reached Europe and incited another economic Hegira. The gold seekers came in ship-loads and they expected to find gold in pailfuls; indeed, many of them were simple enough to believe that gold in quartz meant gold in double pints. They had much to learn, and most of them learned it without delay from the severest of all teachers, *Der Herr Oberbergrat Professor* Experience. In the year 1853 Victoria yielded $54,882,000 in gold.

From the mining-camps eager explorers plunged into the bush, or eucalyptus forest, which, like a sea of perennial foliage, then covered the habitable portions of the Australian continent. Outside them they found the grassy uplands on which the Australian was to grow a later golden fleece, and beyond these pastoral tracts they invaded the never-never land in which the rivers lose their way. The alluvial mining for gold was the beginning of a new era, it led to the discoveries of tin in Tasmania, of golden ironstone at Mount Morgan, of silver-lead ore at Broken Hill; it started a widespread mineral industry on the island continent; with it came a rapid growth of population of a kind superior to that of the first settlements; agriculture waited on mining, the need for food-stuffs stimulated husbandry, towns arose as if by magic, hastily constructed camps became permanent communities, a new civilization swept the aborigines into

the interior, razed the primeval forest, furrowed the soil, cleaved the quarry, built docks, warehouses, and dwellings. Australia was born again. Captain Cook sailed along the coast and placed Australia on a naval chart; Hargraves placed her on the map of the world.

Among the more remarkable explorations of a later day I may instance Western Australia. The interior of that state is an arid plateau; it is the oldest land surface in the globe, and represents the basal wreck of a larger continent. It had been crossed by several parties of explorers, in the hope of finding some oasis in the desert or some outlet of the rivers that fail to reach the sea. In 1887 a discovery of gold was made by Anstey at Yilgarn. This attracted a few prospectors, who scattered farther inland. In October 1892 Bayley and Ford found a rich outcrop 500 miles from the coast, at Coolgardie. The outcrop was 50 feet long, 6 feet wide, and 5 feet high, spangled with coarse gold. In the March following they sold their claim for £6000, and a sixth interest. During the ensuing year the new owners extracted 25,872 oz. of gold from 48 tons of ore, which, therefore, averaged 539 oz. per ton. That started the 'boom'. 1892

Then was seen a strange spectacle. The sandy plain was covered with a monotonous scrub, sparse enough to be traversed easily, yet tall enough to restrict the view and render it easy for the careless to lose their bearings. Many were 'bushed', and perished miserably. Emerging from tracts of stunted forest, the gold-seeker found stretches of sand and spear-grass or else shallow depressions with clay bottoms from which the mirage lured him to unslakable thirst. Water was scarce, and uncertain at the best; a new peril faced the miner; early in the development of this region he learned to dig a hole to salt water and distill the brine in a rough apparatus. But a lack of the prime necessity of life was a grim factor in the search for gold.

With the whisper of each new discovery, crowds of reckless men plunged into the outer desolation. Eager horsemen jostled those on awkward camels, whose swinging gait carried them past the mob of diggers trudging wearily forward. The incident known as the Siberia rush is typical of those days. The name Siberia is a biting satire, for the temperature is that of Tophet. A man came into Coolgardie one night with a story that gold had been found at a spot 30 miles to the north. The rumor vibrated like wireless telegraphy through the tents and corrugated iron shanties. Quietly one arose and another followed. Scores started on horses or on camels; hundreds went on foot, carrying their 'billies' and blankets on their shoulders or trundling their packs in wheelbarrows. Some took the wrong direction, and of these many lost their way and died miserably in the bush. Four hundred reached the scene of discovery. The only water available was in a 'soak' or water-hole seven miles distant. It was soon drained dry by the thirsty diggers. News came to Coolgardie that a water famine was imminent. A government official promptly dispatched a dozen camels bearing water to the succor of the adventurers. In the meantime, most of them, aware of the danger impending, had started to reach the

nearest 'condenser' or distillation plant. Many died on the way, and many more would have perished save for the water brought by the camel-train. Nevertheless, in a few days there was another stampede in another direction. Thus the goldfield was explored. *Sic Etruria crevit.*

We go next to South Africa. The Phenicians sailed round it; the Portuguese landed on its shores; the Dutch founded sundry little settlements; but it was the finding of diamonds and gold that proved the 'open sesame' to the portals of the Dark Continent. Dutch hunters had roved northward from the Cape to the Vaal and the Orange; later Boers had trekked beyond both of these rivers; but none among them had imagined that diamonds were mingled with the pretty garnet, jasper, and agate pebbles bordering the stream. In 1867, in the hamlet of Hopetown, a child found a shining stone and played with it. The mother gave it to a Dutch neighbor, and he in turn asked an Irishman to ascertain what it was. But no one thought it worth anything until a local official noted that it scratched glass. Thereupon it was sent to a mineralogist, who did not hesitate to label it a diamond. But it led to nothing. No others like it were found immediately in the same locality. In March 1869—two years later—a Griqua shepherd found a magnificent diamond near the Orange river; it weighed 83½ carats, and was sold by him for 500 sheep, 10 oxen, and a horse. Subsequently, it brought £25,000, and became known as 'the Star of South Africa.' Indeed, it was the dawn of a new era. With that discovery began a great rush to the banks of the Vaal. At first from the neighboring parts of South Africa and then from every quarter of the globe there thronged a motley mob of fortune-hunters. The majority were men of British descent, but even the stolid Boers were attracted, every European nation was represented, and with them all shades of black and brown, from the undiluted negro to the mezzotint half-breed. To all of these the winding Vaal was as the valley of Sindbad the Sailor.

Meanwhile, bigger discoveries had been made on the farmlands of the Dutch squatters, for it had been proved that the distribution of the gems was not restricted to the alluvium of the river flats, but extended through the surface soil and calcareous cement into the yellow and blue ground constituting the matrix of the diamond. Of these mines, the Kimberley and De Beers were the most important, and on their development hinged events of historic significance.

Among those attracted to the diggings were two remarkable men: an Oxford student named Cecil John Rhodes and a young Hebrew from London called Barnett Isaacs, famous later as Barney Barnato. One became identified with the De Beers, and the other with the Kimberley mine. Both of them saw that consolidation was imperative if the diamond market was not to be glutted. They fought strenuously for control; and Rhodes, backed by Alfred Beit, won. On July 18, 1889, the deal was closed by a cheque for £5,338,650, which was the price of the Kimberley mine. Since then the De Beers Consolidated has distributed £30,000,000 in dividends, and redeemed debentures to the value of £4,822,705.

Kimberley became a distributing point for the adjacent mineral region. In 1884 the De Kaap goldfield was discovered, whereby the districts of Barberton and Pilgrim's Rest came into existence. In 1885 Laurenz Geldenhuis found gold in shale on the hills north of the farm Roodepoort. Later in the same year Arnold detected gold in conglomerate lying on the farm Langlaagte. Both of these finds were made on the Witwatersrand or White Waters range. In December, Harry Struben, who had learned something of mining at Kimberley and Pilgrim's Rest, erected a 5-stamp mill, and with that the exploitation of the Rand may be said to have commenced. On July 18, 1886, the goldfield was proclaimed. The sober veldt sprang into busy life, and the greatest gold-mining industry of the modern world came into being. In the next 25 years the Rand produced £309,872,000 worth of gold, the maximum annual output being in 1912, when it was £37,182,795 from 25,486,361 tons of ore.

Rhodes and his partners participated in that development, but the diamond discoveries had an even wider influence, for they provided capital and energy for the extension of industry into the very heart of Africa. This brings us to the story of Rhodesia.

It was the ambition of Rhodes, always backed generously by Beit, to paint the map red. He worked and schemed to found a new empire in the northern hinterland—a word of which Rhodes was particularly fond. At that time German and Portuguese colonial expansion seemed likely to absorb the vast interior made known by the explorations of Livingstone and Stanley. This threatened the future of that South African union which Rhodes had in mind. By obtaining a concession from Lobengula, chief of the Matabele, who dominated the weaker tribes, he got a foot-hold. With this, in 1888, he incorporated the British South Africa Company, under royal charter, and by the purchase of concessions obtained by other adventurers, he consolidated a great tract of grazing and mining territory under the British flag.

Two years after the Chartered Company was formed, a military expedition was sent by Rhodes to Mashonaland, the southern part of this new country, to cut a road through the bush for 430 miles, from Tuli to Salisbury, which was founded on September 12, 1890. The members of this expedition, having accomplished their task peaceably, disbanded and went to work as prospectors. They uncovered the mines of the Gatooma district. In this case the discovery was not made in the usual way by tracing the gold of the river-bed or the detrital quartz on the hillside to its source in a vein or lode. The prospectors were guided by ancient workings, made by a forgotten people, probably of Arabian origin. And though the first operations were not successful, owing to lack of transport and supplies, they laid the foundation of a prosperous business. The men who did this work were preëminently the pioneers of industry; they were actually enlisted as the Pioneer Corps; they were guided by a famous elephant hunter; they were commanded by a mining operator, now chairman of several London companies; the rank and file included a large number of men

familiar with mining at Kimberley and Johannesburg. Literally, they prepared the way for others, and started the mineral exploration that opened the interior of South Africa to orderly development and civilized habitation from the Cape of Good Hope to the sources of the Nile.

West Africa as a mining region is identified historically with the Gold Coast, a traditional source of wealth. Herodotus speaks of the Carthaginians as receiving gold from native tribes that traded with wild people on the west coast of Africa. During the medieval period Europe obtained most of its scanty imports of gold from this source. Successive traders made an effort to lay hands on the legendary treasure of the region. But they proved abortive. A malarial shore and a dense jungle blocked the passage of the white man. Nevertheless, during the earlier half of the 19th century the export of gold is estimated to have averaged £350,000, or $1,750,000 per annum, all of it the gleanings of native workers. Not until 1880 did real mining begin, on the initiative of an intrepid Frenchman, Marie Joseph Bonnat. An orphan, first a shoeblack and subsequently a *chef* in a Paris hotel, he met there two ivory-hunters to whom he offered his services for one year without pay. He was engaged, and went with them to West Africa. When they retired from business, two years later, they bequeathed their equipment to him. Thereupon he went into business on his own account. On one of his ivory-hunting journeys he was captured by the Ashantis and remained a prisoner in the king's kraal for three years, until released by Sir Garnet Wolseley, in 1874, on the occasion of the Coomassie campaign. While a captive he saw the king's treasures of gold and heard of the diggings on the Tarkwa range. When liberated, he obtained a concession from the king of Eastern Wassau, and returned to Paris, where, in 1877, a company called the Côte d'Or was organized by him to operate the mines now known as the Taquah and Abosso. Forthwith other traders obtained concessions and took them to London, where two or three companies were formed. But these early enterprises did not prosper. As was the case in Rhodesia at first, the lack of transport, the scarcity of supplies, and sickness among the pioneers crippled operations. Bonnat himself did not live to see the fruit of his labors; he died at Taquah in 1881. His was a gallant spirit worthy to rank among the best of the heroic forerunners of civilization.

As a sequel to gold mining in West Africa came the clearing of the bush, the training of the natives, the building of a railway, and the introduction of sanitary reforms. Then followed the finding of tin on the highlands east of the Niger, where now a thriving industry is established. This, in turn, has admitted light and air into the tropical jungle, facilitated the establishment of cocoa, rubber, and cotton culture, and brought a dark corner of the earth within touch of the vitalizing forces of industrial progress.

And now, for our last illustration, we go to Canada. The story of the Yukon is so recent as only to need recalling. That remote corner of the North American continent was slow to be unveiled. The mountains guard-

ing the coast discouraged the Russians who crossed the sea from Kamchatka; the main range barred the way of the English fur-traders and French *voyageurs* who came overland. In 1843 the Russian Zagoskin ascended the Yukon as far as the Tanana, and about the same time Robert Campbell, an agent of the Hudson's Bay Company, descended the river to its confluence with the Porcupine. But the only object of these intrusions into the inhospitable wilderness was the trade in furs. No whisper of gold was heard.

The first gold to come from the Yukon consisted of two nuggets obtained from an Indian in 1880. Small parties of prospectors began to test the creek-bottoms. Encouraging discoveries were made, but none of them was remarkable; moreover, the precarious food supply and the shortness of the season checked enthusiasm. In 1896 the annual output of gold was about $1,000,000, of which only $300,000 came from Canadian territory, for the more productive diggings were on the Alaskan, or American, side of the boundary, which is about 50 miles below Dawson, where the waters of the Klondike mingle with those of the Yukon. Up to that time this vast watershed was of no particular consequence as a mining region. Then suddenly, out of a clear sky, came the tremendous shout of a great gold discovery.

On July 14, 1897, the steamship *Excelsior* arrived at San Francisco bringing miners laden with sacks of gold. They told stories of a new Eldorado in the North, in the valley of the Klondike, on the edge of the Arctic. Again the world heard the bugle-call of adventure. The response was instant. During the following winter 33,000 people landed at Skagway on their way to the Klondike. An eager procession climbed the passes that led over the coast range to the headwaters of the Yukon, down which they voyaged in boats and rafts to Dawson. The horrors of that scramble are almost forgotten. Men, and women also, devoid of experience, physically unfit, laden with packs, toiled up the long ascent in a frenzy to lay hands on the gold. Before this mob reached the diggings the richest ground had been located by the miners and traders previously in the country. Yet some of the newcomers also fared well. The romance of the rush was not with the luckless wastrels, the greedy courtezans, or the drunken desperadoes, but with the quiet strong men who greatly endured and nobly overcame the trials of an unaccustomed life, and returned home to become leaders in a peaceful community.

In 1898, the Klondike yielded $10,000,000, and in 1901, $22,000,000. The total output so far has been $150,000,000.

The story of the discovery remains to be told. In the summer of 1896 Robert Henderson, a Nova Scotian, who had mined in Colorado, found gold across the divide from the Klondike. At this time George Carmack, a squaw man, being short of fresh meat, went up the valley of the Klondike in search of moose. Two Indians went with him. Turning up one of the tributary creeks, they worked their passage through the thick underbush and the thicker mosquitoes until fatigue necessitated a halt. While rest-

ing, the two Indians panned the gravel and found gold. Crossing the divide, Carmack and his Indian friends visited Henderson's camp, but they said nothing to him about their discovery, for he showed a dislike of Indians. Returning, they found more gold on the same creek, now famous as Bonanza. Thereupon, Carmack and each of the Indians located a claim. That was on August 17, 1896. Putting the gold they had panned into a cartridge-shell, they hastened down the Yukon to Fortymile, which was the nearest recording office.

This event opened a new province to human industry. Within a couple of years big steamers were ploughing the waters of the Yukon, a railway had been constructed over the coast range, the telegraph had linked the northern frontier with the nerve centres of the world, and new communities had arisen in the very heart of a vast solitude. It was not long before agriculture was started close to the Arctic circle and children played where lately moose and caribou had roamed at will. Once more, the miner had started the springs of life and called a new world into being.

Other examples of pioneer work might be instanced, did time permit. You will have noted that the lure of gold was the incentive to most of these explorations. The reason is obvious. Gold is a metal occurring in nature in a nearly pure state; in its alluvial form it is readily separable from the river gravel; and even from its matrix in the rock it is extracted by easy methods. Moreover, it commands a high price, and a free market, so that it can be transported in small bulk and sold in unlimited quantity. Gold mining, therefore, has been the prelude to the exploitation of the base metals existing in complex ores. The simple operations of the gold miner have preceded the establishment of economic conditions favorable to the more complicated business of winning the other metals.

The British empire and the American commonwealth alike have advanced in the track of the miner. He made the great West a part of your heritage; he conquered the Overseas Dominions more truly than the soldiers of the King. The curtains that hid Central Africa were parted momentarily by the slave-trader, the elephant hunter, and the missionary, but when these emerged those curtains closed again. It was left to the miner to place his candle so that like "a good deed in a naughty world" it might illumine a path for human industry. The primeval forests, the sunlit valleys, and the grassy plains of Australia remained as they were in the morning of time until the prospector called for his own people to come thither across the sea. The fur-trader traversed the snow-clad plains and penetrated the pine-clad mountains of the Canadian Northwest; the salmon-fisher sailed into the long estuaries; but neither of them touched the heart of that great lone land. Not until the pick of the miner awoke echoes that had slumbered since creation did the vast solitude respond to the pulsations of human endeavor. Hunters, traders, even soldiers and farmers, crossed the prairies from the Mississippi to the Rocky Mountains, and adventured over the desert to the Pacific Coast. They carried the flag, and they hoisted it over the new domain, but it was an empty conquest

and a vain annexation until the miner spoke the word that set the world aflame.

After the prospector has come the mining engineer. The scout has gone in advance of the captain of industry. Those of you who have crossed the range in winter know how the leader breaks the trail by leaving foot-prints into which his followers tread, step by step, greatly to the safety and ease of their travel. That is what the mineral explorer has done for the mining engineer. That is what the mining engineer has done for those behind him. Some of you have been prospectors as well as engineers.

"Have you known the Great White silence, not a snow-gemmed twig a-quiver?
"Have you broken trail on snowshoes; mushed your huskies up the river?
"Have you marked the map's void spaces,
"Felt the savage strength of brute in every thew?"

Again, I ask you to recall how you threaded the pathless forest on your way to examine a new mineral discovery. On the trees at intervals you have seen that the bark was chipped. The trail has been 'blazed' by the prospector, making it easy for you and others to follow. That is what the miner has done in a larger way for civilization. He has done it with geographical exuberance and equatorial amplitude. From "the stark and sullen solitudes that sentinel the Pole" to the "steaming stillness of the orchid-scented glade" in the Tropics, he has left his mark. You know that. No need for the prospector to complain to you, like Kipling's explorer:

"Well I know who'll take the credit; all the clever chaps that followed—
"Came a dozen men together—never knew my desert fears;
"Tracked me by the camps I'd quitted, used the water holes I'd hollowed.
"They'll go back and do the talking. They'll be called the Pioneers!"

No; not by the men of the Columbia School of Mines, who have shared the prospectors' camp-fire, his blankets, his flapjacks, his bacon and beans. You will give credit to whom it belongs. To the man with the faith of a child and the heart of a viking, to the man who has tramped and toiled until he heard "the mile-wide mutterings of unimagined rivers and beyond the nameless timber saw illimitable plains;" to the miner who has crossed the last range of all and lies in the only prospect-hole he could not dig; to the man who was the herald of empire and the pioneer of industry; to him who blazed the trail.