FACTS IN AMERICAN MINING.

By S. L. Bensusan, Esq.

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In this paper I propose to call attention to what has been done in America, in the way of improvements in methods and processes of mining—in the improved apparatus and appliances employed—to give data showing the great results achieved with material and by processes with which we are comparatively unacquainted—point out some of the conditions in which gold, silver, and other metals are found and worked—give sketches of some of the great works undertaken, and their results—and, generally, any other matter that may present itself worthy of note and believed to be not generally known. Whilst endeavouring to confine myself as much as possible to new matter, I doubt not that many will find in the paper material with which they were previously acquainted, a circumstance unavoidable in any case.

Some years since, the American Government appointed a Commission to investigate and report upon the condition of the mining industry in the Western States of America; to this report I am indebted for much of the material in this paper. The report of the Commission contains not only many facts of great scientific interest, but so many valuable inferences are deduced, and such a thorough acquaintance with the subject is displayed, that there is little left to be done beyond culling the matter of interest and presenting it in a useful form.

For convenience of reference the subject will be divided under the following heads, viz.: 1. Mode of occurrence. 2. Methods of mining. 3. Treatment of metals. 4. Statistics. In the present paper I shall deal only with gold and silver.

Mode of occurrence.

Gold, silver, and an alloy of these metals, occur in quartz reefs, frequently largely mixed with copper, lead, zinc, antimony, arsenic, iron, sulphur, &c.

Loose slate.—Near Sacramento and elsewhere large bodies of loose slate occur, containing pyrites. The material is soft, and eight tons per day are crushed with each stamper. The value of the yield is only 20s. to 25s. per ton, but such is the supposed value of such property that half-interest in the Sacramento mine was sold for £35,000.

Cement.—This material is crushed very coarse, passing through a mesh of 8 to 16 holes to the inch, and a light stamper will crush 4 to 6 tons a day.

Sea-sand, arising from the detritus of quartz reefs.—There are cases in which the working of this material have been profitable.

Ancient river beds—in some places a thousand feet deep. One of the largest of these occurs in the Sierra Nevada country, having a width of 100 to 300 yards, and a length of nearly 40 miles. The amount of gold taken from this bed has never been ascertained, but cannot be less than five millions sterling, and probably twice as much. The modern streams run at right angles with the ancient river bed. On the Tuolumne Table Mountain the basalt was found to cover an ancient river bed to a depth of 300 to 1,000 feet. After years of work the channel was reached, and ten feet square of washdirt yielded £20,000; a pint of gravel not unfrequently containing a pound of gold.*

The auriferous belt in California extends about 250 miles in length, with a width ranging from 25 to 50 miles. The veins in this belt are innumerable—but the proportion producing payable gold is very small; the average width of all the veins examined is about three feet, and the "country" rock either slate, granite, or greenstone, but the most prolific of these formations is still undetermined. The mines frequently possess barren zones, both in depth and longitudinal extension, but as frequently "make" again in paying ground.

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* Ancient river beds.—In this country we have an ancient river bed at Kiandra and the vicinity, on the main Dividing Range; the wash is 5 to 10 feet thick. The bed was originally a river-wash, but it has become in places partially cemented with oxide of iron. It consists partly of quartz, some of which is highly impregnated with copper. Single boulders of quartz have been met with producing nearly a hundred pounds worth of gold. The rest of the wash is made up of brecciated fragments of quartz, called by the miners "floating reef," also slate, diorite, albite, felspar, hornblende, augite, &c. The average yield has scarcely been ascertained as yet, and the bed of the ancient stream has not yet been reached. This river bed has been traced about 30 miles, and again comes out in the Snowy Plains, in Victoria, where the Government intend to bore for, and prove it. A body of four men owning what is known as the Scotchman's claim, at New Chum Hill, Kiandra, have driven into the hill a distance of 1,300 feet, and now find that the wash has dipped away beneath them; they have already been ten years at work here, occasionally tapping some part of the wash overhead. The total distance they have driven in all is about 2,300 feet, illustrating an extraordinary case of perseverance under difficulties and privations in a most severe climate. This run of partially cemented wash appears to have followed the main range, thus showing the great alteration of the surface since its deposition. It is considerably above the level of the surrounding country, and about 5,000 feet above the sea level. The bed rock of the country at New Chum Hill is a mica slate, and strongly stained with oxide of iron. Just above the deposit of wash is a bed of grey clay, about 12 feet in thickness; above that a 30-feet bed of lignite; above that a bed 6 feet of clay—over the clay various layers of waterworn gravels, capped by basalt, estimated to possess a thickness in some places of 500 feet. It is estimated that this basalt covers a larger auriferous area than all the known Gold Felds in New South Wales put together, though it is but little known at the present time. Starting from Snowy Plains, it comes out at Kiandra again on the Macquarie, through Mount Misery, on the Rocky River, still following the main range; lastly we hear of gold under basalt on the Palmer, still on the main range, while it is not improbable that it will be met with in New Guinea. Both the basalt and the wash on the main Dividing Range, as well as the gold itself, appear to be different in character from all other alluvial beds in the Colonies, and point to their deposition in an earlier epoch. Most of the gold is coarse, some being found in nuggets of one to two ounces, very little waterworn, and largely alloyed with silver, its value being only about £3 12s. 6d. per ounce. It is probable that many places will be found auriferous along this range where the conditions are similar to those above described.

The Eureka Mine, Amador County, furnishes some curious and interesting facts, in a measure subversive of certain recognised geological dogmas. It is commonly believed that the yield of gold must decrease in depth; but in this mine the value of the yield for the first thirty feet was only 30s. to 60s. per ton, barely sufficient to pay expenses. Below that level it rose from 56s. to 84s.; at 100 feet it yielded £5 12s., at 200 feet, £7 4s., and at 300 feet it attained a yield of £12 per ton. From this we may learn some important lessons. It shows that we must not apply scientific dogmas in all cases; that because the surface is poor, the mine must be unworthy of trial or necessarily poor in depth. This mine yielded in one year a profit of £75,000, and has attained a depth of 1,200 feet. It is a noticeable feature that it exists at the junction of slate and greenstone, the latter being hard and compact, and forming the hanging wall; while the footwall is composed of a soft argillaceous slate. To the junction of these two formations is ascribed much of the success of this mine, and the continuity of the gold in depth, while the soft character of the footwall has enabled the mining to be conducted at small cost. The opinion that quartz veins grow poorer in desending appears to be unsupported by sufficient evidence, but there are a number of circumstances calculated to lead the superficial observer to that conclusion; one of these is found in the fact that as the portion of the reef exposed to atmospheric influence gets weathered, it is necessarily accompanied by the degradation of some of the quartz, in most cases leaving the gold; the capping is therefore not a fair sample of the quartz in the immediate vicinity; then again, every reef varies in richness in different portions of its length and depth, and a prospector would be most likely to select from the richest portions showing on the surface. Moreover, the gold almost invariably exists in bunches, shoots, or chimneys, which cut the axis of the vein horizontally, or vertically, at all angles. Not unfrequently the gold will be on one or other of the walls for a

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On the West Coast of New Zealand, a cemented sea-sand of quite a different character is met with and worked for gold; it is conglomerated with iron, and such is its hardness that, though usually removed by the use of a gad, it has frequently to be blasted with powder. It is unmistakeably a sea deposit, being left bare by the receding sea, as the land has gradually risen. It is crushed in the ordinary way, and leaves large dividends, with a yield of only 1 dwt. per ton. The gold occurs in distant leads, parallel to the sea-coast; they vary from 20 to 50 feet in width; all the rest is barren, in the intervening space between these leads. Their direction is so true that the diggers follow them for miles by compass, frequently cutting their way through the bush for considerable distances, to pick up the precise point indicated by the needle, and seldom mark out a claim anywhere outside of the line. Far back from the water's edge there are a series of these leads, all preserving their parallelism for miles. The operation known as "haymaking" consists in collecting the sand thrown up by the spring tides, consisting largely of titaniferous iron, with loose gold visible to the eye, on walking over it. This is removed, and afterwards treated by running through a box. It is a remarkable fact that all the gold leads on the West Coast partake of the same character of parallelism, and are evidently deposited in the same way. It is, however, believed that the gold is originally carried down by the river running at the back of the range. To show the changes taking place in the level of the land, there may be seen on the West Coast of New Zealand, South of Hokitika, and nearly half a mile back from the sea, the remains of an old whaling vessel surrounded by thick scrub; some part of the hull is still in a good state of preservation, and where the mast once stood, now grows one of the monarchs of the forest.

certain distance, while all the rest of the reef is barren. Where several parallel reefs are found near each other, one may be rich in gold for a considerable distance while all the others are barren, and when the gold suddenly dies out it will not unfrequently be found to commence in a parallel reef, but at a spot at right angles with the point at which it has ceased in the previously producted reefs. This phenomenon has been observed at Hawkin's Hill in this Colony. In the same way that a chimney or shoot of gold will be found to pass diagonally along a reef, leaving barren or poor ground above and below, it not unfrequently happens that other and sometimes richer shoots of gold are met with at greater depth, having a certain parallelism to the first shoot.*

Though soft and easy ground are most favourable for mining exploration, it must not be supposed that payable mines only exist under such conditions. In the Grass Valley the best mines are found in a hard metamorphic slate, and the most productive have generally been the narrowest. The production of gold from this region has not been far short of five millions sterling; and in the best mines here the vein has rarely exceeded a foot to fourteen inches. The size of the vein and character of the rock must not therefore be looked upon as an infallible guide in the selection of a claim.

In regard to the peculiar distribution of gold, it is to be regretted that science has done so little as yet to guide us in its search; but the next best guidance we can have, when the light of science is wanting, appears to be in the accumulation of such facts as may warrant us in drawing some general deductions, in the information afforded by extensive experience, and in the wide publication of results obtained from such experience. In mining generally it may be admitted that much success is due to adventitious circumstances, but it is not the less true that we may derive much benefit from the experience of others, both in knowing where reasonable hope of success may attend the employment of capital, labour, and skill, and not less where the waste of energy and skill may be averted.

One illustration of the peculiar way in which gold occurs may be given by reference to the Sierra Buttes Mine, where the vein, which is enclosed in hard metamorphic slate, varies in width from 6 to 30 feet; the portion nearest the footwall only is productive, and its average width, about 12 feet, alone is removed; here at 750 feet the mine is as productive as at the surface.

The different minerals found in the Western States occupy particular zones and belts, which are for the most part well marked; most of them follow the general course of some mountain chain, or run in series of nearly parallel belts. The copper-bearing belt is principally in serpentine—other magnesian rock, or metamorphic

* The existence of gold on one side of the reef has been noticed in Gippsland, Victoria, and elsewhere. In New Zealand it is very marked, at Heape's Creek, Thames Gold Field.

slate. The gold-bearing belt, east of the copper belt, is characterised by quartz ledges traversing slates, limestones, sandstones, and granite. Crossing the crest of the Sierras we come into regions where the gold is alloyed with silver, and further east it is entirely replaced with silver, associated with copper, antimony, and arsenic —all the metals and minerals being pretty distinctly characterised in their distribution by the nature of the rocky strata and condition of metamorphism.

The age of the gold-bearing rocks in California has not been determined, but a considerable portion are distinctly carboniferous. In the coast mountains gold is found in close proximity to rocks of a tertiary age; and the fact of gold being occasionally found in cinnabar-bearing formations, leads to the belief that it is even as recent as the miocene (or middle tertiary), in opposition to existing views.

Professor Silliman records the examination of some mines in the neighbourhood of Fredericksburg, and states that the gold-bearing quartz usually exists in talcose and mica slate; that in the greater number of cases the eye discerns no gold, though sulphides of iron, zinc, and lead are often seen. In the Moss Mine, quartz which yielded gold to the value of £20 to £40 per ton showed no sign of gold, even with a magnifier, thus proving that we cannot judge of the gold-bearing capabilities of quartz by the sight. In the Walton Mine a more notable instance of this occurred—firm and compact quartz, interspersed with iron pyrites and dark iron ore, gave on first trial £16 per ton, second trial £32, third trial £80, fourth trial over £500 to the ton; but in the first three trials gold was *not* visible to the eye.

Professor Rogers ascertained that the talcose rock underlying a quartz vein was itself gold-bearing to a depth of 6 inches. What other rocks enclosing gold-bearing veins are also auriferous, and to what extent, we have still to learn. *

The distribution of metallic wealth in Western America occurs as follows, viz :–In Pacific Coast Range on west, occur quicksilver, tin, and chromic iron. In Sierra Nevada belt on west slope there are two zones; the foot hill chain, copper mines; a middle line of gold deposits east of this line; and the east base of Sierra Nevada, striking into Mexico, silver mines with but little base metal.

Through New Mexico, Arizona, Middle Nevada, and Idaho, another line of silver mines exists, with complicated association of base metals.

Through New Mexico, Utah and Western Montana, argentiferous galena lodes.

To the east again, the New Mexico, Colorada, Wyoming and Montana gold belt is exceedingly well defined.

* At the Caledonian Reef, in New Zealand, the footwall adjacent to the shoot of gold was itself found to be gold-bearing for a thickness of 15 feet, that portion of the enclosing rock having been crushed with profit.

The Comstock lode lies at the junction of syenite and propylite, occupying the contact plane, along the entire front of the Davidson Range; in places north and south it is entirely walled by propylite; this rock is a species of greenstone, being composed of oligoclase and hornblende.

Methods of Gold-mining.

Hydraulic mining is in great favour in California, but in New South Wales its existence is hardly known. Immense works are undertaken by the enterprising Americans for carrying on this method of mining on a large scale, and hundreds of thousands of pounds have been expended in bringing large bodies of water from distances of 30 or 40 miles for the purpose of washing away whole hills to get at the ancient river beds below containing the gold. In the Blue Gravel Company's claim a tunnel of 1,700 feet had to be cut to ascertain if the ground was payable, in some cases costing £20 per foot. After five years of hard labour the Company had spent £20,000 and were still without any certainty of finding gold.

They now use 500 inches (miners' measurement) of water, equal to a stream of 3 feet wide and 8 inches deep, running at high velocity. They consume over 60 tons of powder annually in loosening the ground, and 3 tons of quicksilver at a time to catch the gold. This Company pays £15 per day, or about £5,000 a year, for the water supplied to them.

To give some idea of the magnitude of the waterworks, I may here mention that the Eureka Company constructed 250 miles of race, at a cost of over £180,000. This Company's receipts for water used, at one time, to be a thousand pounds per day. In 1867 there were no less than 6,000 miles of canals or races in the Western States.

A very ingenious device for carrying water long distances and avoiding circuitous detours in hilly country has been adopted by the introduction of inverted syphons, for carrying water up the sides of hills, by the heavier pressure of a column brought down the opposite slope.

Sluices of great magnitude have been constructed for gold-washing, and in cases where the gold is fine they have been constructed over a mile long; and ground sluices where large bodies of washdirt had to be treated by rapid and inexpensive processes. Few persons unacquainted with this description of gold-mining have much idea of the small quantity of gold that may be made to pay in ground sluicing, with a good head of water. At a small claim on the Shoalhaven, in this country, a cubic yard of earth containing six pennyworth of gold pays wages, and leaves a profit for dividends; and in this particular claim I have washed out payable gold below the tail race, a mile from the spot it was washed from.

The gold-dredging machine has perhaps never been heard of except in California; but it is an actual fact that such a machine was constructed, and used on the Yuba River, the bottom of which was very rocky and rugged, and the machine proved a failure.

The arrastra is too well known to need any remark, except that material that would not yield gold to the value of £15 per ton could not be treated by this apparatus at a profit.

The tom, rocker, the sluice, and hydraulic mining have been made the subject of instructive comparative experiments as to their capabilities; and it has been shown, after careful investigation, that with the tom one man might wash 1 cubic yard of earth per day; with the rocker one man might wash 2 cubic yards of earth per day; with the sluice one man might wash 4 cubic yards of earth per day; with the sluice and hydraulic one man might wash 50 to 100 cubic yards of earth per day.

It is not unusual to use two tons of powder at a blast in some of the large hydraulic claims.

Flumes of great magnitude have been erected in different parts of the States—one to drain the Feather River, at Oroville, cost £35,000, and yielded a profit of £15,000 the first year, but subsequently proved an unprofitable undertaking.

The Frieberg German Barrel and Mexican yard, or Patio processes (which will require no description here) were the principal processes employed for the extraction of silver from its ores; but these are gradually being supplanted by the iron pan.

The Sutro Tunnel.—Among the most remarkable works of magnitude in mining being carried out in the State, one of the foremost is the Sutro tunnel. It is to extend a distance of three and three-fifths miles, and draw the Comstock lodes to a depth of 2,000 feet, and will cost, when completed, one million sterling. The Companies on this great lode have agreed to pay a certain sum on every ton of ore raised from the mines on completion of the work. On the 1st November 1874 the tunnel had been driven 7,792 feet. During three weeks in October the tunnel was driven 80 to 83 feet per week; the last week in October, 116 feet. The size of the tunnel is 10 × 14, and in one month 360 feet had been driven by the Burleigh drill, being the heaviest work of this kind on record. Comparing this work with some of our Australian mining, we will take, by way of example, the adit driven into the Belmore Mine, on the Great Western Company's property, near Icely. The size of their adit is 6 × 4½, and in eighteen months they have driven 480 feet. This gives 6·31 lineal, or 170 cubic feet per week, while the Sutro tunnel, 116 × 10 × 14, gives 16,040 cubic feet, or nearly ten times the work in a given time. In the Hoosac tunnel the average progress under the old system was 49 feet per month. The work performed with the drills was at the rate of 150 feet per month, at a greatly reduced cost, effecting a

saving in time of over five years. Great as is the magnitude of the Sutro tunnel undertaking, there are several others eclipsing it in extent and cost. In the Hartz Mountains a tunnel was constructed 14 miles long; and in Saxony a tunnel of 15 miles is in course of construction, to drain the Frieberg mines. This has already taken several years, and will require forty years more to complete.

A method of transporting timber to the saw-mills of the Carson River valley is sufficiently curious and ingenious to deserve mention. A V-shaped flume is constructed 5 miles in length; the material is 2-inch plank, depth 2 feet, fall 1 in 33, carrying a rapidly flowing stream of water. Heavy cordwood is thrown in, and transported the whole distance of 5 miles in eighteen minutes. At the end of the flume is an iron grating, having the reverse shape af the flume. The water escapes through this grating, and the wood by its own impetus shoots upwards, along the incline, and is delivered over the side.

Treatment of the Metals.

In nearly all the mills of the States some apparatus is used as an adjunct to the stamper battery—amalgamating pans, arrastra, Beath's grinder, centrifugal grinder, Ryerson's pulveriser, superheated steam apparatus, shaking tables, shaking pans, Chilian mills, cast-iron barrels, Ambler's concentrators, Varney's, Knox's, or Wheeler's pans, or two or more of the above.

On the adaptation of the treatment to suit the character of the rock depends the skill and success of the millman; in rock containing fine gold the reduction must be carried to a point according to its fineness, sometimes to an impalpable powder. I have already adverted to the fact of gold often occurring in large quantities in such a fine state of division as to be invisible (even with the aid of a magnifier). If the gold is coarse it is better not to use a fine screen, for reasons which will presently be shown. This is a subject deserving very careful attention. In this country, until lately, the quartz was nearly all stamped with uniform fineness, and at a fixed price per ton, instead of the price being regulated entirely by the fineness of the mesh. The stamping of quartz to the necessary fineness often absorbs double or treble the power and time occupied in ordinary crushing, the latter frequently leaving more gold in the tailings than is extracted. In the early days of California, it was not an uncommon thing to send to the mill ore worth £100 per ton, and to get from it only £14 to £16, the loss being accepted as inevitable. Whether the same sort of thing occurs here we can only say we are not sure about it, but it is certain that many large parcels of tailings in this country have been ascertained to contain more gold than the stone has yielded. From personal observation I can say that there is plenty

of quartz in this country containing ounces of gold, and only yielding pennyweights to the ordinary battery; and this same stone, if subjected to sufficient trituration, would yield up all, or nearly all, its treasure. The ingenious apparatus of Messrs. Lawson & Co. of Canterbury I look upon as eminently adapted for the treatment of some kinds of gold-bearing stone. But it is equally a mistake to use too fine a mesh for quartz containing only coarse gold, there being an unnecessary loss of power and time, without any corresponding gain. There is in fact no royal road by which the tyro may attain perfection of work,—every investigation points to the necessity of continuous and close watching, and the exercise of sound judgment, to meet changes as they occur, to foresee and avert loss, to detect it as soon as it occurs, and devise means of preventing its extension. In the stamper battery used in California there is very little to note; the stamps range in weight from 450 up to 1,500 lbs.; the fall is 8 to 14 inches; speed, 32 to 80 blows per minute; consumption of wood for every 10 tons of ore crushed, from less than one cord up to five cords; loss of mercury, never less than 7 lbs. for every 1,000 tons crushed, and sometimes as much as 100 lbs. for the same quantity; cost of extraction, 8s. to £6 6s. per ton; value of gold, 25s. to £20 per ton of ore crushed—taken from one year's average in each case; cost of stamping, from 2s. to 16s. per ton. In one mine the whole cost of treatment was covered by 2s. 6d. per ton. In the stamping of auriferous quartz it is not an unusual thing to reckon that two-thirds to three-fourths of the gold contents will be saved in the battery. The calculation is made on the total quantity saved, and certainly in the majority of cases no estimate is made of the gold lost in the tailings. The amalgamating copper plates in this country are often only 10 or 15 feet long, and frequently less; and some care is devoted to keeping them pretty clean, that they may work well. In California they are often 100 feet long, and are rarely cleaned, as they act much better when covered with gold. These plates catch gold more or less all the way; and although we have no actual means of proving what quantity of gold is lost after passing the short plates used in this country, we may reasonably conclude that some is lost which ought to be saved.*

The quantity of mercury used has to be regulated as nearly as possible by the quantity of gold it is expected to act upon; as a rule, 2½ to 3ozs. mercury should be used for every ounce of gold supposed to be in the stone, but the appearance of the amalgam is the best guide to an experienced eye. If too large a quantity used, amalgam will be lost; if not enough, it presents a rusty

* In New Zealand there are several reefs where the tailings are worked to a great profit, and many which without the reworking of the tailings would leave a loss instead of a profit. The tailings from one mine alone were sold for £20,000, and it is alleged that the purchasers profited largely by the transaction.

appearance, and gold is being lost without amalgamation. The tendency in this country appears to be to use too much mercury.*

Loss of Gold.

In the year 1867 it was computed that the general loss in the treatment of gold quartz averaged from 20 to 42 per cent. through the State, but the subsequent introduction of improved pans for the treatment of tailings is supposed to have reduced the actual loss in some cases as low as 5 per cent. on the fire assay, when no sulphurets are present.

Chlorination.—The Californians concentrate and roast their pyrites by the usual methods, and appear to look with great favour upon the process of chlorination as a method of extracting the fine gold therefrom. The Commissioners speak of its success with confidence, and in my opinion without sufficient reservation. There certainly are conditions under which the process can be used with great advantage, but I believe they are exceptional. Those under which it appears to be not applicable—and which appear not to have been noticed by the Commissioners—are well known to metallurgists, and are as follow :—

When the pyrites are imperfectly roasted.

When any silver is present, as it becomes chloridized, coats the gold, and prevents it being attacked.

When any antimony or arsenic are present, and antimony gets converted into chloride and precipitates the gold.

When, through careless or imperfect roasting, sulphates are formed; as when metallic iron is present, as in either of these cases the gold would be precipitated.

When lime or carbonate of lime is present, as they absorb the chlorine.

When the gas is imperfectly purified, and hydrochloric acid carried over, as it will react on some metals, producing sulphuretted hydrogen, which will precipitate the gold.

As a general rule the gold in pyrites is fine, but I have known large nuggets of gold enveloped in pyrites, and these would be liable to be lost unless the operation were protracted beyond the usual time allotted to the process. Some years since, Mr. H. A. Thompson condemned chlorination as a commercially practicable process, in the columns of the *Sydney Mail;* I then defended it, but subsequent closer study of the question has developed difficulties, affording me the gratification of recognising Mr. Thompson's superior acquaintance with the subject. Whatever may be the character of the pyrites in California or the skill of the millmen, I think that in New South Wales a very small per-

* It is a common practice in New South Wales to add every hour two spoonfuls or a tablespoonful of mercury, quite regardless of the condition of the amalgam.

centage of the men employed at reduction works would be competent to cope with the chemical complications which would be likely to bar their way to success in the employment of this process.

The yard, barrel, and pan processes for the extraction of gold and silver from their ores have repeatedly been made the subject of comparative experiment, and the following published result of some trials, in the Ophir Mine affords valuable and interesting information:—The yard process cost £6 per ton, and lost 20 per cent. of the metal; the barrel process cost £5 14s. per ton, and lost 15 to 20 per cent. of the metal; the pan process cost £3 per ton, and lost 35 to 40 per cent. of the metal. But this series of experiments did not reveal the whole truth; it was found that the loss by the barrel process was principally gold, and that by the pan principally silver, and the bullion from the pan was found to be worth just twice as much as that from the barrel process.

The Stetefeldt Furnace.—This is the only desulphurizing furnace which appears to claim notice in this paper. The one used at Reno, near Virginia, for desulphurizing and chloridizing the ore, consists of a shaft 20 feet high, by 3 or 4 feet square. At its base there are two fire-places, in opposite sides, with short flues leading into the stacks. The ore having been mixed with 3 to 6 per cent. of salt is crushed under stamps and passed through No. 40 screens. This finely pulverized ore is fed in a continuous stream by machinery from the top of the shaft. Just below the top of the shaft is a flue for the escape of the gases, leading into dust chambers, where any portion of the fine material carried up by the draught may deposit. The main shaft at the end of the dust chambers is 40 feet high. As the fine ore descends, mixed with salt, against the current of hot air ascending in the shaft, it becomes chloridized, giving off sulphurous and sulphuric acid; every atom of the ore being exposed to oxidizing and chloridizing influences. The furnace is said to perform its work with less cost for fuel, labour, and salt, than the ordinary reverberatory—one furnace treating 20 tons in a day, with the labour of eight men, which would require ten reverberatory furnaces and thirty-six men. The fuel used is two cords of wood a day, while the ten reverberatories would require five times the quantity, and the saving in salt is one-half. The bullion produced is larger and richer, and the cost of treatment only about 26s. per ton.

The loss on the Colorado ores has been pretty well ascertained: it is about 30 per cent. Of the quantity saved, 55 per cent. is obtained in the battery and appliances, and 15 per cent. by concentration and treatment of tailings.

Statistics.

The gold yield of California in 1853 exceeded eleven millions sterling. The gross yield from quartz mines is increasing slowly.

The capital invested in mines and mining is returning about 20 per cent. The average earnings per miner is at least 12s. per day on those mines which are opened. In some of the well known mines, the yield averages all the year round £4 per day for every hand employed.

In the mills of Virginia city alone they use no less than 923 pans of various makes, including the Knox, Wheeler, Hepburn, Varney, Wakelee, and Plain, and 400 settlers, agitators, grinders, barrels, tubs, and concentrators.

Fine gold—In the year 1860 the yield of gold was found to be in the Pine-tree district only 40 per cent. of the actual contents, owing to its being so fine as to be invisible to the naked eye. In the Mariposa district, for the same reason, the gold quartz which yields £10 to £12 10s. per ton used only to give 40s. to 60s. In the Pine-tree the whole cost of treatment only averages 24s. per ton.

Reduction works.—In the State of Nevada there are no less than 170; and their cost is put down at two millions sterling.*

Aqueducts.—One is now being constructed to convey the west branch of the Carson River 30 miles to the Empire City; another, known as the Humboldt Ditch, will be no less than 60 miles in length. Both of these are built to convey water to the mines.

Run of gold in quartz reefs.—Careful and systematic observation has demonstrated that they are rarely worked to a profit for more than 2 consecutive miles, and that pay rock rarely extends for more than 1,000 feet along a vein. A large mineral vein, however, is often traceable for 30 or 40 miles in a straight line, the rich portions being often far apart, and the intervals barren. This observation is the result of a very large experience, and no doubt applies to this as well as other countries; though I doubt if it has been made useful as a valuable item to the explorer to guide him in his researches.

The Comstock lode, believed to be the richest in the world, embraces an area of 3 miles in length and a third of a mile in width, equal to the area of a square mile. It produces annually two and a half millions sterling, while the loss on the ores represents not less than a third of the entire value; so that something like three-quarters of a million is allowed to go to waste every year. About 5,000 men are employed, and their average earning is equal to £500 per man per annum. The excavations in tunnels, shafts, &c., aggregate 67½ miles. The timber for mine use and firewood costs annually £200,000.

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*Clande informs us, after examination of some samples of Californian pyrites, that it contains gold, silver, copper, lead, cobalt, iron, arsenic, sulphur, and silica, in varying proportions. In three samples the gold has ranged from 8½ to 98½ ounces per ton, and the silver from 3 ozs. 18 dwts. to 11 ozs. 16 dwts. In the Grass Valley pyrites the bullion consists of 52 per cent. gold, and 48 per cent. silver—a proportion that would defy any attempt at extraction by chlorination.

Taxes on mining industry are very equitable in their character —half per cent. is paid on bullion; every miner earning over £200 a year pays £2 to the revenue.

In conclusion, the present paper has aimed at making known some of the facts connected with American mining, showing its progress in a remarkably short and recent period. The material possesses no claims to interest, beyond that connected with the information it may convey.

It appears from the researches of the United States Geological and Survey Departments that the locale of all the valuable minerals as at present known are well mapped out, while the geology in each case is indicated, and even the variations in the different classes of minerals indicated by changes in the lithological character of the ground. To the intelligent miner who avails himself of such information the value must be incalculable. The record and publication of all the improved processes introduced, as also the analysis and exposition of work performed, showing under what condition it has been attended with success, or otherwise, are no less so. Surely the adoption of a similar course—in any country possessing a sufficient population to justify the expenditure, and looking to its minerals as a source of national wealth—would be desirable. And in cases where the population is sparse, I can scarcely imagine any procedure more likely to attract immigration. Here we have no such advantages; and any prospection having for its object such discoveries must be made by private enterprise and at private expense, while there are no means of recording and mapping the results for general use. Very little Government aid and encouragement have stimulated the enterprising Americans as individuals to risk much and achieve more, and we may reasonably hope that the same results would be obtained in this country.

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